



MATHEMATISCH TECHNISCHE
SOFTWARE-ENTWICKLUNG GMBH

CNC Exercises for the FANUC programming key

MTS TeachWare

Teacher Version

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CNC Exercises

MTS TeachWare

© MTS Mathematisch Technische Software-Entwicklung GmbH

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NC program for CNC milling with control FANUC

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Milling: process layout, set-up form, programming sheet

Turning: process layout, set-up form, programming sheet

1 Introduction

To the Teacher

As a trainer, instructor or in similar position you are concerned with the company's or educational training and further education in CNC technique. This set of exercises is to support you with the CNC training and to facilitate your preparation. A flexible application of the book is intended. You are free to decide which approaches to choose for which exercise at what time and whether to apply it in frontal, group or individual teaching mode, just according to the particular training situation. Therefore, the exercises do not depend on each other in a firm sequence.

The solutions of this edition are adapted to the control FANUC extended for milling and for turning.

Copying of all documents from the exercise and solution volumes as class sets stating the originator and only for training services is permitted.

We hope that this set of exercises gives you new suggestions and facilitates your daily preparation work. We wish a wide range of application as well as enjoyable and successful work.

Your MTS Training Team

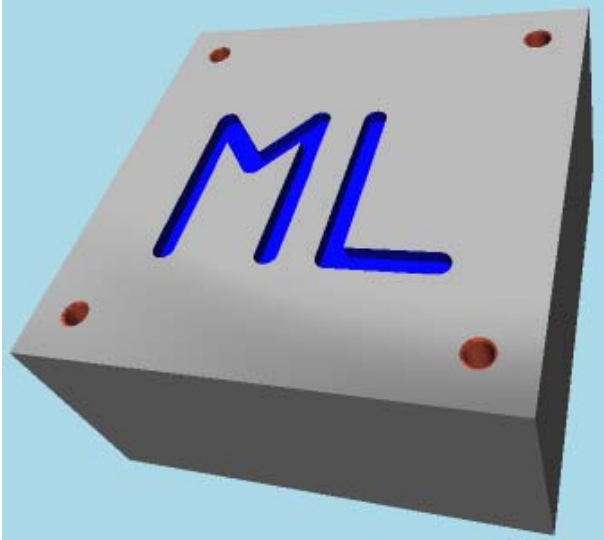
Berlin, 2005

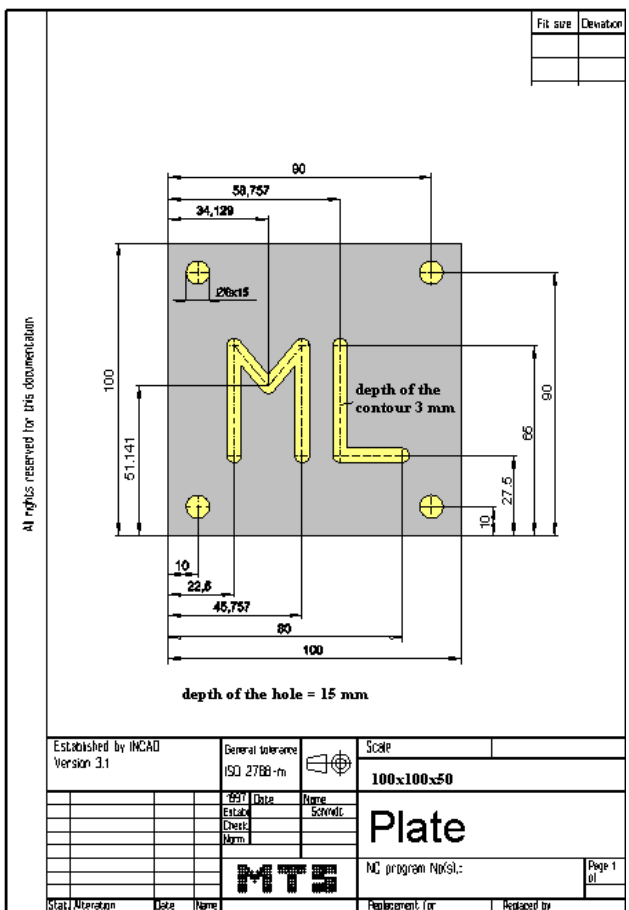
2 Exercises CNC Basics

2.1 NC program for CNC milling with control FANUC

2.1.1 Exercise: ML-plate

The plate of the drawing is to be manufactured as individual workpart on a CNC vertical milling machine. The blank is made of AlMg1 dimensioned 100 x 100 x 50 mm. Prepare the production on the MTS - Simulator. Define the workpart zero, plan the operation sequence, work out the process layout and the set-up form. Test and correct the program.



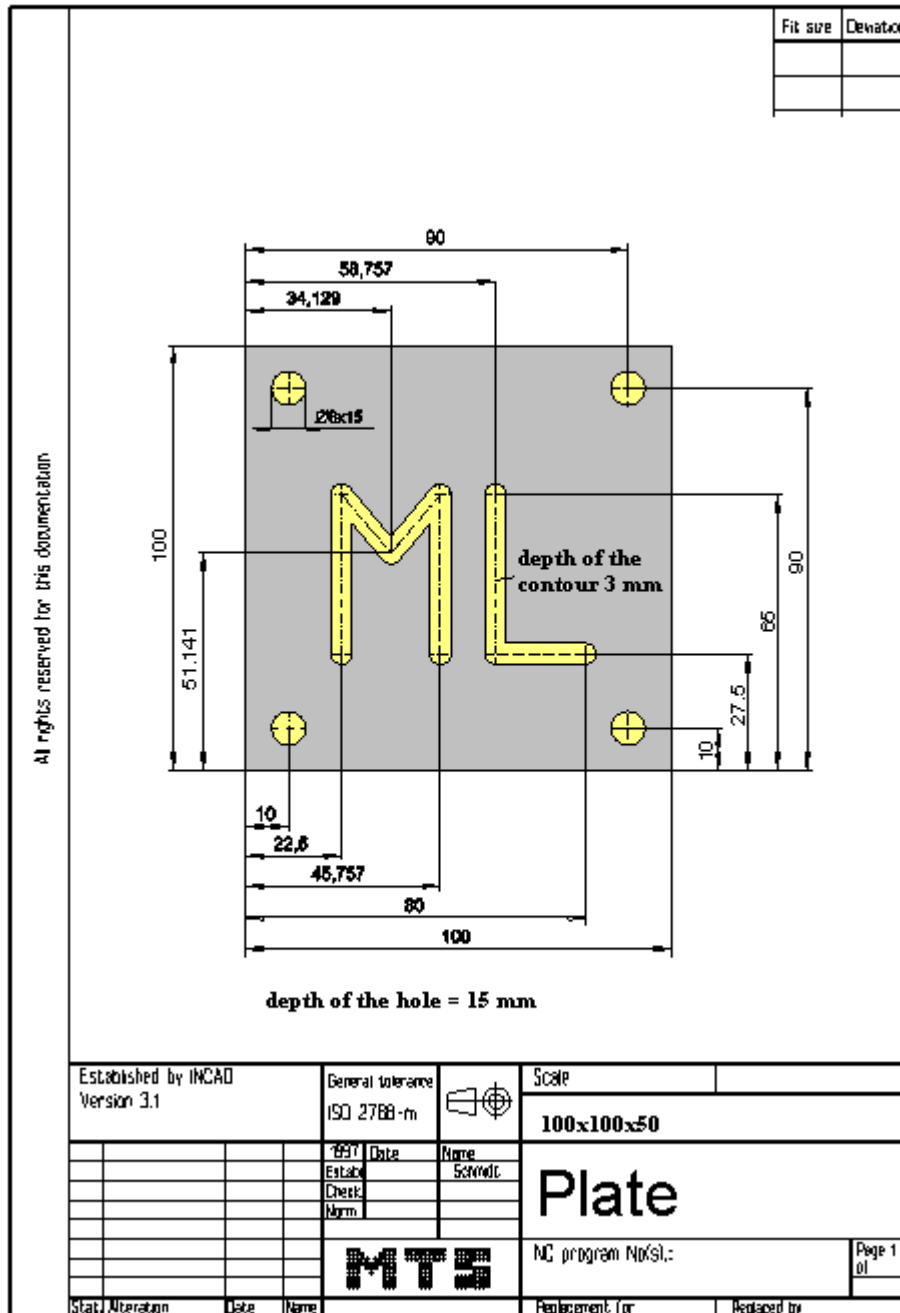


Learning Objective:

The learner is able to describe the structure of a simple NC milling program and to write parts of it on his own. He knows the essential steps of set-up, edit and automatic modes in the CNC Simulator for Milling and comprehends them in the proper sequence.

Special Training Elements:

Set up and machine a blank at the simulator; select and set up tools.



2.1.2 Possible Solution: Program ML-PLATE.FNC

```

()
(( 9.11.2005 14:52
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21i
(
( BLANK DIMENSIONS X+100.000 Y+100.000 Z+050.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+050.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SHELL END MILL\MW-040 032 HSS ISO 2586"
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-05.0 013K HSS ISO 1641"
( T03 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T04 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
( T05 "ISO SK 30\SLOT MILLING TOOL\MS-16.0 032K HSS ISO 1641"
( T06 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
(
( TOOL COMPENSATION
( D01 T01 R020.000 Z+115.500 N01
( D02 T02 R002.500 Z+072.000 N01
( D03 T03 R002.500 Z+097.900 N01
( D04 T04 R000.000 Z+065.000 N01
( D05 T05 R008.000 Z+107.000 N01
( D06 T06 R000.000 Z+065.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
()
$G54
%
O10
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T6 M6
N0024 S2800 M3
N0026 G0 G43 Z50. H6
N0028 G0 X10. Y10.
N0030 G0 Z2.
N0032 G1 Z-3. F40 M7
N0034 G0 Z2.
N0036 G0 X90.
N0038 G1 Z-3.
N0040 G0 Z2.
N0042 G0 Y90.
N0044 G1 Z-3.
N0046 G0 Z2.
N0048 G0 X10.
N0050 G1 Z-3.

```

NC program for CNC milling with control FANUC

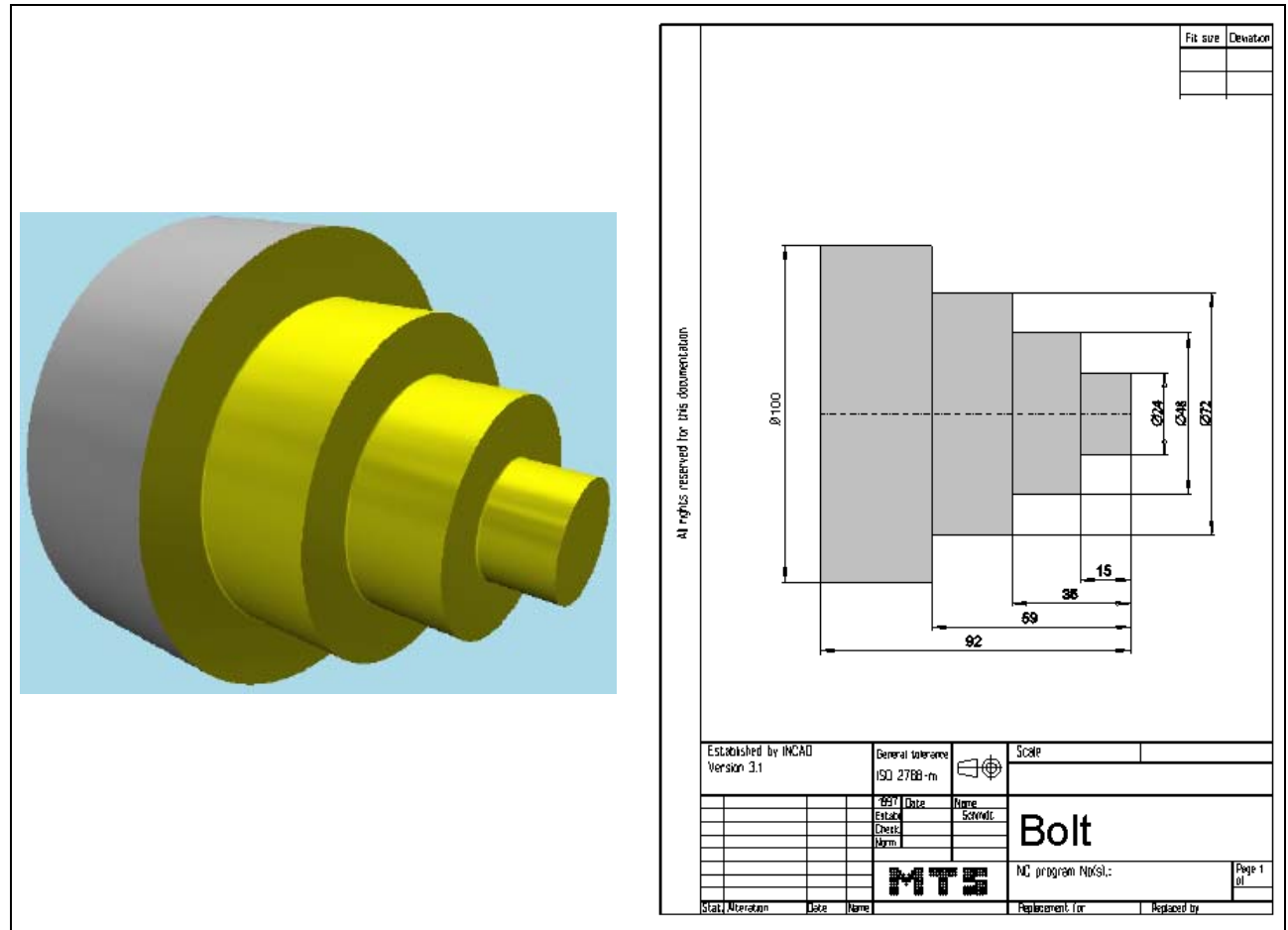
```
N0052 G0 Z2.  
N0054 G0 Z100.  
N0056 M5  
N0058 M9  
N0060 T3 M6  
N0062 S1800 M3  
N0064 G0 G43 Z50. H3  
N0066 G0 Y10.  
N0068 G0 Z2.  
N0070 G1 Z-15. F100 M7  
N0072 G0 Z2.  
N0074 G0 X90.  
N0076 G1 Z-15.  
N0078 G0 Z2.  
N0080 G0 Y90.  
N0082 G1 Z-15.  
N0084 G0 Z2.  
N0086 G0 X10.  
N0088 G1 Z-15.  
N0090 G0 Z2.  
N0092 G0 Z100.  
N0094 M5  
N0096 M9  
N0098 T2 M6  
N0100 S2000 M3  
N0102 G0 G43 Z50. H2  
N0104 G0 X22.5 Y27.5  
N0106 G0 Z2.  
N0108 G1 Z-3. F120 M7  
N0110 G1 Y65. F160  
N0112 G1 X34.129 Y51.141  
N0114 G1 X45.757 Y65.  
N0116 G1 Y27.5  
N0118 G0 Z2.  
N0120 G0 X80.  
N0122 G1 Z-3.  
N0124 G1 X58.757  
N0126 G1 Y65.  
N0128 G0 Z2.  
N0130 G0 Z100.  
N0132 M5  
N0134 M9  
N0136 G0 X150. Y150.  
N0138 M5  
N0140 M30  
%
```

3 NC program for CNC turning with control FANUC

3.1 Exercise: Bolt

The bolt on the drawing made of AlMg1 is to be made on a CNC lathe in higher batch quantity. Prepare the manufacturing process with the MTS CNC Simulator including following steps: define workpart zero, set up the processing sequence, determine tools, fixtures and technological data; generate, set up, test and correct the program at the CNC simulator. A bolt with an external diameter of \varnothing 100 mm and the length of 93 mm is to be clamped for the test.

Use a maximal cutting depth of 5mm for the separate cuts.



Learning Objective: The learner can accomplish simple steps at the MTS CNC Simulator such as to start CNC simulation software, select operation modes, referencing, set up tools, define tool zeros, set up blank and fixture, generate, test and correct simple NC programs.

Special Training Elements: Set up and machine a blank at the simulator; select and set up tools. Use simple canned cycle G90. G90 is a modal cycle. G80 or G0, G1 cancels G90.

	Fit size	Deviation	
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">All rights reserved for this documentation.</p>			
Established by INCAD Version 3.1	General tolerance ISO 2768-m	Scale	
	1997 Date Name Estab Schmidt	<h1>Bolt</h1>	
	Check Norm		
	MTS	NC program No(s):	
Stat. Iteration	Date	Name	Page 1 of 1
		Replacement for	Replaced by

3.1.1 Possible solution: Program BOLZEG1.DNC

```

()
(( 15.11.2005 07:03
(
( CONFIGURATION
( MACHINE MTS01 TM-016_-R1_-060x0646x0920
( CONTROL FANUC 21I CODE-A
(
( PART
( CYLINDER D100.000 L093.000
( MATERIAL "AlMg1::Aluminium"
( DENSITY 002.70
(
( MAIN SPINDLE WITH WORKPART
( CHUCK "Chuck Turn\Jaw chuck\KFD-HS 160"
( STEP JAW "Jaws\Step jaw\HM-110_130-02.001"
( TYPE OF CHUCK EXTERNAL CHUCK OUTSIDE STEP JAW
( CHUCKING DEPTH E18.000
(( Rechte Fläche des Werkstückes: Z+0217.000
(
(
( TAILSTOCK
( TAILSTOCK POSITION Z+1095.000
(
( CURRENT TOOL T01
( TOOLS
( T01 "DIN69880 V 30\LEFT CORNER TOOL\CL-SCLCL-2020 L 1208 ISO30"
( T02 "DIN69880 V 30\LEFT CORNER TOOL\CL-SVJCL-2020 L 1604 ISO30"
(
( TOOL COMPENSATION
( D01 T01 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E005.005 I-000.800 K-000.800 A+004.375
L011.855 N01
( D02 T02 Q3 R000.400 X+070.000 Z+0045.000 G000.000 E052.393 I-000.400 K-000.400 A+002.372
L016.178 N01
(
( WORKPART ZEROPOINTS
(( Rechte Fläche des Werkstückes: Z+0217.000
( G54 X+000.000 Z+0216.000
(
(
)
$G54
:3
N10 G40 G00
N20 G99
N30 M5
N40 M9
N50 ( set new zero point 'G54': X0. Z0. )
N60 T0101
N70 G50 S3500
N80 G96 S0240 M4
N90 G00 X102. Z0.1
N100 G01 X-2. F0.15 M7
N110 G00 X101. Z2.
N115 G90 X90.0 Z-58.8 F0.3
N120 X80.0
N125 X73.0
N126 G00 X73
N127 G90 X63 Z-34.8 F0.3
N128 X55.
N130 X49.
N140 G00 X49.
N150 G90 X39. Z-14.8 F0.3

```

Exercise: Bolt

N160 X31.
N170 X25.
N430 G00 X150. Z100.
N440 T0202
N450 G50 S4500
N460 G96 S0380 M4
N470 G00 X-1.6 Z2.
N480 G42 G01 Z0. F0.1
N490 G01 X24.
N500 G01 Z-15.
N510 G01 X48.
N520 G01 Z-35.
N530 G01 X72.
N540 G01 Z-59.
N550 G01 X102.
N560 G40
N570 G00 X150. Z100.
N580 M5
N590 M9
N600 M30

4 Exercises CNC Milling

Magazinbelegung - Bestückung

Datei Eintrag Ansicht Layout Grafik Hilfe

Schneidendurchmesser	D	10.000
Schneidenlänge	Lt	22.000
Ausspannlänge	LA	44.100
Schaftdurchmesser	Ds	10.000
Anzahl der Zähne	TN	4.000
Attribute		
M3/M4		M3
Korrekturwerte		
1: Zylinderschaft Fräsen\Bohrnutenfräser Schlichten\SMTF R-x1...		
1 -> 2 Zylinderschaft Fräsen		
2: Zylinderschaft Fräsen\Bohrnutenfräser Schlichten\SMTF R-x1...		
Schaftdurchmesser	Ds	10.000
Gesamtlänge	L	72.000
Schneidenlänge	Lt	22.000
Schneidendurchmesser	D	10.000
Werkzeuglängenoffset	LO	0.000
Anzahl der Zähne	TN	4.000
Radialer Versatz	RO	5.000

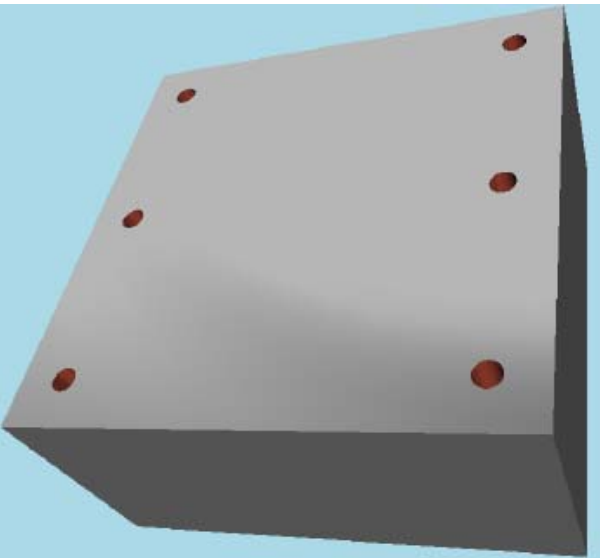
Bereit 3/24 NUM

4.1 NC programs using linear interpolation

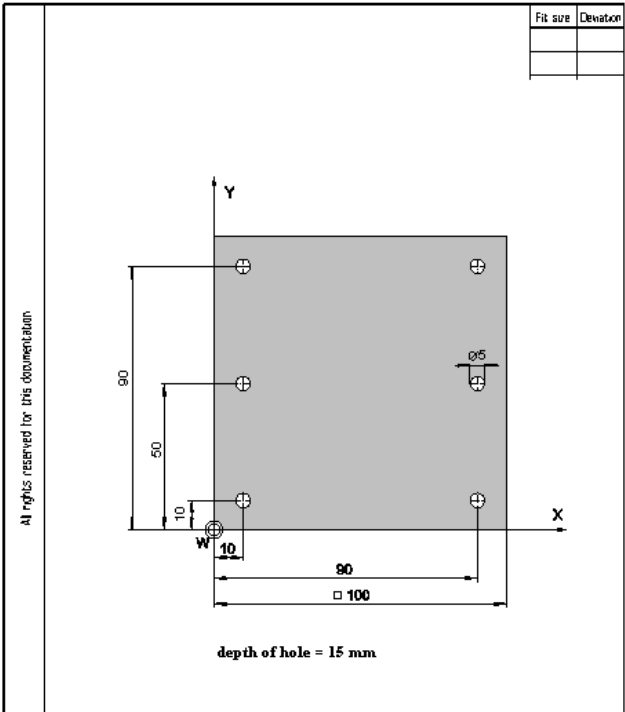
4.1.1 Exercise 1: Jig Plate 1

The jig plate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 100 x 100 x 50 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.

Use the commands G00 and G01.



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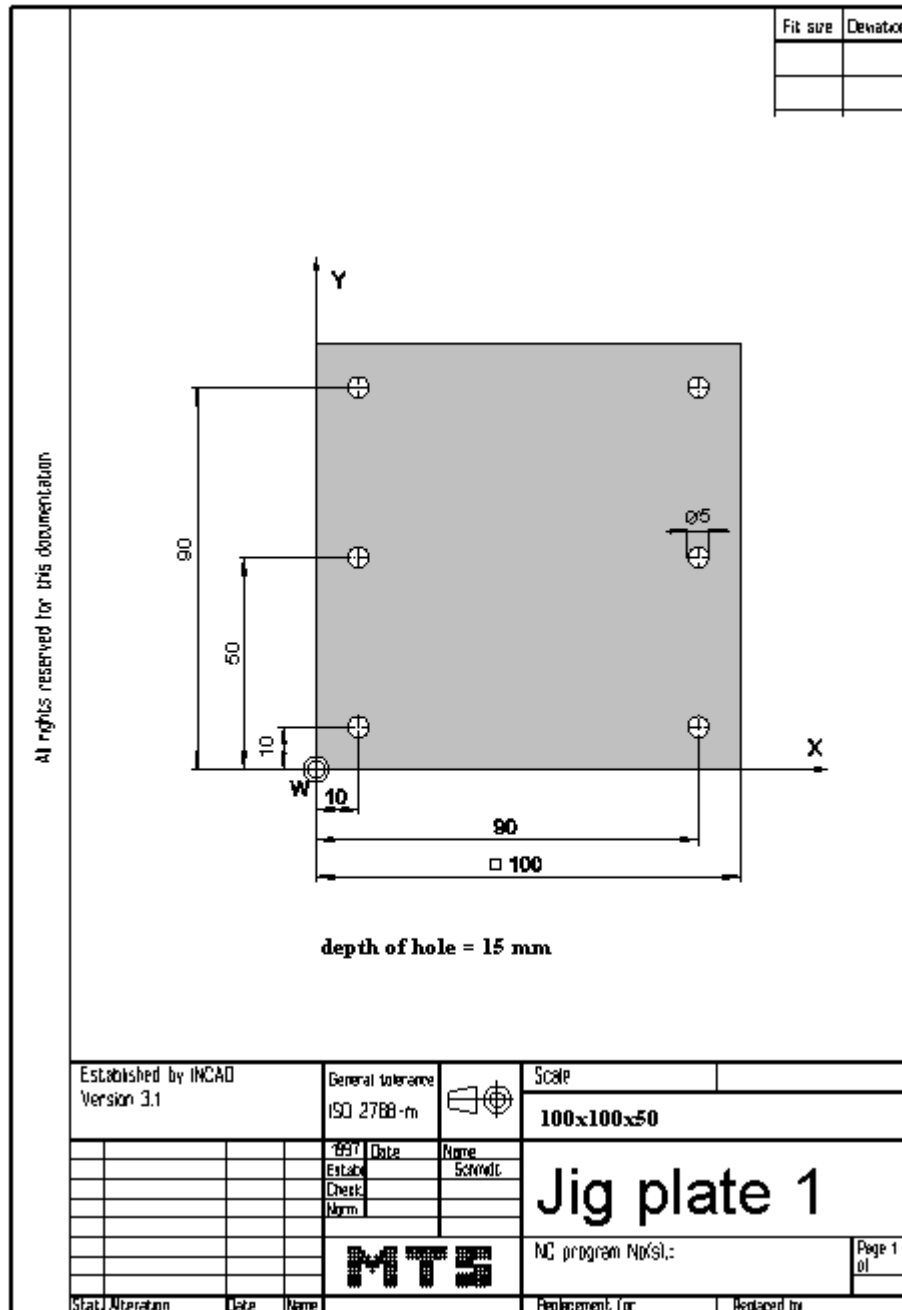


depth of hole = 15 mm

Established by		General tolerance		Scale	
INCAD Version 3.1		ISO 2768-m		100:100:50	
#537	Date	Name			
Estab.		Schematic	<h1 style="margin: 0;">Jig plate 1</h1> <p style="margin: 0;">NC program M051:</p>		
Check					
Norm					
Stat.	Iteration	Date	Name	Replacement for	Replaced by

Learning Objective: The learner is able to describe the structure of a simple NC milling program and to write parts of it on his own. He knows the essential steps of set-up, edit and automatic modes in the CNC Simulator for Milling and comprehends them in the proper sequence.

Special Training Elements: Set up and machine a blank at the simulator; select and set up tools. Movements with G00 and G01



4.1.2 Possible solution: Program BILDG1.FNC

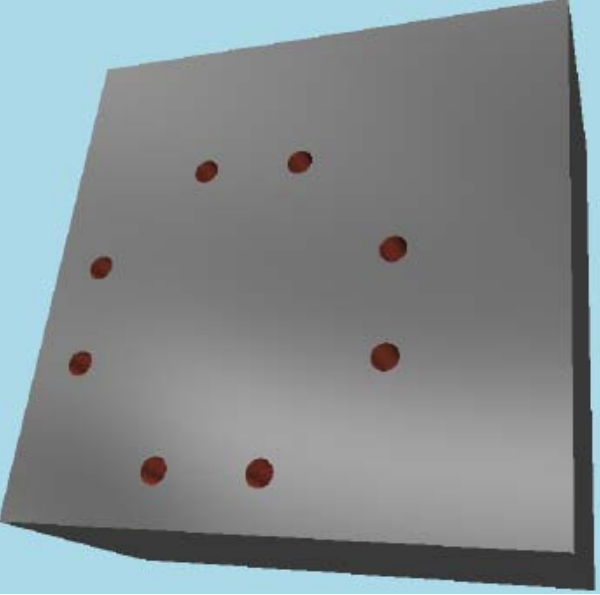
```
()
(( 9.11.2005 14:29
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+100.000 Y+100.000 Z+050.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+050.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SHELL END MILL\MW-040 032 HSS ISO 2586"
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-20.0 038K HSS ISO 1641"
( T03 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T04 "ISO SK 30\TAP\TA-M06.0 1.00 HSS ISO 2857"
( T05 "ISO SK 30\SLOT MILLING TOOL\MS-16.0 032K HSS ISO 1641"
( T06 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
(
( TOOL COMPENSATION
( D01 T01 R020.000 Z+115.500 N01
( D02 T02 R010.000 Z+119.000 N01
( D03 T03 R002.500 Z+097.900 N01
( D04 T04 R000.000 Z+090.000 N01
( D05 T05 R008.000 Z+107.000 N01
( D06 T06 R000.000 Z+065.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( G54 X+200.000 Y+150.000 Z+120.000
(
()
$G54
%
O1
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T6 M6
N0024 S2800 M3
N0026 G0 G43 Z50. H6
N0028 G0 X10. Y10.
N0030 G0 Z2.
N0032 G1 Z-2. F40 M7
N0034 G0 Z2.
N0036 G0 Y50.
N0038 G1 Z-2.
N0040 G0 Z2.
N0042 G0 Y90.
N0044 G1 Z-2.
N0046 G0 Z2.
```

```
N0048 G0 X90.  
N0050 G1 Z-2.  
N0052 G0 Z2.  
N0054 G0 Y50.  
N0056 G1 Z-2.  
N0058 G0 Z2.  
N0060 G0 Y10.  
N0062 G1 Z-2.  
N0064 G0 Z2.  
N0066 G0 Z100.  
N0068 M5  
N0070 M9  
N0072 T3 M6  
N0074 S1800 M3  
N0076 G0 G43 Z50. H3  
N0078 G0 X10.  
N0080 G0 Z2.  
N0082 G1 Z-15. F80 M7  
N0084 G0 Z2.  
N0086 G0 Y50.  
N0088 G1 Z-15.  
N0090 G0 Z2.  
N0092 G0 Y90.  
N0094 G1 Z-15.  
N0096 G0 Z2.  
N0098 G0 X90.  
N0100 G1 Z-15.  
N0102 G0 Z2.  
N0104 G0 Y50.  
N0106 G1 Z-15.  
N0108 G0 Z2.  
N0110 G0 Y10.  
N0112 G1 Z-15.  
N0114 G0 Z2.  
N0116 G0 Z100.  
N0118 M5  
N0120 M9  
N0122 G0 X150. Y150.  
N0124 M5  
N0126 M30  
%
```

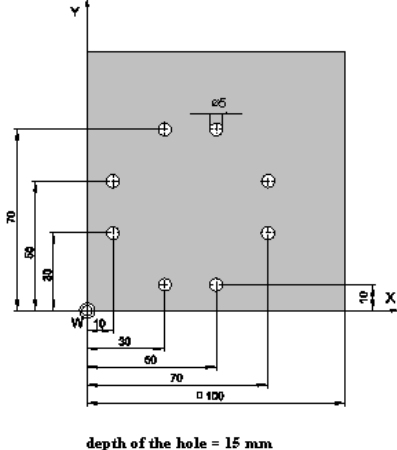
4.1.3 Exercise 1: Jig Plate 2

The jig plate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 100 x 100 x 50 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.

Use the commands G00 and G01.



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depth of the hole = 15 mm

Fit size	Deviation

Established by INCAD Version 3.1		General tolerance ISO 2768-m		Scale 100x100x50	
				<h2>Jig plate 2</h2>	
				NC program M(XS):	
				Page 1 of 1	
Stat.	Alteration	Date	Name	Prepared by	Replaced by

Learning Objective: The learner is able to describe the structure of a simple NC milling program and to write parts of it on his own. He knows the essential steps of set-up, edit and automatic modes in the CNC Simulator for Milling and comprehends them in the proper sequence.

Special Training Elements: Set up and machine a blank at the simulator; select and set up tools. Movements with G00 and G01

		Fit size	Deviation

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depth of the hole = 15 mm

Established by INCAD Version 3.1	General tolerance ISO 2768-m		Scale 100x100x50									
	<table border="1" style="width: 100%; border-collapse: collapse; font-size: x-small;"> <tr><td style="width: 15%;">Etabl.</td><td style="width: 15%;">Date</td><td style="width: 15%;">Name</td></tr> <tr><td>Check</td><td></td><td>Schmid</td></tr> <tr><td>Norm.</td><td></td><td></td></tr> </table>	Etabl.	Date	Name	Check		Schmid	Norm.			Jig plate 2	
Etabl.	Date	Name										
Check		Schmid										
Norm.												
		NC program No(s):	Page 1 of 1									
Stat.	Iteration	Date	Name									
		Replacement for	Replaced by									

4.1.4 Possible solution: Program BILDG1A.FNC

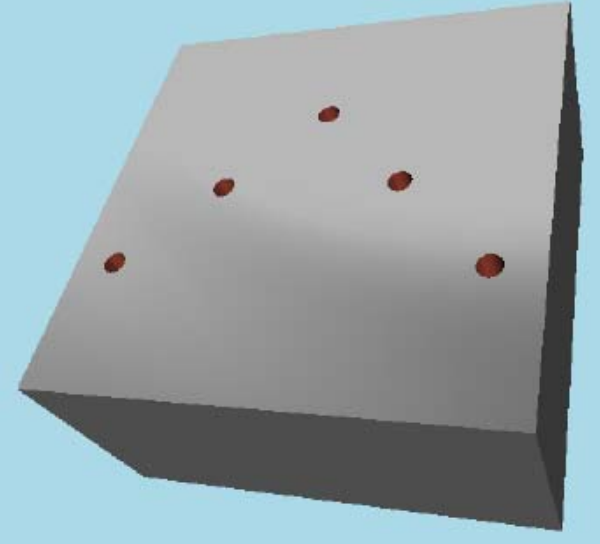
```
()
(( 9.11.2005 14:29
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+100.000 Y+100.000 Z+050.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+050.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SHELL END MILL\MW-040 032 HSS ISO 2586"
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-20.0 038K HSS ISO 1641"
( T03 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T04 "ISO SK 30\TAP\TA-M06.0 1.00 HSS ISO 2857"
( T05 "ISO SK 30\SLOT MILLING TOOL\MS-16.0 032K HSS ISO 1641"
( T06 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
(
( TOOL COMPENSATION
( D01 T01 R020.000 Z+115.500 N01
( D02 T02 R010.000 Z+119.000 N01
( D03 T03 R002.500 Z+097.900 N01
( D04 T04 R000.000 Z+090.000 N01
( D05 T05 R008.000 Z+107.000 N01
( D06 T06 R000.000 Z+065.000 N01
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( G54 X+200.000 Y+150.000 Z+120.000
(
()
$G54
%
O2
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T6 M6
N0024 S2800 M3
N0026 G0 G43 Z50. H6
N0028 G0 X10.
N0030 G0 Z2.
N0032 G1 Z-2. F40 M7
N0034 G0 Z2.
N0036 G0 Y30.
N0038 G1 Z-2.
N0040 G0 Z2.
N0042 G0 X30. Y10.
N0044 G1 Z-2.
N0046 G0 Z2.
N0048 G0 X50.
```

```
N0050 G1 Z-2.  
N0052 G0 Z2.  
N0054 G0 X70. Y30.  
N0056 G1 Z-2.  
N0058 G0 Z2.  
N0060 G0 Y50.  
N0062 G1 Z-2.  
N0064 G0 Z2.  
N0066 G0 X50. Y70.  
N0068 G1 Z-2.  
N0070 G0 Z2.  
N0072 G0 X30.  
N0074 G1 Z-2.  
N0076 G0 Z2.  
N0078 G0 Z100.  
N0080 M5  
N0082 M9  
N0084 T3 M6  
N0086 S1800 M3  
N0088 G0 G43 Z50. H3  
N0090 G0 X10. Y50.  
N0092 G0 Z2.  
N0094 G1 Z-15. F80 M7  
N0096 G0 Z2.  
N0098 G0 Y30.  
N0100 G1 Z-15.  
N0102 G0 Z2.  
N0104 G0 X30. Y10.  
N0106 G1 Z-15.  
N0108 G0 Z2.  
N0110 G0 X50.  
N0112 G1 Z-15.  
N0114 G0 Z2.  
N0116 G0 X70. Y30.  
N0118 G1 Z-15.  
N0120 G0 Z2.  
N0122 G0 Y50.  
N0124 G1 Z-15.  
N0126 G0 Z2.  
N0128 G0 X50. Y70.  
N0130 G1 Z-15.  
N0132 G0 Z2.  
N0134 G0 X30.  
N0136 G1 Z-15.  
N0138 G0 Z2.  
N0140 G0 Z100.  
N0142 M5  
N0144 M9  
N0146 G0 X150. Y150.  
N0148 M5  
N0150 M30  
%
```

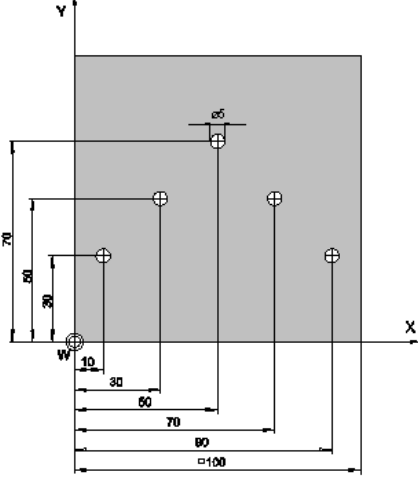
4.1.5 Exercise 1: Jig Plate 3

The jig plate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 100 x 100 x 50 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.

Use the commands G00 and G01



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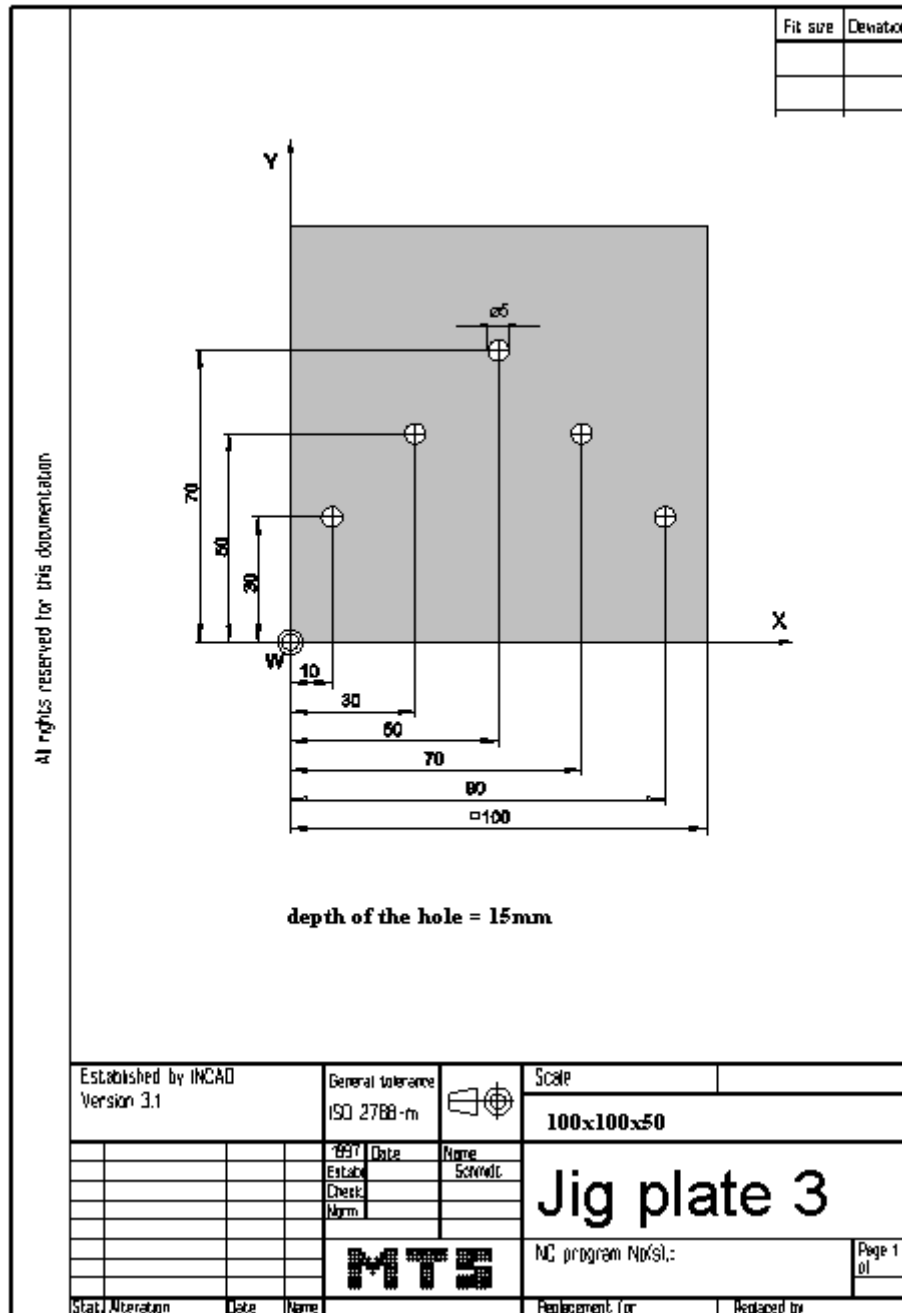
depth of the hole = 15 mm

Fit size		Deviation	

Established by INCAD Version 3.1		General tolerance ISO 2768-m		Scale 100x100x50	
				<h2 style="margin: 0;">Jig plate 3</h2>	
		MTS		NC program No(S):	
Stat./Material	Date	Name	Replacement for	Replaced by	Page 1 of 1

Learning Objective: The learner is able to describe the structure of a simple NC milling program and to write parts of it on his own. He knows the essential steps of set-up, edit and automatic modes in the CNC Simulator for Milling and comprehends them in the proper sequence.

Special Training Elements: Set up and machine a blank at the simulator; select and set up tools. Movements with G00 and G01



4.1.6 Possible solution: Program BILDG1B.FNC

```
()
(( 9.11.2005 14:29
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+100.000 Y+100.000 Z+050.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+050.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SHELL END MILL\MW-040 032 HSS ISO 2586"
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-20.0 038K HSS ISO 1641"
( T03 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T04 "ISO SK 30\TAP\TA-M06.0 1.00 HSS ISO 2857"
( T05 "ISO SK 30\SLOT MILLING TOOL\MS-16.0 032K HSS ISO 1641"
( T06 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
(
( TOOL COMPENSATION
( D01 T01 R020.000 Z+115.500 N01
( D02 T02 R010.000 Z+119.000 N01
( D03 T03 R002.500 Z+097.900 N01
( D04 T04 R000.000 Z+090.000 N01
( D05 T05 R008.000 Z+107.000 N01
( D06 T06 R000.000 Z+065.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( G54 X+200.000 Y+150.000 Z+120.000
(
( )
$G54
%
O3
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T6 M6
N0024 S2800 M3
N0026 G0 G43 Z50. H6
N0028 G0 X10. Y30.
N0030 G0 Z2.
N0032 G1 Z-2. F40 M7
N0034 G0 Z2.
N0036 G0 X30. Y50.
N0038 G1 Z-2.
N0040 G0 Z2.
N0042 G0 X50. Y70.
N0044 G1 Z-2.
N0046 G0 Z2.
```

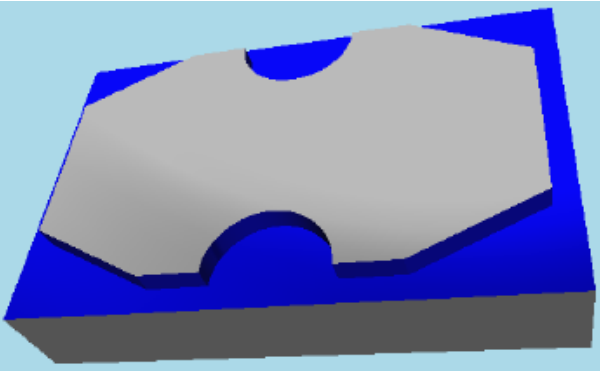
```
N0048 G0 X70. Y50.  
N0050 G1 Z-2.  
N0052 G0 Z2.  
N0054 G0 X90. Y30.  
N0056 G1 Z-2.  
N0058 G0 Z2.  
N0060 G0 Z100.  
N0062 M5  
N0064 M9  
N0066 T3 M6  
N0068 S1800 M3  
N0070 G0 G43 Z50. H3  
N0072 G0 X10.  
N0074 G0 Z2.  
N0076 G1 Z-15. F80 M7  
N0078 G0 Z2.  
N0080 G0 X30. Y50.  
N0082 G1 Z-15.  
N0084 G0 Z2.  
N0086 G0 X50. Y70.  
N0088 G1 Z-15.  
N0090 G0 Z2.  
N0092 G0 X70. Y50.  
N0094 G1 Z-15.  
N0096 G0 Z2.  
N0098 G0 X90. Y30.  
N0100 G1 Z-15.  
N0102 G0 Z2.  
N0104 G0 Z100.  
N0106 M5  
N0108 M9  
N0110 G0 X150. Y150.  
N0112 M5  
N0114 M30  
%
```

4.2 NC programs using circular interpolation

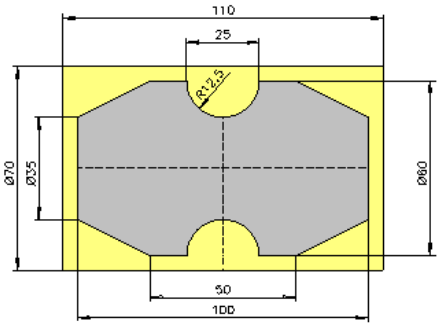
4.2.1 Exercise 2: Contourplate 1

The contourplate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 100 x 70 x 25 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.

Use the circular commands G02 or G03 and the cutter radius compensation.



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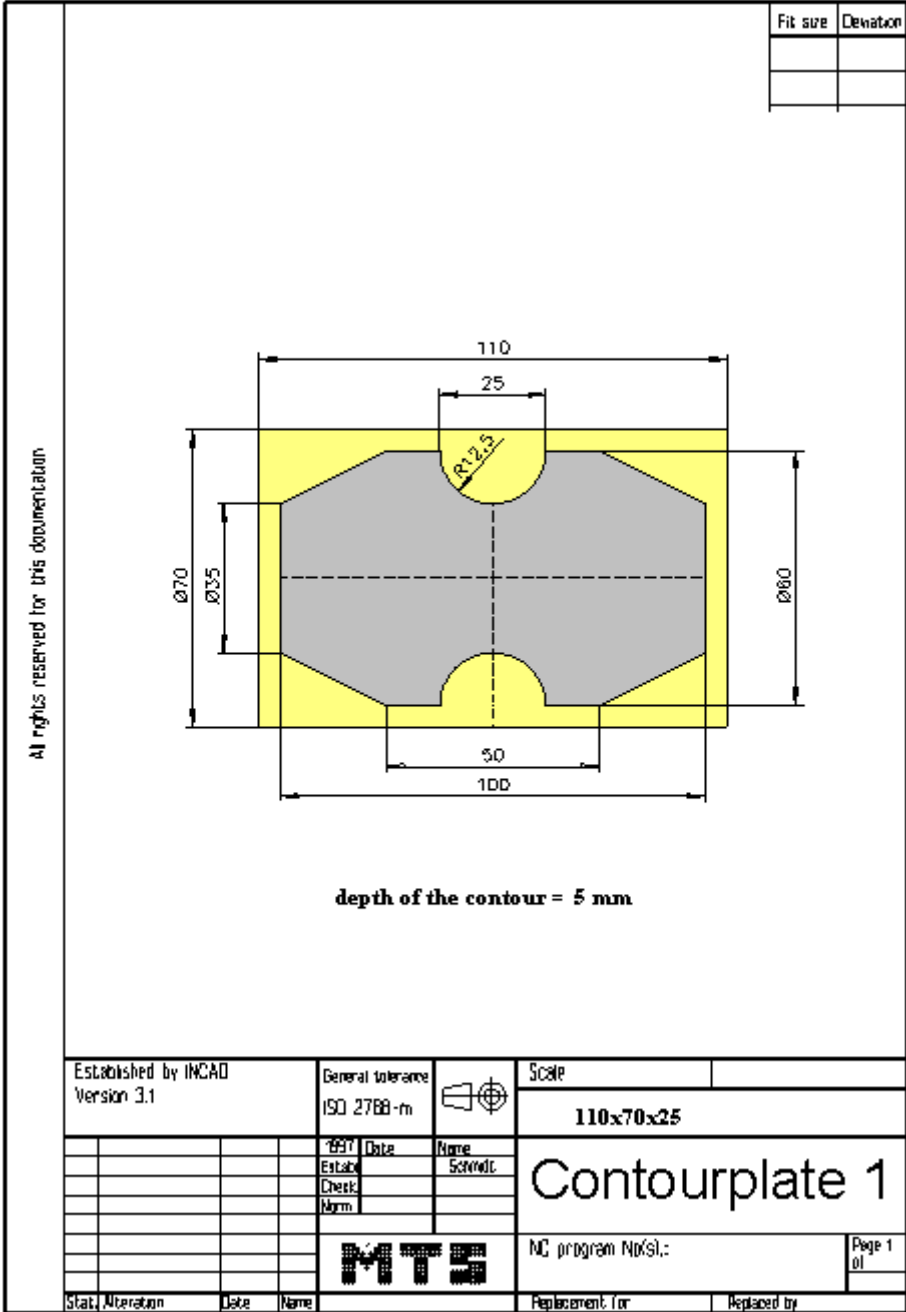
depth of the contour = 5 mm

Fit size	Deviation

Established by INCAD Version 3.1	General tolerance ISO 2768-m	Scale 110x70x25	
		<h1>Contourplate 1</h1>	NC program M05St.: Page 1 of 1

Learning Objective: The learner is able to solve a CNC milling task with systematic planning of the procedure and the application of existing system functions.

Special Training Elements: Cutter radius compensation, commands for circular arcs.



4.2.2 Possible solution: Program PLATT1A.FNC

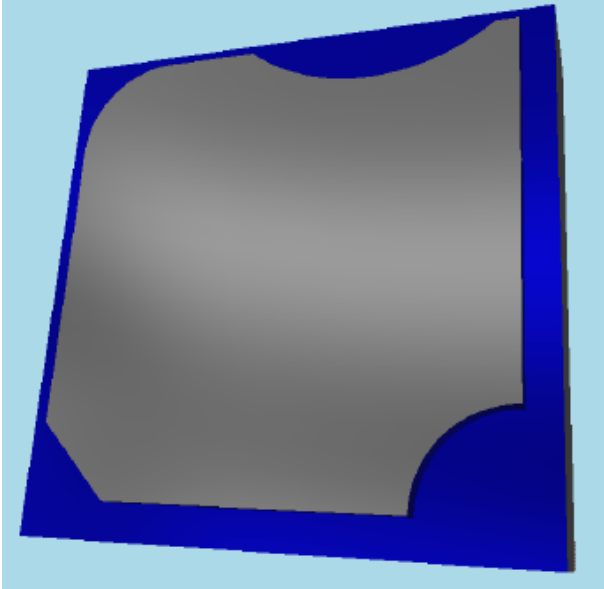
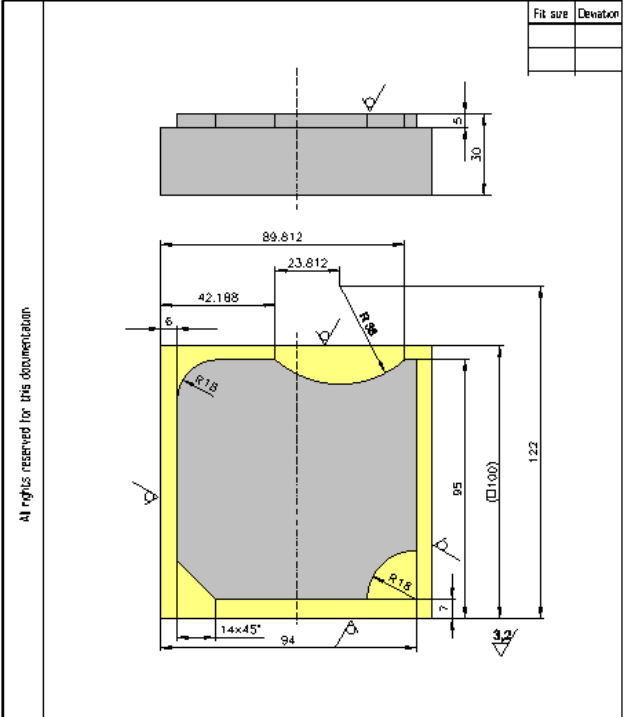
```
()
(( 9.11.2005 12:09
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+110.000 Y+070.000 Z+025.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+130.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\ViselRS 160"
( CHUCKING DEPTH E+015.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SLOT MILLING TOOL\MS-22.0 075L HSS ISO 1641"
(
( TOOL COMPENSATION
( D01 T01 R011.000 Z+140.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+130.000
( G54 X+200.000 Y+150.000 Z+130.000
(
()
$G54
%
O13
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T1 M6
N0024 S2000 M3
N0026 G0 G43 Z50. H1
N0028 G0 X120. Y90.
N0030 G0 Z2.
N0032 G1 Z-5. F200 M7
N0034 G41 G1 X110. Y80. D1
N0036 G1 X105. Y65.
N0038 G1 Y17.5
N0040 G1 X80. Y5.
N0042 G1 X67.5
N0044 G3 X42.5 I-12.5 J0.
N0046 G1 X30.
N0048 G1 X5. Y17.5
N0050 G1 Y52.5
N0052 G1 X30. Y65.
N0054 G1 X42.5
N0056 G3 X67.5 I12.5 J0.
N0058 G1 X80.
N0060 G1 X105. Y52.5
N0062 G1 Y50.
N0064 G3 X120. Y25. I24.916 J-2.051
N0066 G40
```

```
N0068 G0 Z100.  
N0070 G0 X124.363 Y35.098  
N0072 M5  
N0074 M9  
N0076 G0 X150. Y100.  
N0080 M30  
%
```

4.2.3 Exercise 2: Contourplate 2

The contourplate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 100 x 100 x 25 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.

Use the circular commands G02 or G03 and the cutter radius compensation.

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Fit size	Deviation

Established by INCAD Version 3.1

General tolerance ISO 2768-m

Scale

APP	Date	Name

Contourplate 2

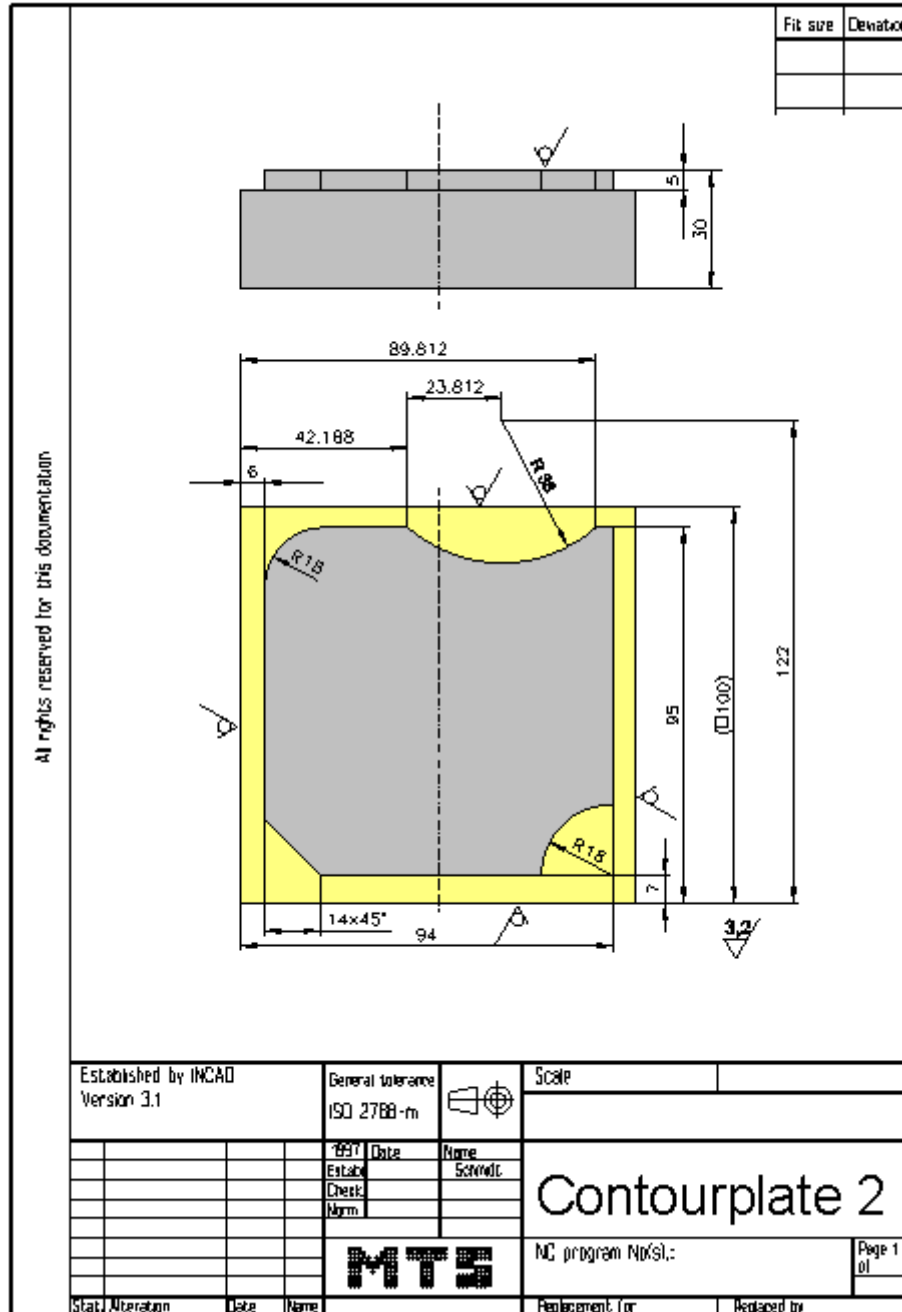
NC program M(XS):

Page 1 of 1

Stat.	Modification	Date	Name	Replacement for	Replaced by

Learning Objective: The learner is able to solve a CNC milling task with systematic planning of the procedure and the application of existing system functions.

Special Training Elements: Cutter radius compensation, commands for circular arcs.



4.2.4 Possible solution: Program PLATTE6.FNC

```
()
(( 9.11.2005 12:40
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+100.000 Y+100.000 Z+030.000
( PART POSITION X+200.000 Y+120.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+120.000 Z+135.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+015.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SLOT MILLING TOOL\MS-30.0 045K HSS ISO 1641"
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-10.0 022K HSS ISO 1641"
(
( TOOL COMPENSATION
( D01 T01 R015.000 Z+136.000 N01
( D02 T02 R005.000 Z+087.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+120.000 Z+135.000
( G54 X+200.000 Y+120.000 Z+135.000
(
(
)
$G54
%
O14
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T1 M6
N0024 S2000 M3
N0026 G0 G43 Z50. H1
N0028 G0 X120.
N0030 G0 Z2.
N0032 G1 Z-5. F200 M7
N0034 G41 G1 X115. Y85. D1
N0036 G3 X94. Y64. I0. J-21.
N0038 G1 Y25.
N0040 G3 X76. Y7. I0. J-18.
N0042 G1 X20.
N0044 G1 X6. Y21.
N0046 G1 Y77.
N0048 G2 X24. Y95. I18. J0.
N0050 G1 X42.188
N0052 G3 X89.812 I23.812 J29.614
N0054 G1 X94.
N0056 G1 Y70.
N0058 G3 X115. Y49. I21. J0.
N0060 G40
N0062 G0 Z100.
```

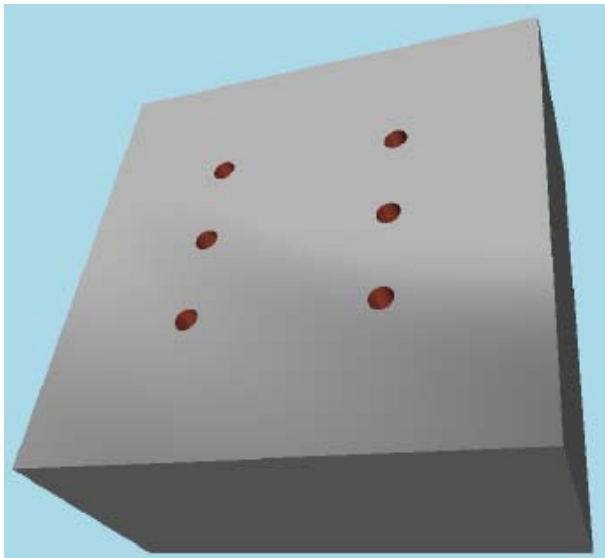
```
N0064 G0 X115. Y64.  
N0066 M5  
N0068 M9  
N0070 G0 X150. Y150.  
N0072 M5  
N0074 M30  
%
```

4.3 NC programs using canned cycles

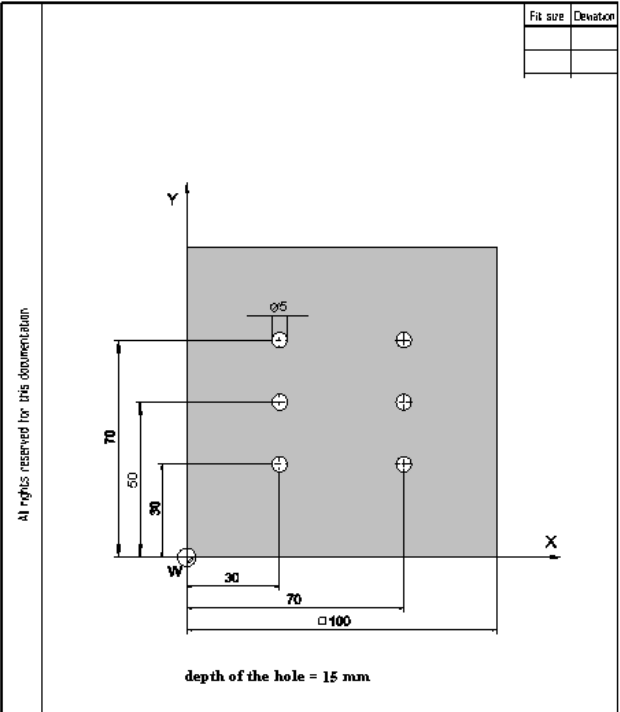
4.3.1 Exercise 3: Plate 1

The plate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 100 x 100 x 50 mm. Prepare, test and correct the manufacturing process with the MTS CNC Milling Simulator. Define the workpart zero, work out the process layout, set-up form and NC program.

Use the ISO commands.



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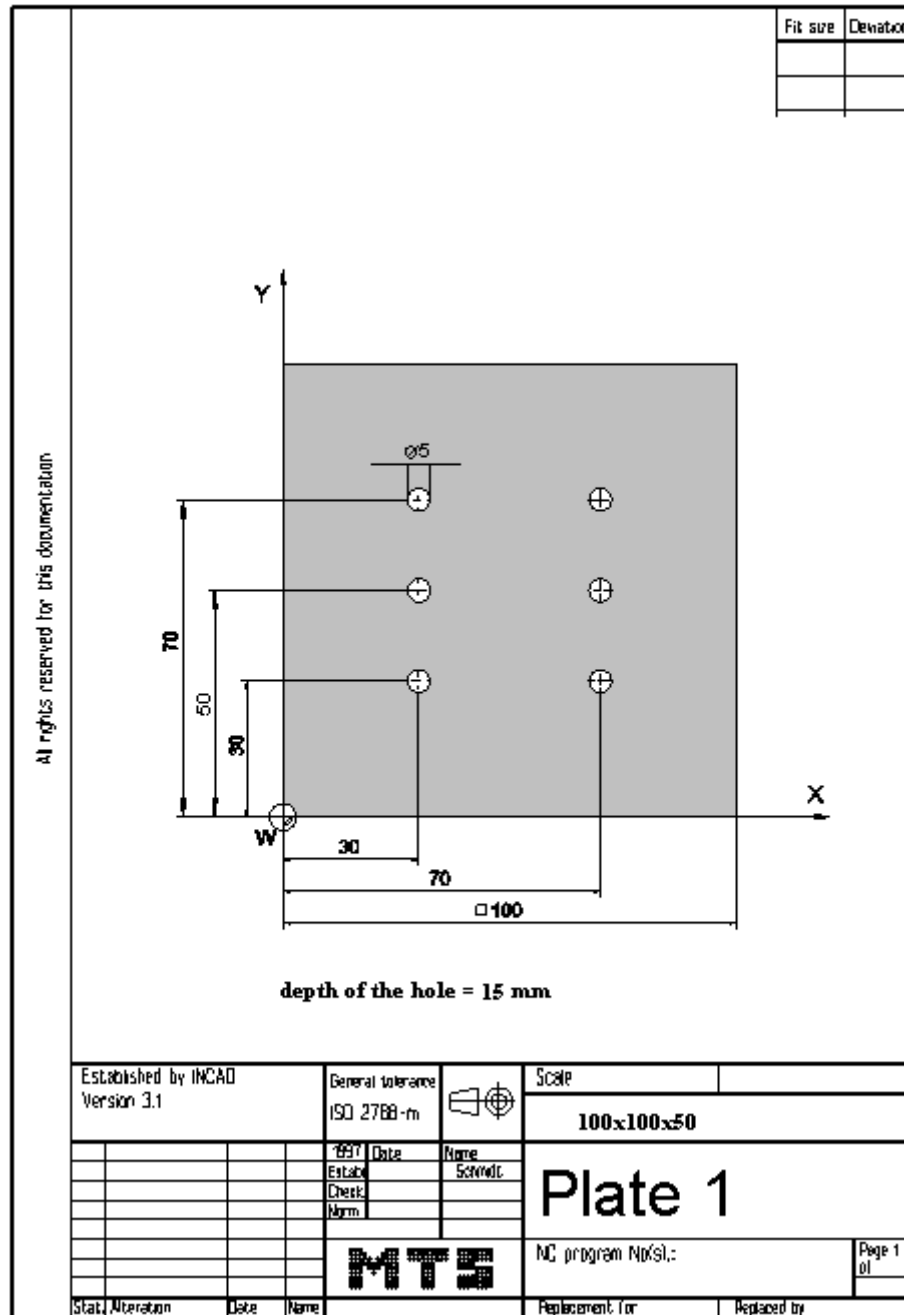


depth of the hole = 15 mm

Established by INCAO		General tolerances	SCALE		
Version 3.1		ISO 2768-m	100x100x50		
			Plate 1		
			NC program No(s):	Page 1 of 1	
Stat.	Alteration	Date	Name	Replacement for	Replaced by

Learning Objective: The learner is capable of preparing and testing the CNC milling of a workpart of medium complexity on a CNC simulating and programming desk by himself including the work organization.

Special Training Elements: Use ISO commands G0 and G1.



Possible solution: Program BILDG75.FNC

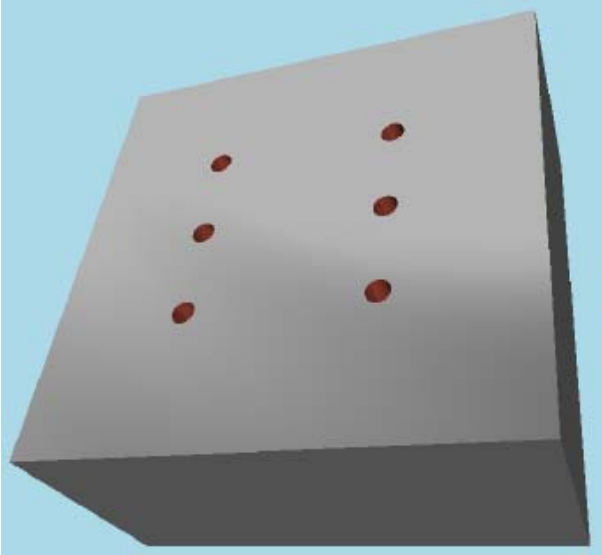
```
()
(( 9.11.2005 15:08
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+100.000 Y+100.000 Z+050.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\ViselRS 160"
( CHUCKING DEPTH E+050.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SHELL END MILL\MW-040 032 HSS ISO 2586"
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-20.0 038K HSS ISO 1641"
( T03 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T04 "ISO SK 30\TAP\TA-M06.0 1.00 HSS ISO 2857"
( T05 "ISO SK 30\SLOT MILLING TOOL\MS-16.0 032K HSS ISO 1641"
( T06 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
(
( TOOL COMPENSATION
( D01 T01 R020.000 Z+115.500 N01
( D02 T02 R010.000 Z+119.000 N01
( D03 T03 R002.500 Z+097.900 N01
( D04 T04 R000.000 Z+090.000 N01
( D05 T05 R008.000 Z+107.000 N01
( D06 T06 R000.000 Z+065.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( G54 X+200.000 Y+150.000 Z+120.000
(
(
)
$G54
%
O4
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T6 M6
N0024 S2800 M3
N0026 G0 G43 Z50. H6
N0028 G0 X30. Y30.
N0030 G0 Z2.
N0032 G1 Z-2. F40 M7
N0034 G0 Z2.
N0036 G0 Y50.
N0038 G1 Z-2.
N0040 G0 Z2.
N0042 G0 Y70.
N0044 G1 Z-2.
N0046 G0 Z2.
N0048 G0 X70.
```

N0050 G1 Z-2.
N0052 G0 Z2.
N0054 G0 Y50.
N0056 G1 Z-2.
N0058 G0 Z2.
N0060 G0 Y30.
N0062 G1 Z-2.
N0064 G0 Z2.
N0066 G0 Z100.
N0068 M5
N0070 M9
N0072 T3 M6
N0074 S1800 M3
N0076 G0 G43 Z50. H3
N0078 G0 X30.
N0080 G0 Z2.
N0082 G1 Z-15. F80 M7
N0084 G0 Z2.
N0086 G0 Y50.
N0088 G1 Z-15.
N0090 G0 Z2.
N0092 G0 Y70.
N0094 G1 Z-15.
N0096 G0 Z2.
N0098 G0 X70.
N0100 G1 Z-15.
N0102 G0 Z2.
N0104 G0 Y50.
N0106 G1 Z-15.
N0108 G0 Z2.
N0110 G0 Y30.
N0112 G1 Z-15.
N0114 G0 Z2.
N0116 G0 Z100.
N0118 M5
N0120 M9
N0122 G0 X150. Y150.
N0126 M30
%

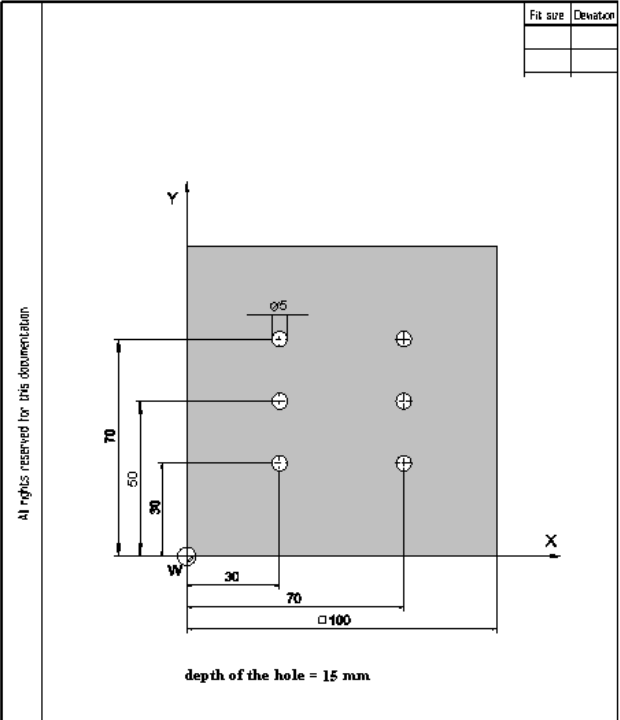
4.3.2 Exercise 3: Plate 2

The plate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 100 x 100 x 50 mm. Prepare, test and correct the manufacturing process with the MTS CNC Milling Simulator. Define the workpart zero, work out the process layout, set-up form and NC program.

Use the canned cycle G81 and G83.



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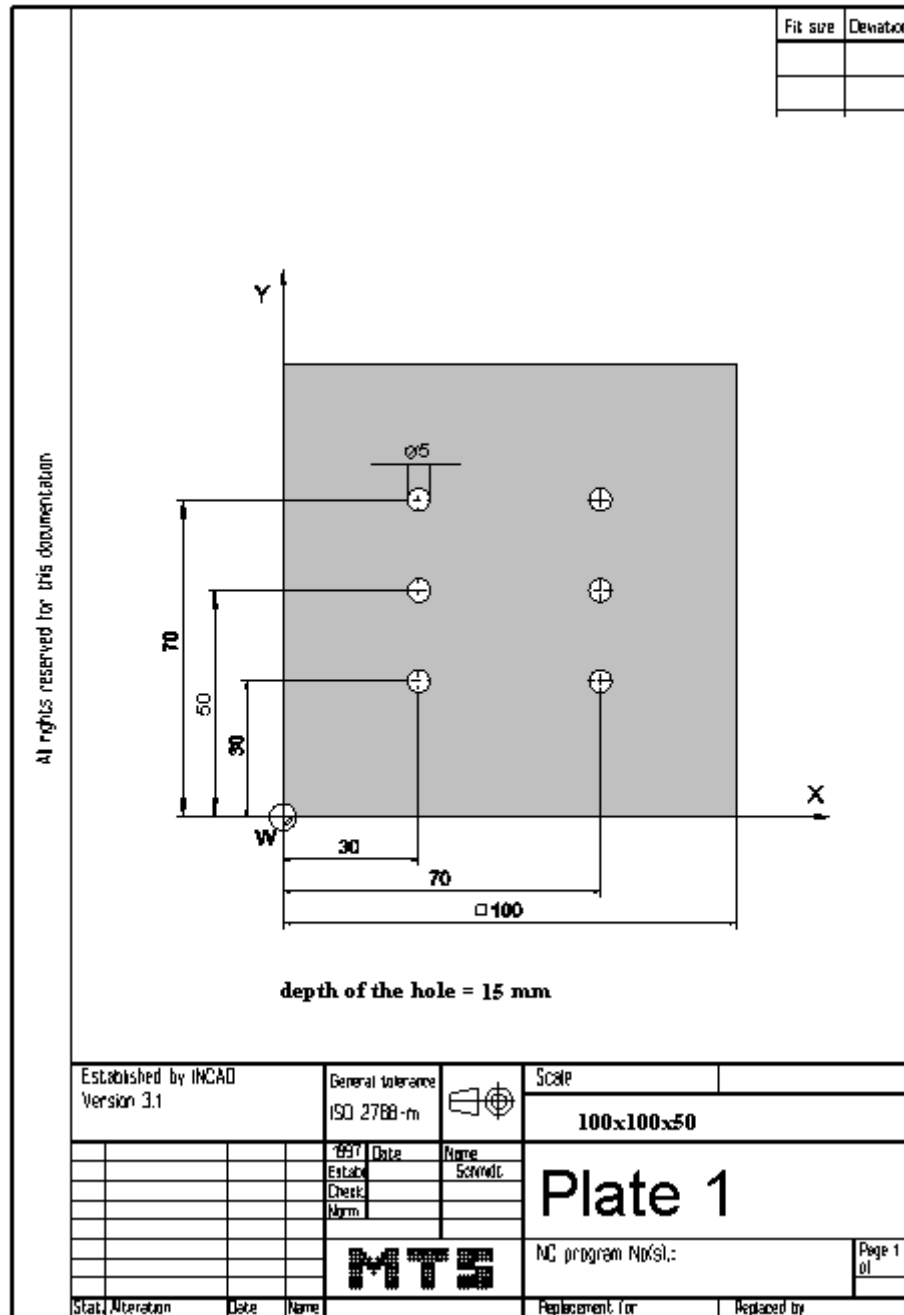


depth of the hole = 15 mm

Established by INCAD		General tolerance	Scale
Version 3.1		ISO 2768-m	100x100x50
#991	Date	Name	Plate 1
Entsch.		Schneidc.	
Check			
Norm			
MTS			NC program MtkStl: Page 1 of 1
Stat.	Mitwirkend	Date	Name
Replacement for			Replaced by

Learning Objective: The learner is capable of preparing and testing the CNC milling of a workpart of medium complexity on a CNC simulating and programming desk by himself including the work organization.

Special Training Elements: Use cycle G81 and G83 as modal comand and repeat it at several positions. Cancele the cycle with G80.



Possible solution: Program BILDG83.FNC

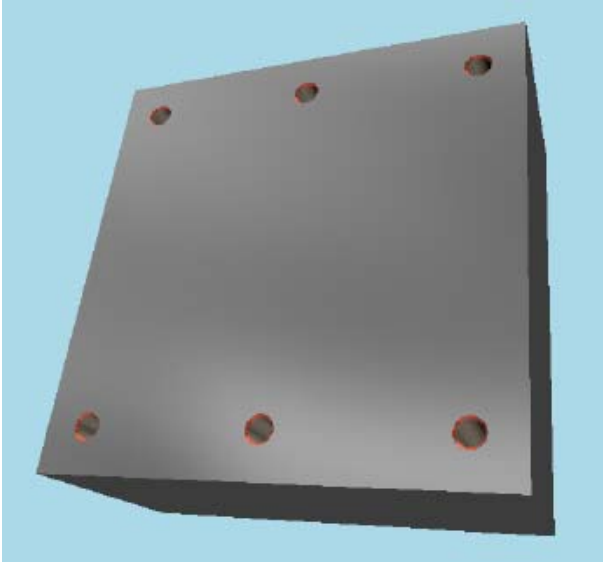
```
()
(( 9.11.2005 15:14
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+100.000 Y+100.000 Z+050.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\ViselRS 160"
( CHUCKING DEPTH E+050.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SHELL END MILL\MW-040 032 HSS ISO 2586"
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-20.0 038K HSS ISO 1641"
( T03 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T04 "ISO SK 30\TAP\TA-M06.0 1.00 HSS ISO 2857"
( T05 "ISO SK 30\SLOT MILLING TOOL\MS-16.0 032K HSS ISO 1641"
( T06 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
(
( TOOL COMPENSATION
( D01 T01 R020.000 Z+115.500 N01
( D02 T02 R010.000 Z+119.000 N01
( D03 T03 R002.500 Z+097.900 N01
( D04 T04 R000.000 Z+090.000 N01
( D05 T05 R008.000 Z+107.000 N01
( D06 T06 R000.000 Z+065.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( G54 X+200.000 Y+150.000 Z+120.000
(
(
)
$G54
%
O5
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T6 M6
N0024 S2800 M3
N0026 G0 G43 Z50. H6
N0028 G0 X50.
N0030 F40
N0034 G0 Z20.
N0036 G81 G98 X30. Y70. Z-2. R2.
N0040 X30. Y50.
N0042 X30. Y30.
N0048 X70. Y30.
N0050 X70. Y50.
N0052 X70. Y70.
N0054 G80
N0056 G0 Z100.
```

N0058 M5
N0060 T3 M6
N0062 S1800 M3
N0064 G0 G43 Z50. H3
N0068 F80
N0072 G0 Z20.
N0074 G83 G98 X30. Y70. Z-35. R2. Q20.
N0078 X30. Y50.
N0080 X30. Y30.
N0086 X70. Y30.
N0088 X70. Y50.
N0090 X70. Y70.
N0092 G80
N0094 G0 Z100.
N0096 M5
N0098 G0 X150. Y150.
N0102 M30
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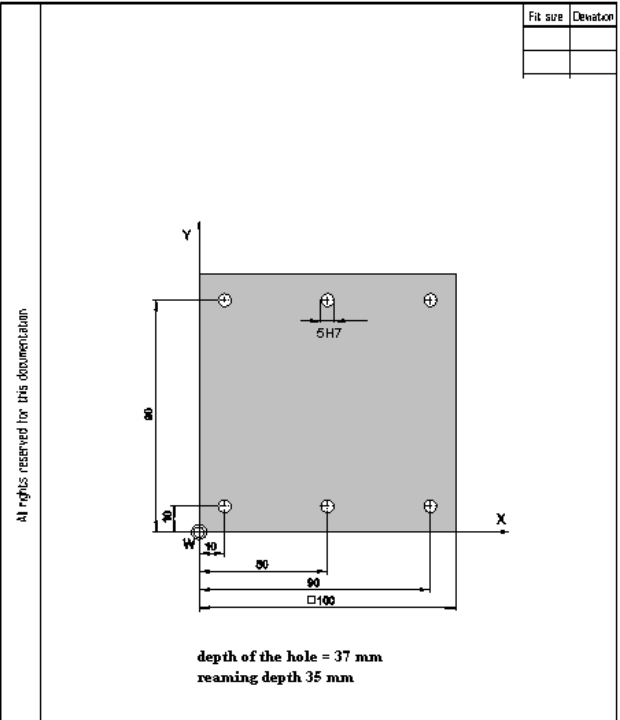
4.3.3 Exercise 3: Plate 3

The plate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 100 x 100 x 50 mm. Prepare, test and correct the manufacturing process with the MTS CNC Milling Simulator. Define the workpart zero, work out the process layout, set-up form and NC program.

The borehole must be reamed. Use the canned cycle G85.



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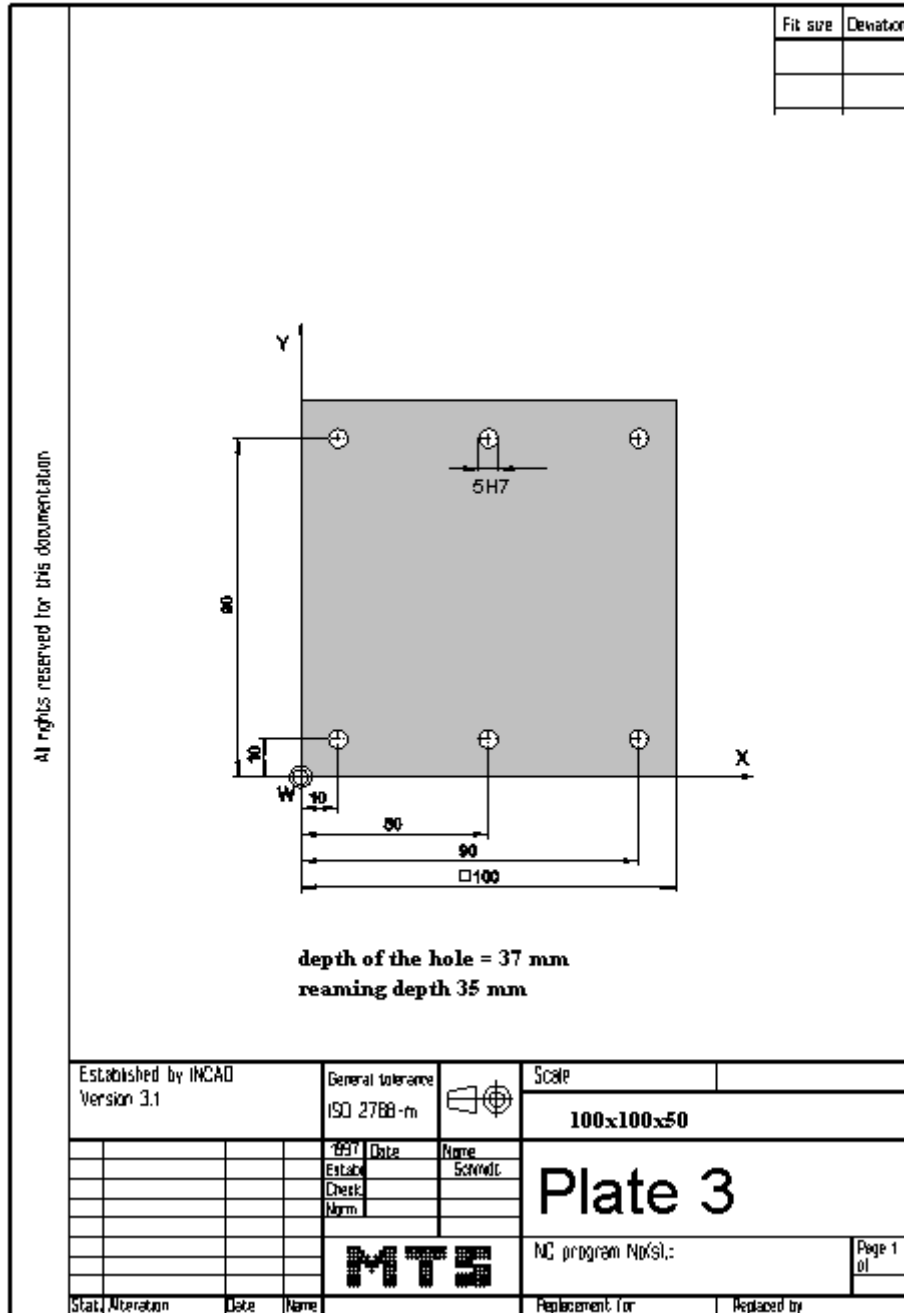
Fit size	Deviation

depth of the hole = 37 mm
remaining depth 35 mm

Established by INCAD Version 3.1		General tolerance ISO 2768-m	Scale 100x100x50		
			Plate 3		
			NC program M03/01	Page 1 of 1	
Stat.	Modifikation	Date	Name	Replacement for	Replaced by

Learning Objective: The learner is capable of preparing and testing the CNC milling of a workpart of medium complexity on a CNC simulating and programming desk by himself including the work organization.

Special Training Elements: Use cycles G81, G83 and G85 as modal command and repeat it at several positions. Write the positions into a subprogram. Cancel the cycle with G80.



4.3.4 Possible solution: Program BILDG85.FNC

```
()
(( 9.11.2005 15:18
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL MTS VMC01
(
( BLANK DIMENSIONS X+100.000 Y+100.000 Z+050.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\ViselRS 160"
( CHUCKING DEPTH E+050.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T03 "ISO SK 30\DRILL\DR-04.80 047 HSS ISO 235"
( T06 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
( T10 "ISO SK 30\REAMER\RE-D05.0 H7 HSS ISO 521"
(
( TOOL COMPENSATION
( D03 T03 R002.400 Z+092.900 N01
( D06 T06 R000.000 Z+065.000 N01
( D10 T10 R000.000 Z+130.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( G54 X+200.000 Y+150.000 Z+120.000
(
(
)
$G54
%
O6
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T6 M6
N0024 S2800 M3
N0026 G0 G43 Z50. H6
N0028 G0 X50.
N0030 F40
N0034 G0 Z20.
N0036 G81 G98 Z-3 R2. K0
N0038 M98 P8500
N0056 G0 Z100.
N0058 M5
N0060 T3 M6
N0062 S1800 M3
N0064 G0 G43 Z50. H3
N0066 G0 X50. Y50.
N0068 F80
N0072 G0 Z20.
N0074 G83 G98 Z-37. R4. Q20. K0
N0076 M98 P8500
N0094 G0 Z100.
```

N0096 M5
N0100 T10 M6
N0102 S150 M3
N0104 G0 G43 Z50. H10
N0110 G0 Z20.
N0112 G85 G98 Z-35. R6. K0
N0114 M98 P8500
N0132 G0 Z100.
N0134 M5
N0136 G0 X150. Y150.
N0138 M5
N0140 M30
%

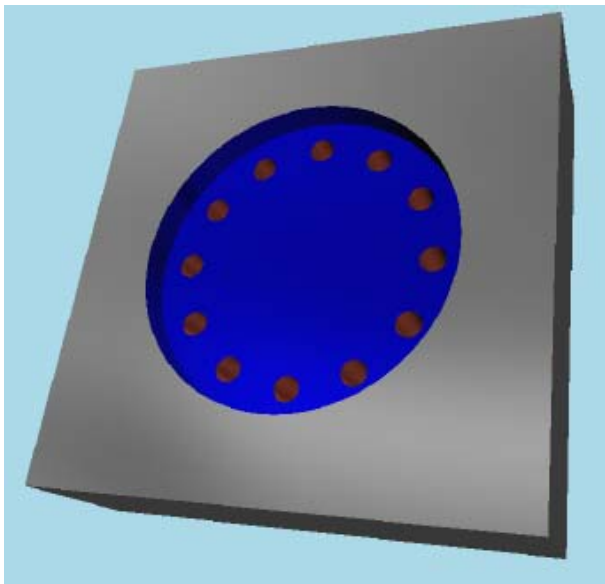
:8500
N0010 G99 X10. Y10.
N0015 X50. Y10.
N0020 G98 X90. Y10.
N0025 G99 X90. Y90.
N0030 X50. Y90.
N0035 G98 X10. Y90.
N0040 G80
N0045 M99

4.4 NC programs with further machining cycles

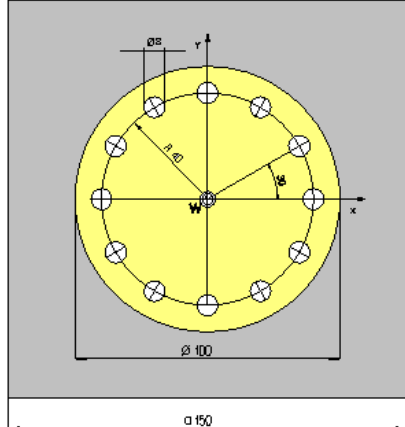
4.4.1 Exercise 4: Plate a with bolt holes and a circular pocket

The plate a on the drawing with bolt holes and a circular pocket is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 150 x 150 x 50 mm. Prepare, test and correct the manufacturing process with the MTS CNC Milling Simulator. Define the workpart zero, work out the process layout, set-up form and NC program.

Use cycles G81 and G83 and a subprogram for the hole pattern.



	Fit size	Deviation



depth of circle pocket 10 mm
depth of the hole = 35 mm top surface

Established by INCAD Version 3.1	General tolerance ISO 2768-m		Scale 150x150x50								
	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Date</td> <td style="width: 50%;">Time</td> </tr> <tr> <td>Estab.</td> <td>Schmitz</td> </tr> <tr> <td>Check</td> <td></td> </tr> <tr> <td>Norm</td> <td></td> </tr> </table>	Date	Time	Estab.	Schmitz	Check		Norm		Plate A	
Date	Time										
Estab.	Schmitz										
Check											
Norm											
			NC program No/St.:								
Stat.	Mitarb.	Date	Name								
		Replacement for	Replaced by								

Learning Objective: The learner can describe the function and the calling of cycles.

Special Training Elements: Use cycles G81 and G83 as modal command and repeat it at several positions. Write a subprogram. Rotate the coordinate system incremental and give the position of executing the cycle. Call the subprogram with repetition. Cancel the cycle with G80.

Fit size	Deviation

depth of circle pocket 10 mm
depth of the hole = 35 mm top surface

Established by INCAD Version 3.1		General tolerance ISO 2768-m		Scale 150x150x50														
		<table border="1" style="font-size: small;"> <tr> <td>1997</td> <td>Date</td> <td>Name</td> </tr> <tr> <td>Estab.</td> <td></td> <td>Schmid</td> </tr> <tr> <td>Check:</td> <td></td> <td></td> </tr> <tr> <td>Norm.</td> <td></td> <td></td> </tr> </table>		1997	Date	Name	Estab.		Schmid	Check:			Norm.			Plate A		Page 1 of 1
1997	Date			Name														
Estab.		Schmid																
Check:																		
Norm.																		
		NC program No(s):																
MTS				Replacement for														
Stat.	Iteration	Date	Name	Replaced by														

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4.4.2 Possible solution: Program BOHR9120.FNC

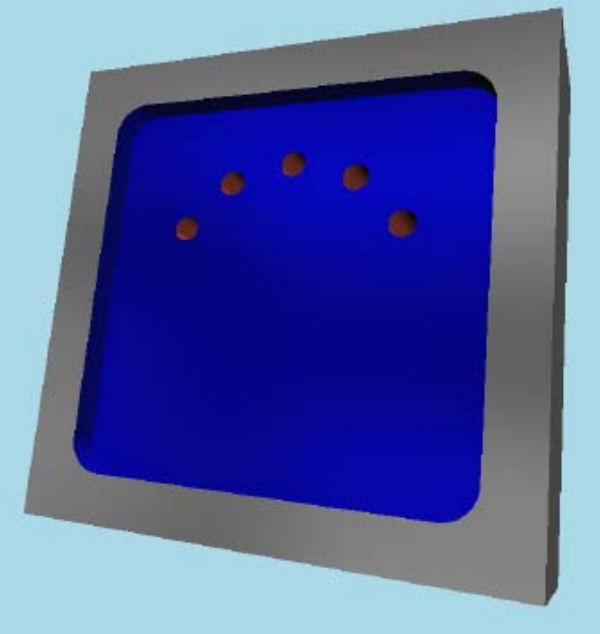
```
()
(( 10.11.2005 07:20
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+150.000 Y+150.000 Z+050.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+050.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-20.0 075L HSS ISO 1641"
( T03 "ISO SK 30\DRILL\DR-08.00 075 HSS ISO 235"
( T06 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
(
( TOOL COMPENSATION
( D02 T02 R010.000 Z+140.000 N01
( D03 T03 R004.000 Z+120.900 N01
( D06 T06 R000.000 Z+065.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( G54 X+275.000 Y+225.000 Z+120.000
(
(
()
$G54
%
O7
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T2 M6
N0024 S1200 M3
N0026 G0 G43 Z50. H2
N0028 G0 X0. Y0.
N0030 G0 Z20.
N0032 G0 Z2.
N0034 G1 Z0. F200
N0036 G1 Z-10. F60
N0038 G1 X16. F200
N0040 G2 X-16. I-16. J0.
N0042 G2 X16. I16. J0.
N0044 G1 X28.
N0046 G2 X-28. I-28. J0.
N0048 G2 X28. I28. J0.
N0050 G2 X40. I6. J0.
N0052 G2 X-40. I-40. J0.
N0054 G2 X40. I40. J0.
N0056 G2 X0. I-20. J0. F600
N0058 G0 Z20.
```

```
N0060 G0 Z100.  
N0062 G0 X150. Y150.  
N0064 M5  
N0066 T6 M6  
N0068 S2800 M3  
N0070 G0 G43 Z50. H6  
N0072 G0 X0. Y0.  
N0074 F40  
N0076 G0 X40.  
N0078 G0 Z20.  
N0080 G81 G99 Z-13. R-9. K0  
N0082 M98 P129120  
N0106 G80  
N0111 G69  
N0108 G0 Z100.  
N0110 M5  
N0112 T3 M6  
N0114 S1800 M3  
N0116 G0 G43 Z50. H3  
N0118 G0 X0. Y0.  
N0120 F80  
N0122 G0 X40.  
N0124 G0 Z20.  
N0126 G83 G99 Z-35. R-9. Q10. K0  
N0128 M98 P129120  
N0152 G80  
N0157 G69  
N0154 G0 Z100.  
N0156 M5  
N0158 G0 X150. Y150.  
N0162 M30  
%  
  
:9120  
N0015 G68 G91 R30  
N0020 G90 X40 Y0  
N0025 M99
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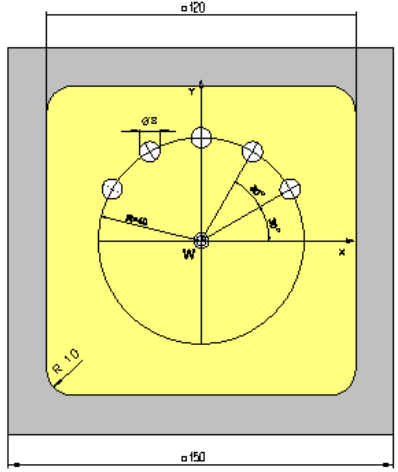
4.5 Exercise 5: Plate B with bolt holes and a square pocket

The plate B on the drawing with bolt holes and a square pocket is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 150 x 150 x 50 mm. Prepare, test and correct the manufacturing process with the MTS CNC Milling Simulator. Define the workpart zero, work out the process layout, set-up form and NC program.

Use cycles G81 and G83 and a subprogram for the hole pattern.



	Fit size	Deviation



depth of square pocket 10 mm

depth of hole = 35 mm top surface

Established by INCAD Version 3.1		General tolerance ISO 2768-mS	Scale 150x150x50
Drawn	Date	Drawn	Plate B
Entered		Checked	
Checked		Approved	
Approved			
NC program M(KS):		Page 1 of 1	
State	Modification	Date	Name
Prepared by		Replaced by	

Learning Objective: The learner can describe the function and the calling of canned cycles.

Special Training Elements: Use cycle G81 as modal command and repeat it at several positions, retraction to clearance plane (G99). Write the positions into the first subprogram and cancel the cycle with G80. In the second subprogram rotate the coordinate system and go to the position of execution. Call the subprogram with repetition. Cancel the cycle with G80.

Exercise 5: Plate B with bolt holes and a square pocket

	Fit size	Deviation

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depth of square pocket 10 mm
depth of hole = 35 mm top surface

Established by INCAD Version 3.1		General tolerance ISO 2768-m		Scale 150x150x50	
		1997 Date	Name	Plate B	
		Estab	Schmidt		
		Check			
		Norm			
		NC program No(S):		Page 1 of	
Stat	Iteration	Date	Name	Replacement for	Replaced by

4.5.1 Possible solution: Program BOHR9140.FNC

```
()
(( 10.11.2005 07:35
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+150.000 Y+150.000 Z+050.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\ViselRS 160"
( CHUCKING DEPTH E+050.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-18.0 032K HSS ISO 1641"
( T03 "ISO SK 30\DRILL\DR-08.00 075 HSS ISO 235"
( T06 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
(
( TOOL COMPENSATION
( D02 T02 R009.000 Z+107.000 N01
( D03 T03 R004.000 Z+120.900 N01
( D06 T06 R000.000 Z+065.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( G54 X+275.000 Y+225.000 Z+120.000
(
(
()
$G54
%
O8
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T2 M6
N0024 S1200 M3
N0026 G0 G43 Z50. H2
N0028 G0 X0. Y0.
N0030 G0 Z20.
N0032 G0 Z2.
N0034 G1 Z-10. F60
N0036 G1 Y14.4 F200
N0038 G1 X14.4
N0040 G1 Y-14.4
N0042 G1 X-14.4
N0044 G1 Y28.8
N0046 G1 X28.8
N0048 G1 Y-28.8
N0050 G1 X-28.8
N0052 G1 Y39.9
N0054 G1 X39.9
N0056 G1 Y-39.9
N0058 G1 X-39.9
```

Exercise 5: Plate B with bolt holes and a square pocket

N0060 G1 Y39.9

N0062 G2 X-28.8 Y51. I11.1 J0.

N0064 G1 X50.

N0066 G2 X51. Y50. IO. J-1.

N0068 G1 Y-50.

N0070 G2 X50. Y-51. I-1. J0.

N0072 G1 X-50.

N0074 G2 X-51. Y-50. IO. J1.

N0076 G1 Y50.

N0078 G2 X-50. Y51. I1. J0.

N0080 G1 X-28.8

N0082 G2 X0. Y0. IO. J-33.632 F600

N0084 G0 Z-9.

N0086 G0 Z20.

N0088 G0 Z100.

N0090 G0 X150. Y150.

N0092 M5

N0094 T6 M6

N0096 S2800 M3

N0098 G0 G43 Z50. H6

N0100 G0 X0. Y0.

N0102 F40

N0104 G0 X34.641 Y20.

N0106 G0 Z20.

N0108 G81 G99 Z-13. R-9. K0

N0110 M98 P9140

N0122 G0 Z100.

N0124 M5

N0126 T3 M6

N0128 S1800 M3

N0130 G0 G43 Z50. H3

N0132 G0 X0. Y0.

N0134 F80

N0136 G0 X34.641 Y20.

N0138 G0 Z20.

N0140 G83 G99 Z-25. R-9. Q10. K0

N0144 M98 P59141

N0149 G80

N0154 G69

N0154 G0 Z100.

N0156 M5

N0158 G0 X150. Y150.

N0162 M30

%

:9140

N0110 X34.641 Y20.

N0112 X20. Y34.641

N0114 X0. Y40.

N0116 X-20. Y34.641

N0118 G98 X-34.641 Y20.

N0120 G80

N0125 M99

%

:9141

N0015 G68 G91 R30

N0020 G90 X40 Y0

N0025 M99

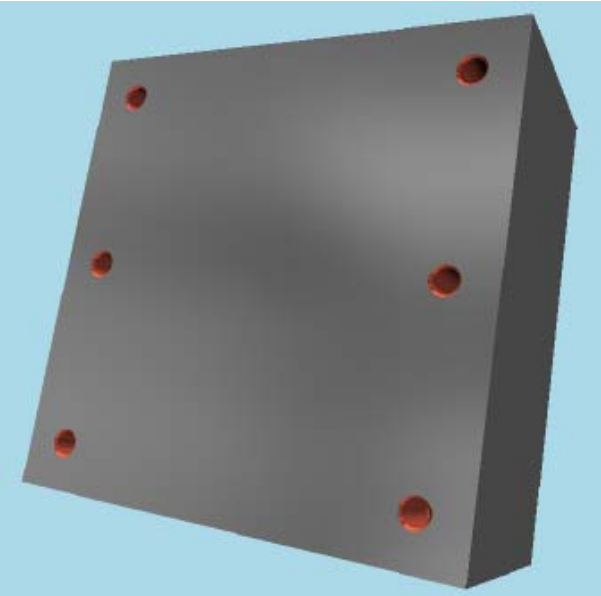
%

4.6 NC programs using subprogram technology

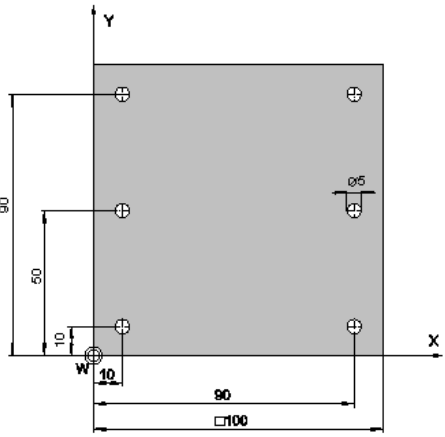
4.6.1 Exercise 6: Plate S1

The plate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 100 x 100 x 50 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.

Program with ISO code.



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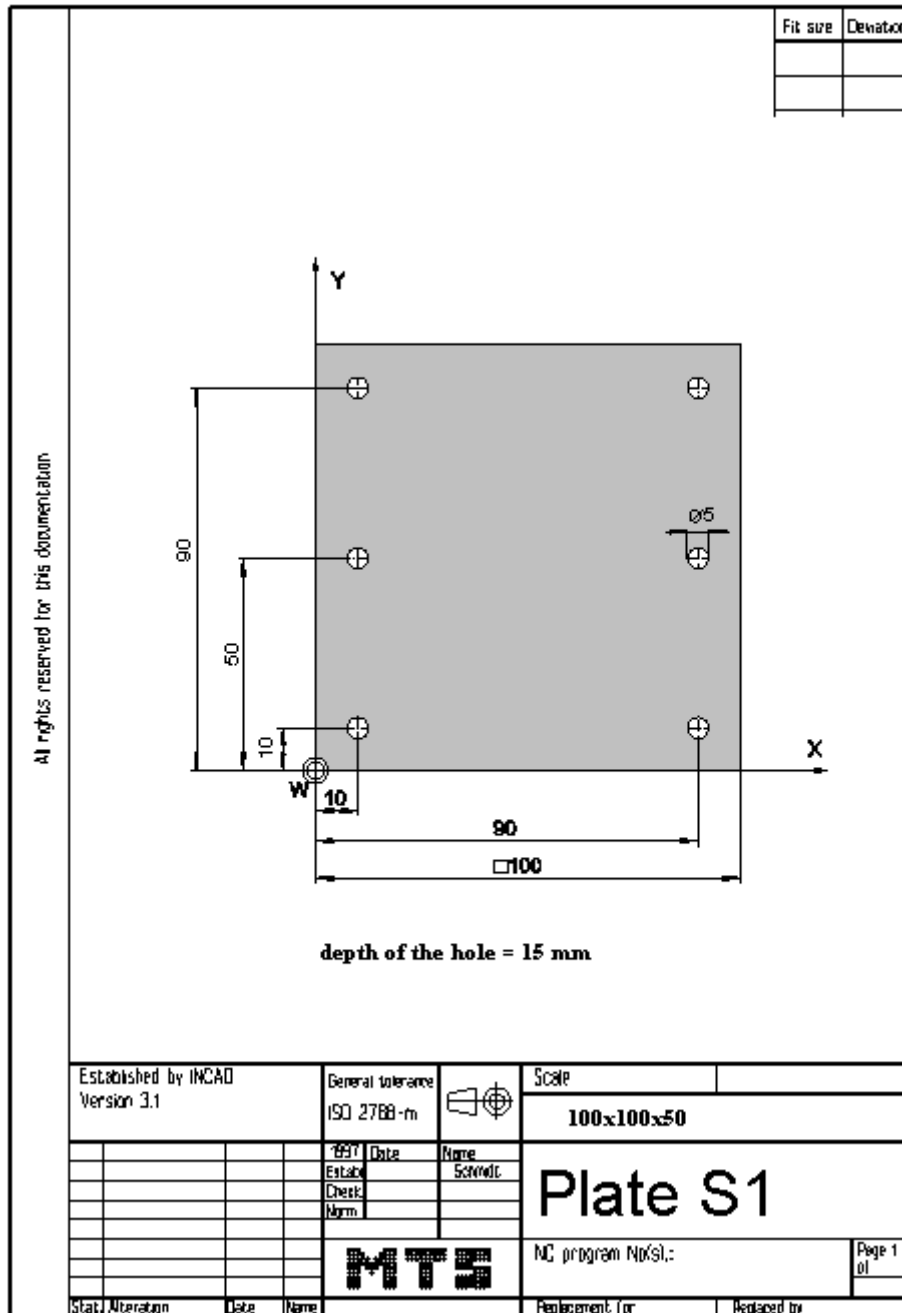


depth of the hole = 15 mm

Established by INCAD		General tolerance	Scale			
Version 3.1		ISO 2768-m	100x100x50			
Estab.	Date	Drawn	Plate S1			
Check		Scale				
Drawn						
		MTS	NC program No(S):			
Stat.	Microkann	Date	Name	Replacement for	Replaced by	Page 1 of 1

Learning Objective: The learners are capable of optimizing program runs by the use the subprogram technology.

Special Training Elements: Use ISO code.



4.6.2 Possible solution: Program UNTG1.FNC

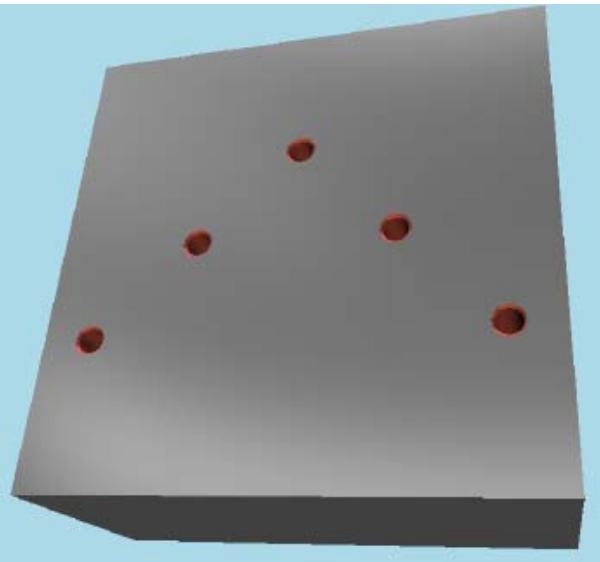
```
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( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+100.000 Y+100.000 Z+050.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+050.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T03 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T06 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
(
( TOOL COMPENSATION
( D03 T03 R002.500 Z+097.900 N01
( D06 T06 R000.000 Z+065.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( G54 X+200.000 Y+150.000 Z+120.000
(
(
)
$G54
%
O17
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T6 M6
N0024 S2800 M3
N0026 G0 X10. Y10.
N0028 G0 G43 Z2. H6
N0030 G1 Z-3. F40 M7
N0032 G0 Z2.
N0034 G0 Y50.
N0036 G1 Z-3.
N0038 G0 Z2.
N0040 G0 Y90.
N0042 G1 Z-3.
N0044 G0 Z2.
N0046 G0 X90.
N0048 G1 Z-3.
N0050 G0 Z2.
N0052 G0 Y50.
N0054 G1 Z-3.
N0056 G0 Z2.
N0058 G0 Y10.
N0060 G1 Z-3.
N0062 G1 Z100.
```

N0064 M5
N0066 M9
N0068 G1 X150. Y150.
N0070 T3 M6
N0072 S1800 M3
N0074 G0 X10. Y10.
N0076 G0 G43 Z2. H3
N0078 G1 Z-15. F80 M7
N0080 G0 Z2.
N0082 G0 Y50.
N0084 G1 Z-15.
N0086 G0 Z2.
N0088 G0 Y90.
N0090 G1 Z-15.
N0092 G0 Z2.
N0094 G0 X90.
N0096 G1 Z-15.
N0098 G0 Z2.
N0100 G0 Y50.
N0102 G1 Z-15.
N0104 G0 Z2.
N0106 G0 Y10.
N0108 G1 Z-15.
N0110 G1 Z100.
N0112 M5
N0114 M9
N0116 G1 X150. Y150.
N0120 M30
%

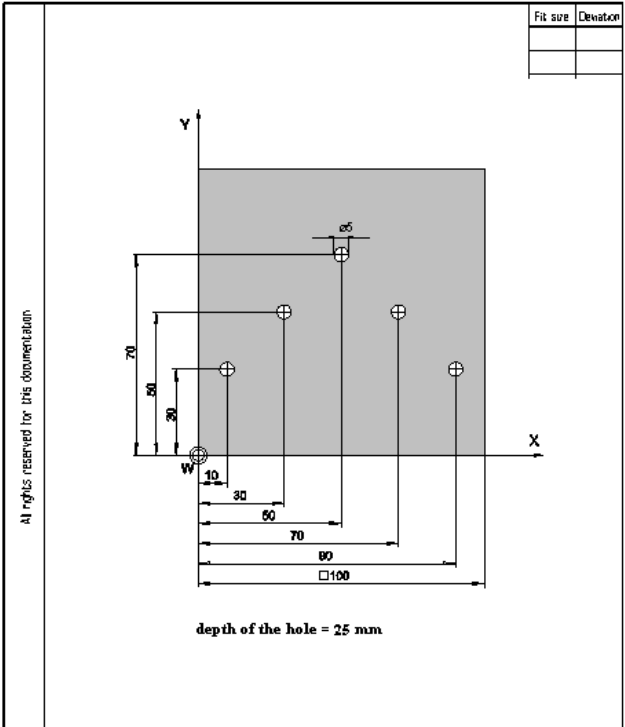
4.6.3 Exercise 6: Plate S2

The jig plate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 100 x 100 x 50 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.

Use cycles G81 with repetition..



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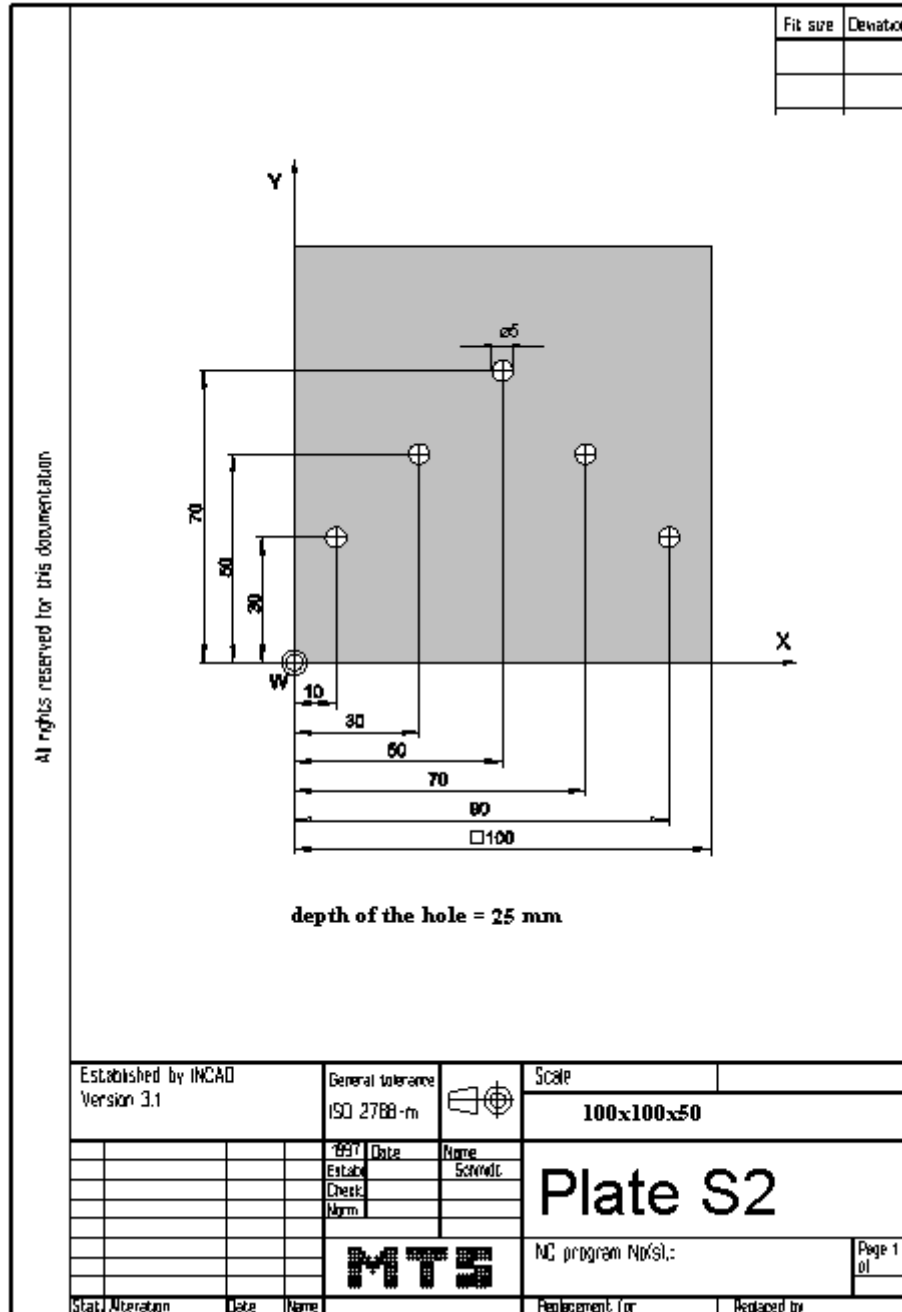


depth of the hole = 25 mm

Established by INCAD Version 3.1		General tolerance ISO 2768-m	Scale 100x100x50			
EST	Date	Name	<h2>Plate S2</h2>			
Estab		Schmitt				
Check						
Norm						
MTS			NC program No(S):			
Stat	Merkmal	Date	Name	Replacement for	Replaced by	Page 1 of 1

Learning Objective: The learners are capable of optimizing program runs by the use the subprogram technology.

Special Training Elements: Use cycles G81 with repetition and as modal command with repetition. If using drilling cycle with repetition K, G91 is necessary.



4.6.4 Possible solution: Program UNTG1B.FNC

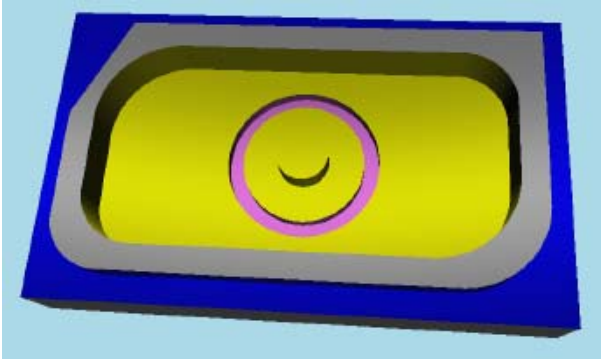
```
()
(( 9.11.2005 14:15
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+100.000 Y+100.000 Z+050.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+050.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T03 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T06 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
(
( TOOL COMPENSATION
( D03 T03 R002.500 Z+097.900 N01
( D06 T06 R000.000 Z+065.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+120.000
( G54 X+200.000 Y+150.000 Z+120.000
(
(
)
$G54
%
O18
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54 G90 G97
N0022 T6 M6
N0024 S2800 M3
N0026 G0 X-10. Y10. M8
N0028 G0 G43 Z5. H6
N0030 G81 G91 X20. Y20. Z-5. R-3. K3
N0034 X20. Y-20. K2
N0040 G80
N0058 G0 G90 Z100.
N0060 M5
N0062 M9
N0064 G0 X150. Y150.
N0069 T3 M6
N0066 S1800 M3
N0068 G0 X-10. Y10. M8
N0073 G0 G43 Z5. H3
N0070 G81 G91 X20. Y20. Z-17. R-3. K3
N0072 X20. Y-20. K2
N0100 G0 G90 Z100.
N0106 G0 X150. Y150.
N0110 M30
%
```

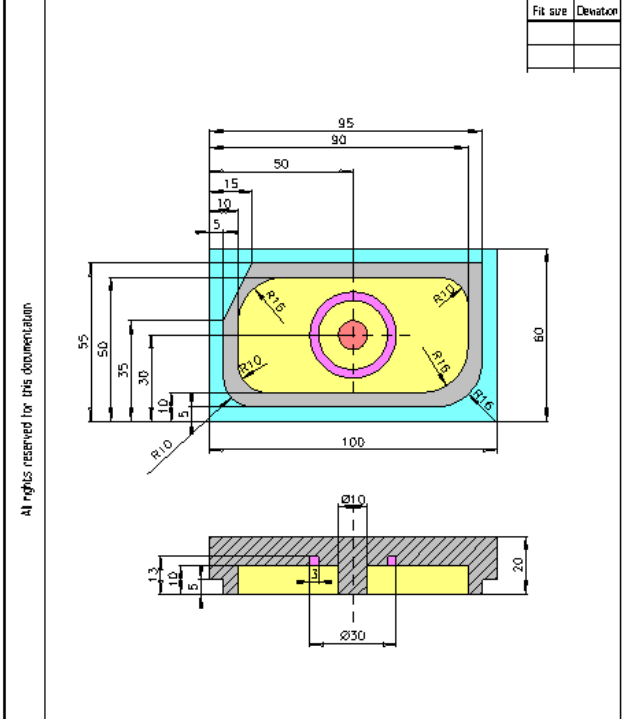
4.7 Complex NC programs

4.7.1 Exercise 7: Plate

The plate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 100 x 100 x 25 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.

Process layout and set-up form.



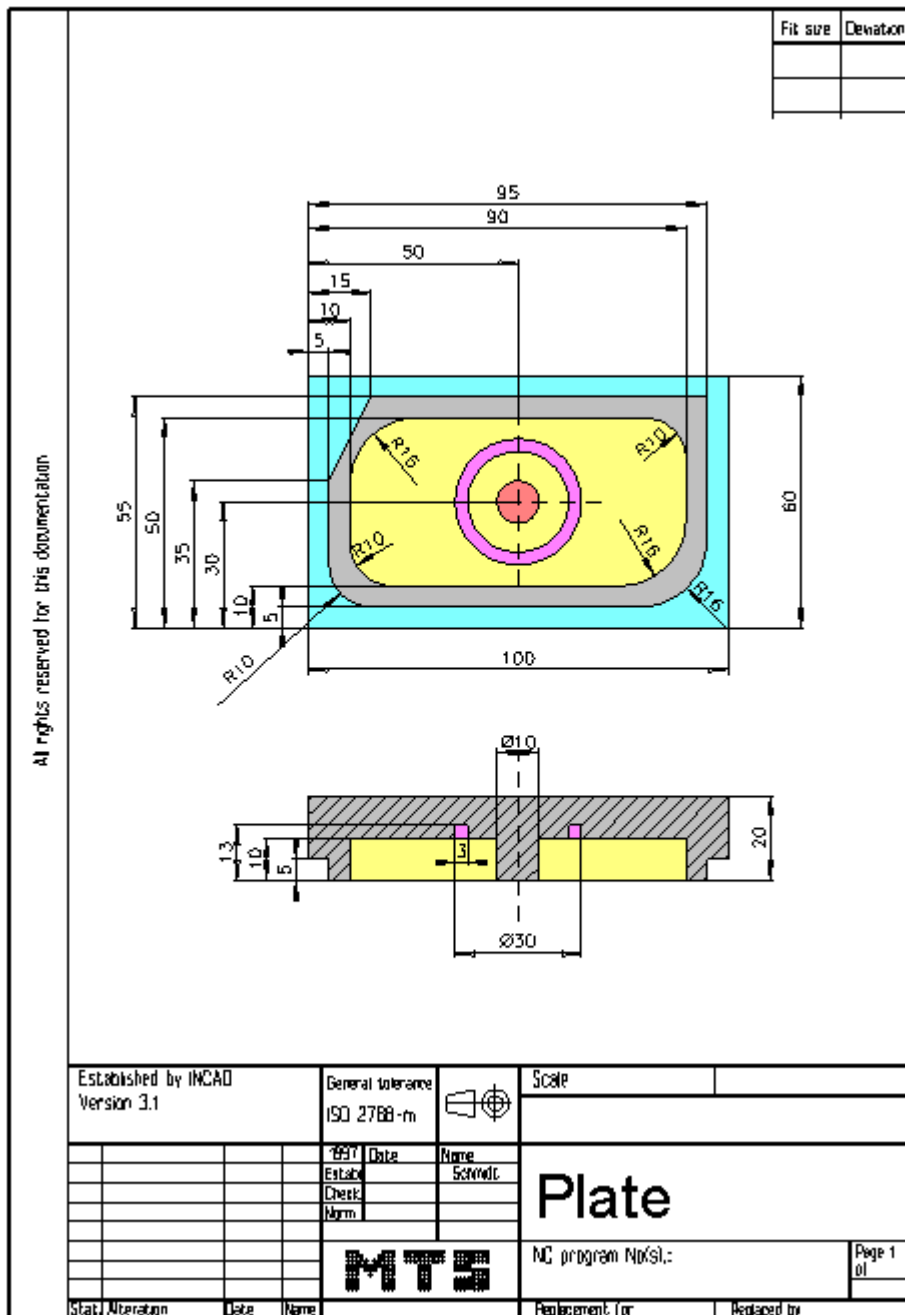


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Established by INCAD Version 3.1		General tolerance ISO 2768-m	Scale									
		<table border="1" style="font-size: x-small;"> <tr><td>Drawn</td><td>Date</td><td>Name</td></tr> <tr><td>Checked</td><td></td><td>Schwarz</td></tr> <tr><td>Approved</td><td></td><td></td></tr> </table>	Drawn	Date	Name	Checked		Schwarz	Approved			<h1>Plate</h1>
Drawn	Date	Name										
Checked		Schwarz										
Approved												
		NC program No(S):	Page 1 of 1									
Stat.	Iteration	Date	Name	Replacement for	Replaced by							

Learning Objective: He is capable of milling a workpart of medium complexity. He writes and tests an operable CNC program.

Special Training Elements: Use ISO commands.



4.7.2 Possible solution: Program: PLATTE8.FNC

```

()
(( 15.11.2005 16:13
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+100.000 Y+060.000 Z+020.000
( PART POSITION X+200.000 Y+160.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+160.000 Z+128.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+012.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SLOT MILLING TOOL\MS-14.0 026K HSS ISO 1641" FFFF00
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-10.0 022K HSS ISO 1641"
( T03 "ISO SK 30\SLOT MILLING TOOL\MS-30.0 045K HSS ISO 1641"
( T04 "ISO SK 30\TAP\TA-M06.0 1.00 HSS ISO 2857"
( T05 "ISO SK 30\SLOT MILLING TOOL\MS-03.0 010K HSS ISO 1641" FF80FF
(
( TOOL COMPENSATION
( D01 T01 R007.000 Z+113.000 N01
( D02 T02 R005.000 Z+087.000 N01
( D03 T03 R015.000 Z+136.000 N01
( D04 T04 R000.000 Z+090.000 N01
( D05 T05 R001.500 Z+066.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+160.000 Z+128.000
( G54 X+200.000 Y+160.000 Z+128.000
(
(
)
$G54
%
O15
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T3 M6
N0024 S950 M3
N0026 G0 G43 Z50. H3
N0028 G0 X130. Y60.
N0030 G0 Z2.
N0032 G1 Z-5. F300 M7
N0034 G41 G1 X120. Y50. D3 F200
N0036 G3 X95. Y25. I0. J-25.
N0038 G1 Y21.
N0040 G2 X79. Y5. I-16. J0.
N0042 G1 X15.
N0044 G2 X5. Y15. I0. J10.
N0046 G1 Y35.
N0048 G1 X15. Y55.
N0050 G1 X95.

```

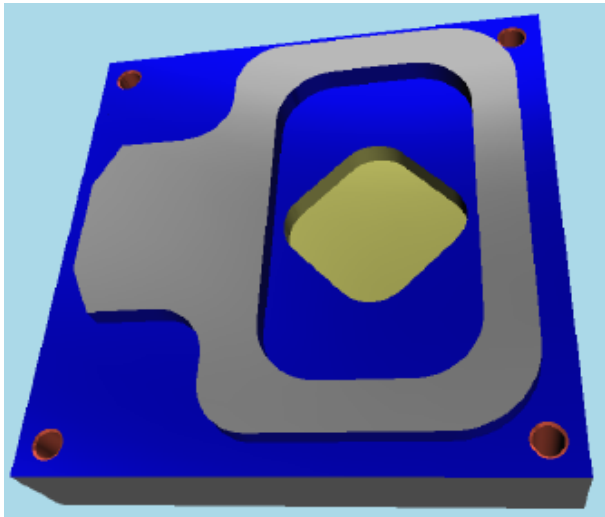
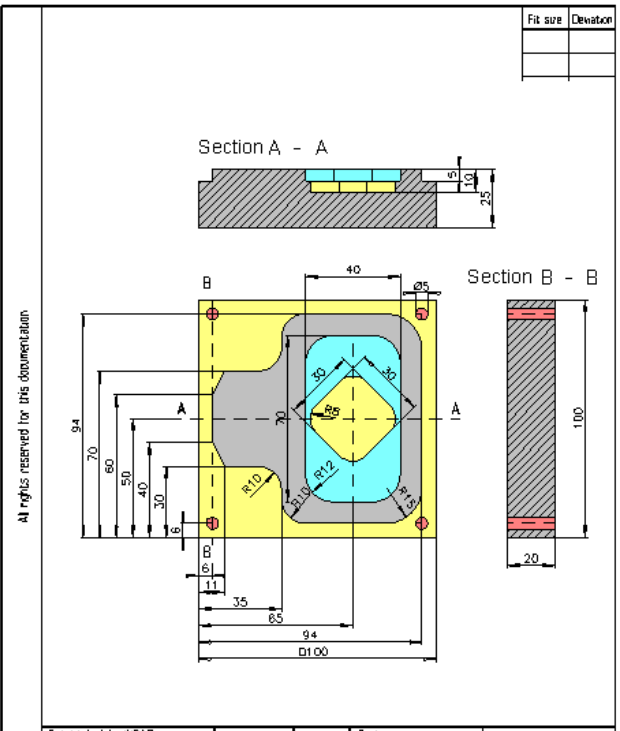
Complex NC programs

N0052 G1 Y25.
N0054 G3 X125. Y0. I24.995 J-0.506
N0056 G40
N0058 G0 Z100.
N0060 G0 X121.997 Y14.696
N0062 M5
N0064 M9
N0066 T1 M6
N0068 S2000 M3
N0070 G0 G43 Z50. H1
N0072 G0 X50. Y30.
N0074 G0 Z2.
N0076 G1 Z-5. F300 M7
N0078 G41 G1 X90. Y30. D1 F200
N0080 G1 Y40.
N0082 G3 X80. Y50. I-10. J0.
N0084 G1 X26.
N0086 G3 X10. Y34. I0. J-16.
N0088 G1 Y20.
N0090 G3 X20. Y10. I10. J0.
N0092 G1 X74.
N0094 G3 X90. Y26. I0. J16.
N0096 G1 Y35.
N0098 G40
N0100 G0 Z2.
N0102 G0 X83. Y35.
N0104 G0 X70. Y30.
N0106 G0 Z-4.
N0108 G1 Z-10. F300
N0110 G41 G1 X90. Y30. D1 F200
N0112 G1 Y40.
N0114 G3 X80. Y50. I-10. J0.
N0116 G1 X26.
N0118 G3 X10. Y34. I0. J-16.
N0120 G1 Y20.
N0122 G3 X20. Y10. I10. J0.
N0124 G1 X74.
N0126 G3 X90. Y26. I0. J16.
N0128 G1 Y35.
N0130 G40
N0132 G0 Z100.
N0134 G0 X83. Y35.
N0136 M5
N0138 M9
N0140 G0 Z50. M3
N0142 G0 X70. Y30.
N0144 G0 Z2.
N0146 G1 Z-10. F300 M7
N0148 G41 G1 X55. Y30. D1 F200
N0150 G2 I-5. J0.
N0152 G40
N0154 G0 Z2.
N0156 G0 X62. Y30.
N0158 G0 X37.
N0160 G1 Z-5.
N0162 G1 X18.
N0164 G1 Z-10.
N0166 G1 X37.
N0168 G0 Z100.
N0170 M5
N0172 M9
N0174 T5 M6
N0176 S2500 M3

N0178 G0 G43 Z50. H5
N0180 G0 X63.5
N0182 G0 Z-8.
N0184 G1 Z-13. F300
N0186 G2 I-13.5 J0. F160
N0188 G0 Z100.
N0190 M5
N0192 G0 X110. Y80.
N0196 M30
%

4.7.3 Exercise 8: Contact plate

The contact plate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 100 x 100 x 25 mm. Prepare, test and correct the manufacturing process with the MTS CNC Milling Simulator. Define the workpart zero, work out the process layout, set-up form and NC program.

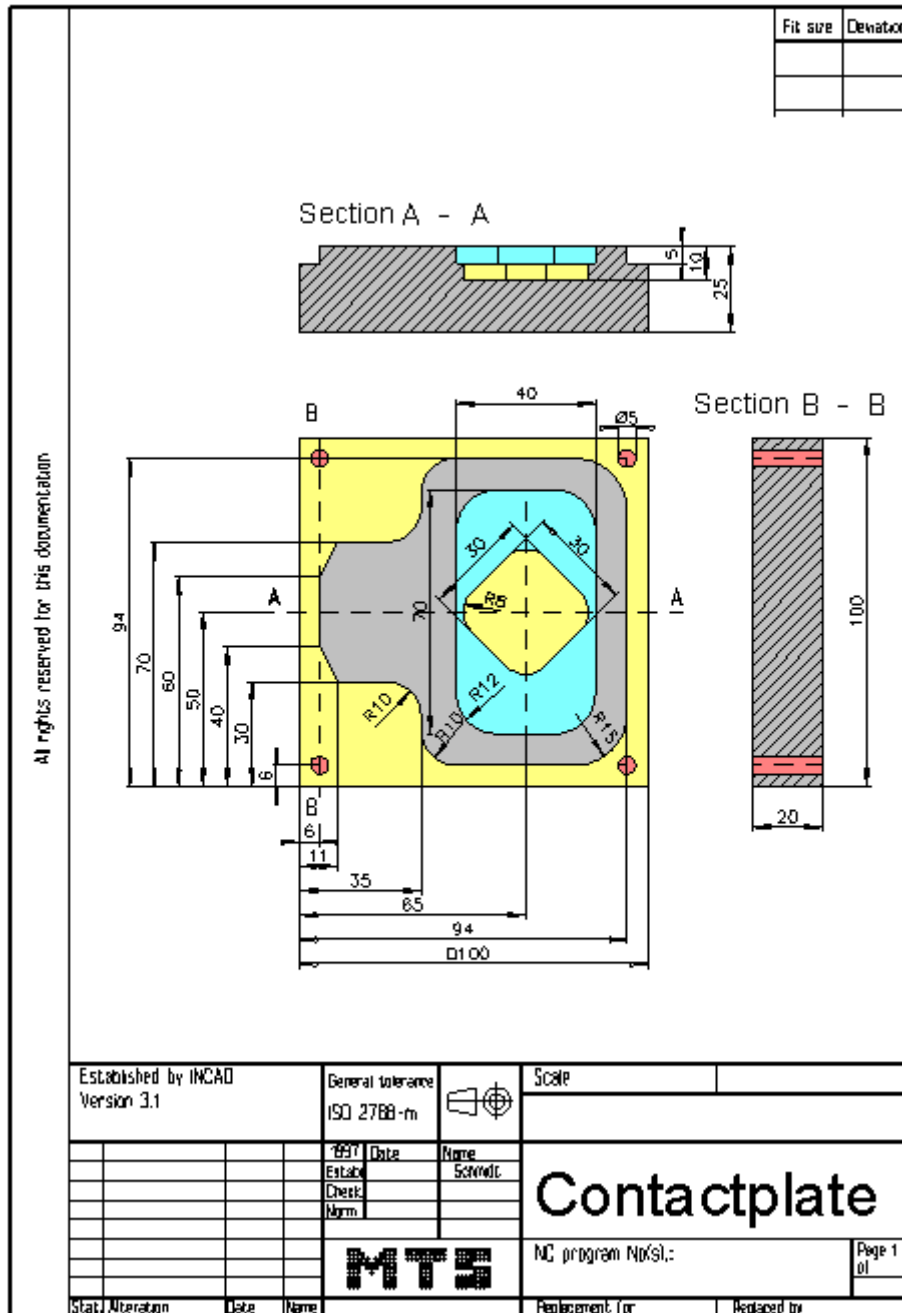
Fit	Deviation

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Established by INCAD Version 3.1		General tolerance ISO 2768-m	Scale
			<h1>Contactplate</h1>
			NC program No:Sl:
			Page 1 of 1
Stat:	Mitwirkend	Date:	
		Name:	

Learning Objective: He is capable of milling a workpart of medium complexity He writes and tests an operable CNC program.

Special Training Elements: Cutter radius compensation, canned cycles. For drilling operation shift the origin and rotate. Use a subprogram with repetition. Cancel rotation and zero shift.



4.7.4 Possible solution: Program: KONTAKT.FNC

```
()
(( 16.11.2005 06:47
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+100.000 Y+100.000 Z+025.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+130.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+015.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SHELL END MILL\MW-040 032 HSS ISO 2586"
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-10.0 022K HSS ISO 1641" FFFF80
( T03 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T04 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
( T05 "ISO SK 30\SLOT MILLING TOOL\MS-16.0 032K HSS ISO 1641"
( T06 "ISO SK 30\SLOT MILLING TOOL\MS-05.0 013K HSS ISO 1641"
( T07 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T08 "ISO SK 30\SIDEMILL\ME-20.0 038K HSS ISO 1641" 0000FF
(
( TOOL COMPENSATION
( D01 T01 R020.000 Z+115.500 N01
( D02 T02 R005.000 Z+087.000 N01
( D03 T03 R002.500 Z+097.900 N01
( D04 T04 R000.000 Z+065.000 N01
( D05 T05 R008.000 Z+107.000 N01
( D06 T06 R002.500 Z+072.000 N01
( D07 T07 R002.500 Z+097.900 N01
( D08 T08 R010.000 Z+119.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+130.000
( G54 X+200.000 Y+150.000 Z+130.000
(
(
)
$G54
%
O9
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T5 M6
N0024 S1300 M3
N0026 G0 G43 Z50. H5
N0028 G0 X118. Y85.
N0030 G0 Z2.
N0032 G1 Z-5. F300 M7
N0034 G41 G0 X112. Y73. D5
N0036 G3 X94. Y55. I0. J-18. F200
N0038 G1 Y21.
```

N0040 G2 X79. Y6. I-15. J0.
 N0042 G1 X45.
 N0044 G2 X35. Y16. I0. J10.
 N0046 G1 Y20.
 N0048 G3 X25. Y30. I-10. J0.
 N0050 G1 X11.
 N0052 G1 X6. Y40.
 N0054 G1 Y60.
 N0056 G1 X11. Y70.
 N0058 G1 X25.
 N0060 G3 X35. Y80. I0. J10.
 N0062 G1 Y84.
 N0064 G2 X45. Y94. I10. J0.
 N0066 G1 X79.
 N0068 G2 X94. Y79. I0. J-15.
 N0070 G1 Y50.
 N0072 G3 X112. Y32. I18. J0.
 N0074 G40
 N0076 G0 Z50.
 N0078 G0 X112. Y40.
 N0080 G0 X65. Y50.
 N0082 G0 Z20.
 N0084 G0 Z2.
 N0086 G0 Y35.
 N0088 G1 Z-5. F60
 N0090 G1 Y65. F200
 N0092 G2 Y77. I0. J6.
 N0094 G1 X73.
 N0096 G2 X77. Y73. I0. J-4.
 N0098 G1 Y27.
 N0100 G2 X73. Y23. I-4. J0.
 N0102 G1 X57.
 N0104 G2 X53. Y27. I0. J4.
 N0106 G1 Y73.
 N0108 G2 X57. Y77. I4. J0.
 N0110 G1 X65.
 N0112 G2 Y65. I0. J-6. F600
 N0114 G0 Z-4.
 N0116 G0 Z20.
 N0118 G0 Y50.
 N0120 G0 Z100.
 N0122 M5
 N0124 M9
 N0126 T2 M6
 N0128 S1600 M3
 N0130 G0 G43 Z50. H2
 N0132 G0 Z2. M7
 N0134 G0 Z-3.
 N0136 G1 Z-10. F60
 N0138 G1 X61.464 Y53.536 F200
 N0140 G1 X65. Y57.071
 N0142 G1 X72.071 Y50.
 N0144 G1 X65. Y42.929
 N0146 G1 X57.929 Y50.
 N0148 G2 Y57.071 I3.536 J3.536
 N0150 G1 X62.879 Y62.021
 N0152 G2 X67.121 I2.121 J-2.121
 N0154 G1 X77.021 Y52.121
 N0156 G2 Y47.879 I-2.121 J-2.121
 N0158 G1 X67.121 Y37.979
 N0160 G2 X62.879 I-2.121 J2.121
 N0162 G1 X52.979 Y47.879
 N0164 G2 Y52.121 I2.121 J2.121

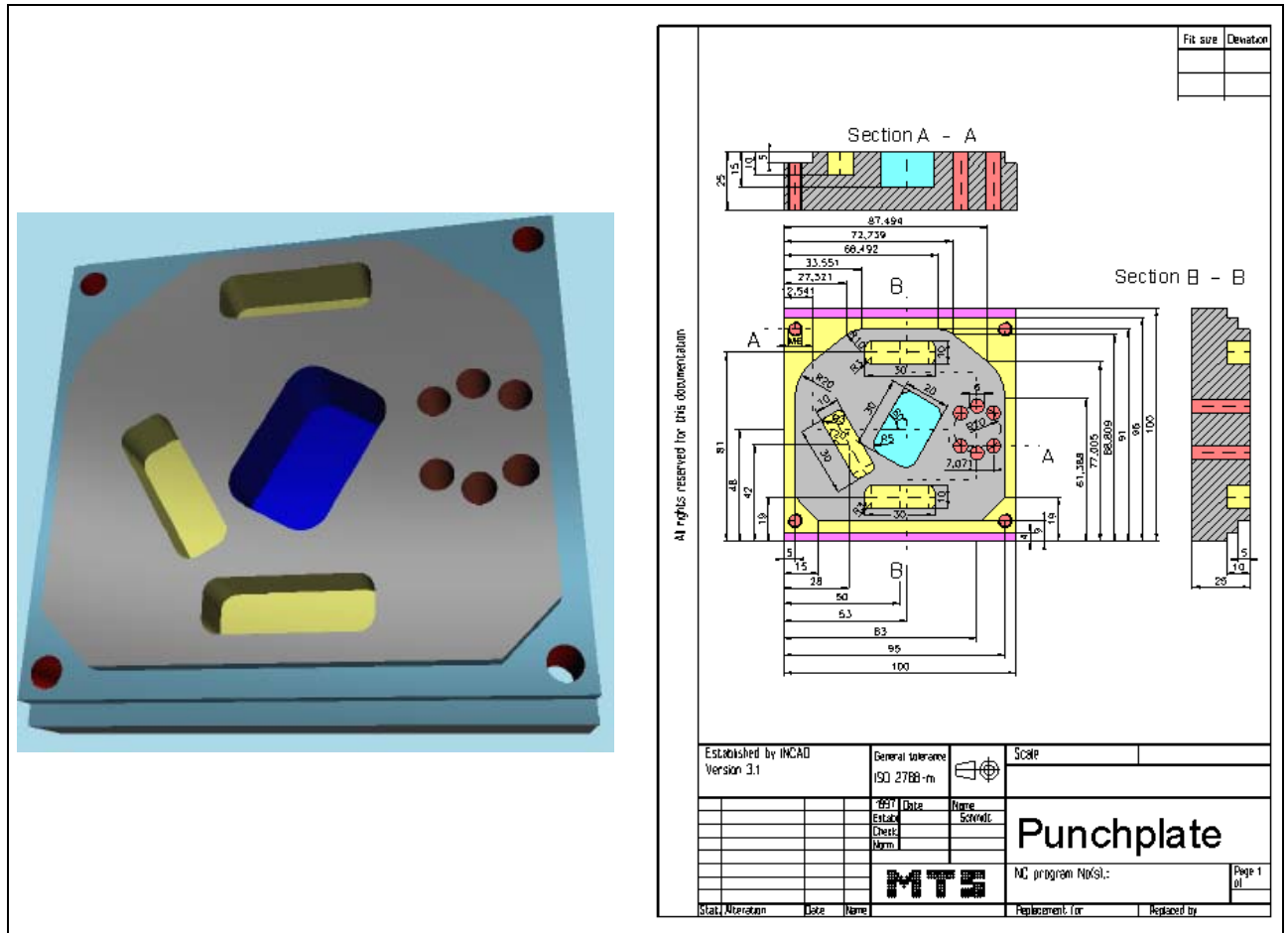
Complex NC programs

N0166 G1 X57.929 Y57.071
N0168 G2 X65. Y50. I3.536 J-3.536 F600
N0170 G0 Z-9.
N0172 G0 Z-3.
N0174 G0 Z100.
N0176 M5
N0178 M9
N0180 T8 M6
N0182 S1100 M3
N0184 G0 G43 Z50. H8
N0186 G0 X20. Y-12.
N0188 G0 Z2.
N0190 G1 Z-5. F300 M7
N0192 G1 Y7. F150
N0194 G1 X0.
N0196 G1 Y15.
N0198 G0 Z2.
N0200 G0 X-20. Y88.
N0202 G1 Z-5.
N0204 G1 X17.
N0206 G1 Y100.
N0208 G1 X-12.
N0210 G0 Z100.
N0212 M5
N0214 M9
N0216 T4 M6
N0218 S2800 M3
N0220 G0 G43 Z50. H4
N0222 G0 X6. Y6.
N0224 F40
N0226 G0 Z20.
N0228 G81 G98 Z-8. R-3. K0
N0233 G52 X50. Y50.
N0238 G68 R225
N0243 M98 P41000
N0248 G80
N0248 G69
N0253 G52 G90 X0. Y0.
N0244 G0 Z100.
N0246 M5
N0248 T3 M6
N0250 S1600 M3
N0252 G0 G43 Z50. H3
N0254 G0 X6.
N0256 F70
N0258 G0 Z20.
N0260 G83 G98 Z-31. R-3. Q15. K0
N0262 G68 X50. Y50. R225
N0264 M98 P41000
N0274 G80
N0279 G69
N0276 G0 Z100.
N0278 M5
N0282 M30
%

:O1000
N0015 G90 X62.225 Y0
N0020 G68 G91 R90
N0025 M99
%

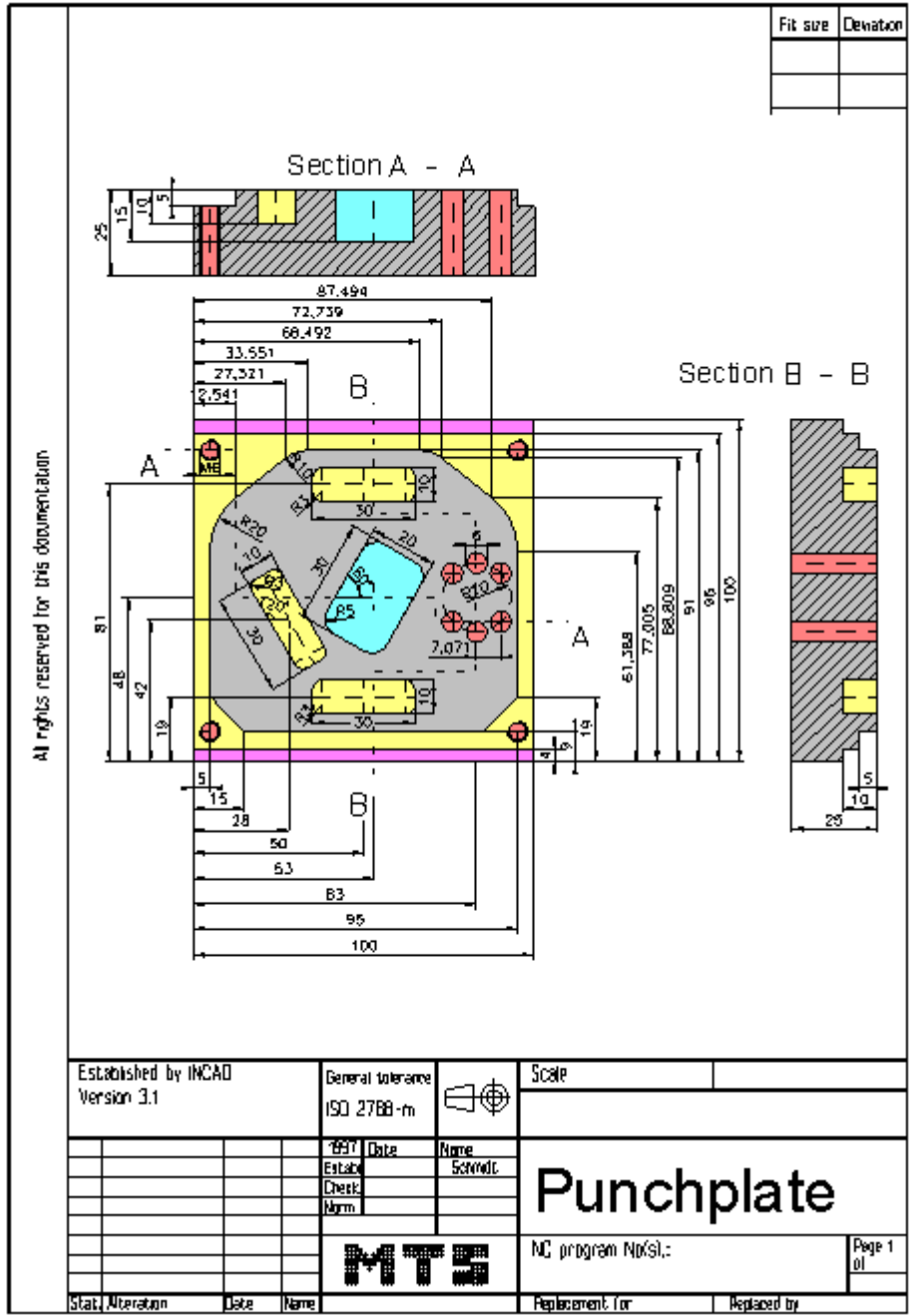
4.8 Exercise 9: Punch plate

The punch plate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 100 x 100 x 25 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.



Learning Objective: The learner is in an exam-like situation. He is capable of milling a workpart of higher complexity. He writes and tests an operable CNC program.

Special Training Elements: Cutter radius compensation, canned cycles. For centering, drilling and tapping use cycles and a subprogram for the positions. The next hole positions program in the main program. Define only cycles.



4.8.1 Possible solution: Program: STANZPL.FNC

```

()
(( 16.11.2005 07:32
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+100.000 Y+100.000 Z+025.000
( PART POSITION X+200.000 Y+130.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+130.000 Z+130.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+015.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SHELL END MILL\MW-040 032 HSS ISO 2586"
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-06.0 043L HSS ISO 1641" FFFF80
( T03 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T04 "ISO SK 30\TAP\TA-M06.0 1.00 HSS ISO 2857"
( T05 "ISO SK 30\SLOT MILLING TOOL\MS-10.0 022K HSS ISO 1641"
( T06 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
( T07 "ISO SK 30\DRILL\DR-06.00 063 HSS ISO 235"
( T08 "ISO SK 30\SLOT MILLING TOOL\MS-08.0 047L HSS ISO 1641"
(
( TOOL COMPENSATION
( D01 T01 R020.000 Z+115.500 N01
( D02 T02 R003.000 Z+105.000 N01
( D03 T03 R002.500 Z+097.900 N01
( D04 T04 R000.000 Z+090.000 N01
( D05 T05 R005.000 Z+087.000 N01
( D06 T06 R000.000 Z+065.000 N01
( D07 T07 R003.000 Z+108.900 N01
( D08 T08 R004.000 Z+109.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+130.000 Z+130.000
( G54 X+200.000 Y+130.000 Z+130.000
( G55 X+228.000 Y+172.000 Z+130.000
( G56 X+253.000 Y+178.000 Z+130.000
( G57 X+283.000 Y+178.000 Z+130.000
(
()
$G54
$G55
$G56
$G57
%
O16
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T1 M6
N0024 S950 M3
N0026 G0 G43 Z50. H1

```

Exercise 9: Punch plate

N0028 G0 X125. Y125.
N0030 G0 Z2.
N0032 G0 Z-10. M7
N0034 G42 G1 X125. Y96. D1 F200
N0036 G1 X-25.
N0038 G40
N0040 G0 Z2.
N0042 G0 X-25. Y116.
N0044 G0 Y-25.
N0046 G0 Z-10.
N0048 G42 G1 X-25. Y4. D1
N0050 G1 X125.
N0052 G40
N0054 G0 Z2.
N0056 G0 X125. Y-16.
N0058 G0 Y100.
N0060 G0 Z-5.
N0062 G41 G1 X115. Y100. D1
N0064 G3 X95. Y75. I4.995 J-24.496
N0066 G1 Y19.
N0068 G1 X85. Y9.
N0070 G1 X15.
N0072 G1 X5. Y19.
N0074 G1 Y61.388
N0076 G2 X12.541 Y77.005 I20. J-0.028
N0078 G1 X27.321 Y88.809
N0080 G2 X33.551 Y91. I6.247 J-7.809
N0082 G1 X66.492
N0084 G2 X72.739 Y88.809 I0. J-10.
N0086 G1 X87.494 Y77.005
N0088 G2 X95. Y61.388 I-12.494 J-15.617
N0090 G1 Y48.
N0092 G3 X125. Y18. I30. J0.
N0094 G40
N0096 G0 Z100.
N0098 G0 X125. Y38.
N0100 M5
N0102 M9
N0104 T6 M6
N0106 S2800 M3
N0108 G0 G43 Z20. H6
N0112 F40
N0116 G81 G98 Z-10. R-3. K0
N0118 M98 P2000
N0134 M5
N0136 T3 M6
N0138 S2200 M3
N0140 G0 G43 Z20. H3
N0146 G83 G98 Z-29. R-3. Q15. K0
N0148 M98 P2000
N0164 M5
N0166 T4 M6
N0168 S500 M3
N0170 G0 G43 Z20. H4
N0176 G84 G98 Z-29. R-1. K0
N0178 M98 P2000
N0194 M5
N0196 G55
N0198 T2 M6
N0200 S2200 M3
N0202 G0 G43 Z50. H2
N0204 G0 X0. Y0.
N0206 G0 Z20.

N0208 G0 Z2.
N0210 G0 X5. Y-8.66
N0212 G1 Z-6. F30
N0214 G1 X-5. Y8.66 F100
N0216 G2 X-6. Y10.392 I-0.5 J0.866
N0218 G1 X-4.268 Y11.392
N0220 G1 X7.732 Y-9.392
N0222 G1 X4.268 Y-11.392
N0224 G1 X-7.732 Y9.392
N0226 G1 X-6. Y10.392
N0228 G2 X-5. Y8.66 I0.5 J-0.866 F300
N0230 G0 Z-5.
N0232 G0 X5. Y-8.66
N0234 G1 Z-12. F30
N0236 G1 X-5. Y8.66 F100
N0238 G2 X-6. Y10.392 I-0.5 J0.866
N0240 G1 X-4.268 Y11.392
N0242 G1 X7.732 Y-9.392
N0244 G1 X4.268 Y-11.392
N0246 G1 X-7.732 Y9.392
N0248 G1 X-6. Y10.392
N0250 G2 X-5. Y8.66 I0.5 J-0.866 F300
N0252 G0 Z-11.
N0254 G0 Z20.
N0256 G0 X0. Y0.
N0258 G54
N0260 G0 X50. Y19.
N0262 G0 Z2.
N0264 G0 X40.
N0266 G1 Z-6. F30
N0268 G1 X60. F100
N0270 G2 X62. I1. J0.
N0272 G1 Y17.
N0274 G1 X38.
N0276 G1 Y21.
N0278 G1 X62.
N0280 G1 Y19.
N0282 G2 X60. I-1. J0. F300
N0284 G0 Z-5.
N0286 G0 X40.
N0288 G1 Z-12. F30
N0290 G1 X60. F100
N0292 G2 X62. I1. J0.
N0294 G1 Y17.
N0296 G1 X38.
N0298 G1 Y21.
N0300 G1 X62.
N0302 G1 Y19.
N0304 G2 X60. I-1. J0. F300
N0306 G0 Z-11.
N0308 G0 Z20.
N0310 G0 X50.
N0312 G0 Y81.
N0314 G0 Z2.
N0316 G0 X40.
N0318 G1 Z-6. F30
N0320 G1 X60. F100
N0322 G2 X62. I1. J0.
N0324 G1 Y79.
N0326 G1 X38.
N0328 G1 Y83.
N0330 G1 X62.
N0332 G1 Y81.

Exercise 9: Punch plate

N0334 G2 X60. I-1. J0. F300
N0336 G0 Z-5.
N0338 G0 X40.
N0340 G1 Z-12. F30
N0342 G1 X60. F100
N0344 G2 X62. I1. J0.
N0346 G1 Y79.
N0348 G1 X38.
N0350 G1 Y83.
N0352 G1 X62.
N0354 G1 Y81.
N0356 G2 X60. I-1. J0. F300
N0358 G0 Z-11.
N0360 G0 Z20.
N0362 G0 X50.
N0364 G0 Z100.
N0366 M5
N0368 G56
N0370 T8 M6
N0372 S1800 M3
N0374 G0 X0. Y0.
N0376 G0 G43 Z20. H8 M7
N0378 G0 Z2.
N0380 G0 X-2.5 Y-4.33
N0382 G1 Z-8. F30
N0384 G1 X2.5 Y4.33 F100
N0386 G2 X5.5 Y9.526 I1.5 J2.598
N0388 G1 X9.83 Y7.026
N0390 G2 X10.196 Y5.66 I-0.5 J-0.866
N0392 G1 X0.196 Y-11.66
N0394 G2 X-1.17 Y-12.026 I-0.866 J0.5
N0396 G1 X-9.83 Y-7.026
N0398 G2 X-10.196 Y-5.66 I0.5 J0.866
N0400 G1 X-0.196 Y11.66
N0402 G2 X1.17 Y12.026 I0.866 J-0.5
N0404 G1 X5.5 Y9.526
N0406 G2 X2.5 Y4.33 I-1.5 J-2.598 F300
N0408 G0 Z-7.
N0410 G0 X-2.5 Y-4.33
N0412 G1 Z-12.5 F30
N0414 G1 X2.5 Y4.33 F100
N0416 G2 X5.5 Y9.526 I1.5 J2.598
N0418 G1 X9.83 Y7.026
N0420 G2 X10.196 Y5.66 I-0.5 J-0.866
N0422 G1 X0.196 Y-11.66
N0424 G2 X-1.17 Y-12.026 I-0.866 J0.5
N0426 G1 X-9.83 Y-7.026
N0428 G2 X-10.196 Y-5.66 I0.5 J0.866
N0430 G1 X-0.196 Y11.66
N0432 G2 X1.17 Y12.026 I0.866 J-0.5
N0434 G1 X5.5 Y9.526
N0436 G2 X2.5 Y4.33 I-1.5 J-2.598 F300
N0438 G0 Z-11.5
N0440 G0 X-2.5 Y-4.33
N0442 G1 Z-17. F30
N0444 G1 X2.5 Y4.33 F100
N0446 G2 X5.5 Y9.526 I1.5 J2.598
N0448 G1 X9.83 Y7.026
N0450 G2 X10.196 Y5.66 I-0.5 J-0.866
N0452 G1 X0.196 Y-11.66
N0454 G2 X-1.17 Y-12.026 I-0.866 J0.5
N0456 G1 X-9.83 Y-7.026
N0458 G2 X-10.196 Y-5.66 I0.5 J0.866

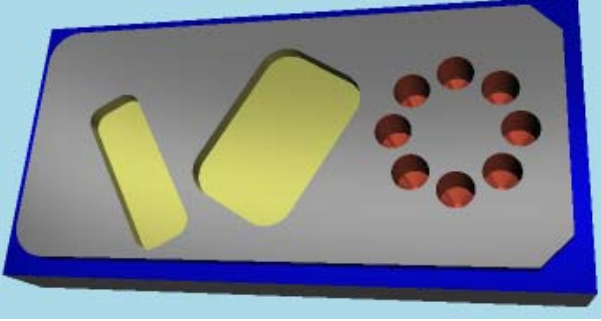
N0460 G1 X-0.196 Y11.66
N0462 G2 X1.17 Y12.026 I0.866 J-0.5
N0464 G1 X5.5 Y9.526
N0466 G2 X2.5 Y4.33 I-1.5 J-2.598 F300
N0468 G0 Z-16.
N0470 G0 Z20.
N0472 G0 X0. Y0.
N0474 G0 Z100.
N0476 M5
N0478 M9
N0480 G57
N0482 T6 M6
N0484 S2800 M3
N0486 G0 X0.
N0488 M7
N0490 F40
N0492 G0 X7.071 Y7.071
N0494 G0 G43 Z20. H6
N0496 G81 G98 Z-3. R2. K0
N0498 X7.071 Y7.071
N0500 X0. Y10.
N0502 X-7.071 Y7.071
N0510 X-7.071 Y-7.071
N0512 X0. Y-10.
N0514 X7.071 Y-7.071
N0516 G80
N0518 G0 Z100.
N0520 M5
N0522 M9
N0524 T7 M6
N0526 S2200 M3
N0528 G0 X0. Y0.
N0530 M7
N0532 F80
N0534 G0 X7.071 Y7.071
N0536 G0 G43 Z20. H7
N0538 G83 G98 Z-28. R2. Q15. K0
N0540 X7.071 Y7.071
N0542 X0. Y10.
N0544 X-7.071 Y7.071
N0552 X-7.071 Y-7.071
N0554 X0. Y-10.
N0556 X7.071 Y-7.071
N0558 G80
N0560 G0 Z100.
N0564 M9
N0566 M5
N0568 M30
%

:2000
N0010 X5. Y9.
N0015 X5. Y91.
N0020 X95. Y91.
N0025 X95. Y9.
N0030 G80
N0035 G0 Z100.
N0040 M99
%

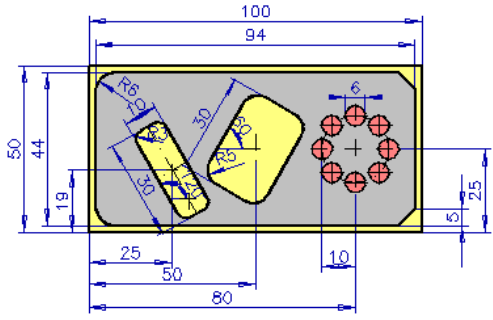
Exercise 9: Punch plate

4.8.2 Exercise 10: Device

The punchplate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 100 x 100 x 16 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.



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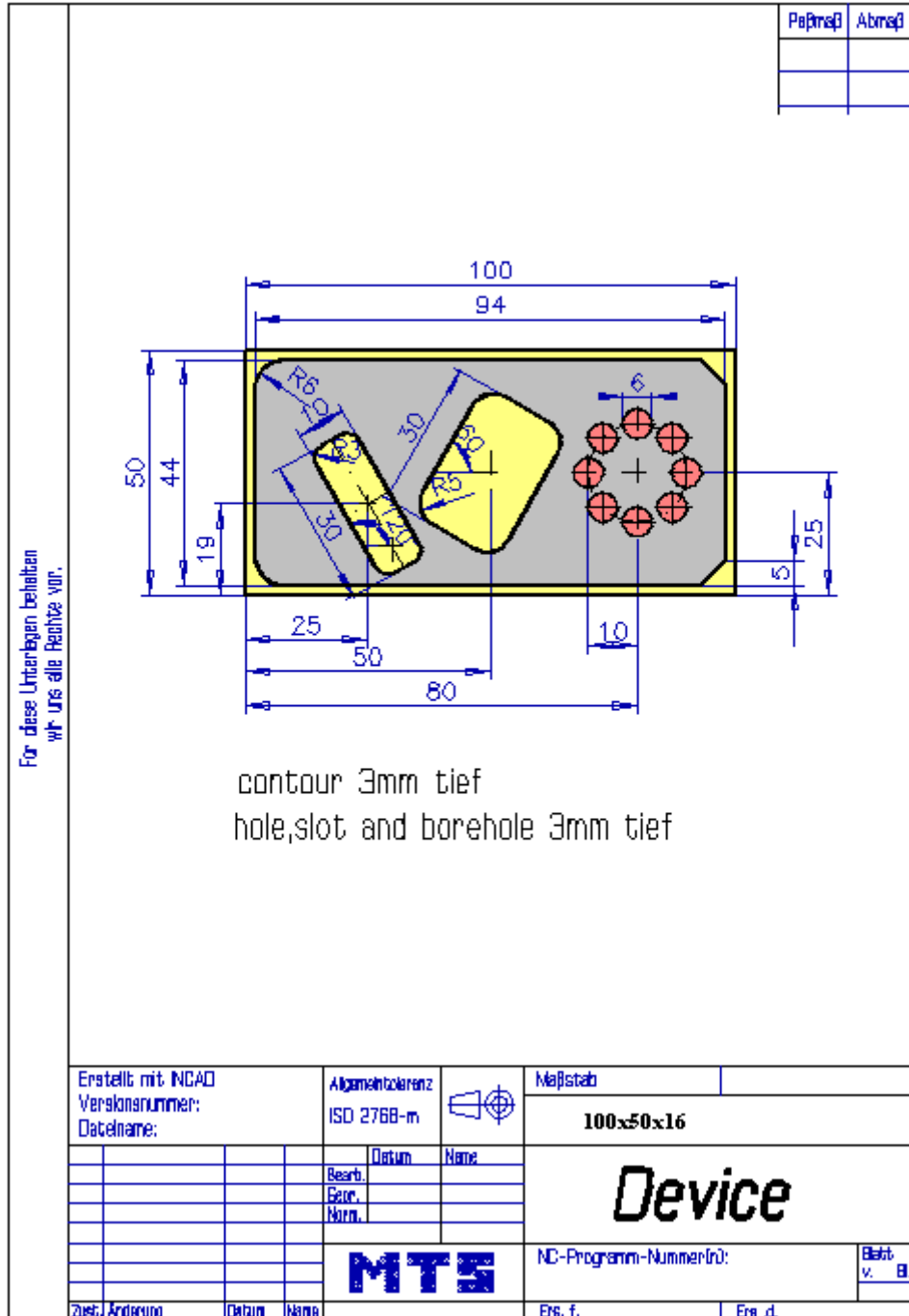


contour 3mm tief
hole, slot and borehole 3mm tief

Erstellt mit: NCAD		Allgemeinanz: ISO 2768-m		Meßstab: 100x50x16	
Versionsnummer:		Datum:		Device	
Dateiname:		Name:			
				MTS	
				NC-Programm-Nummer(n):	

Learning Objective: The learner is in an exam-like situation. He is capable of milling a workpart of higher complexity He writes and tests an operable CNC program.

Special Training Elements: Cutter radius compensation, canned cycles.



For these drawings we retain all rights.

Erstellt mit: NCAD	Allgemeintoleranz: ISD 2768-m	Maßstab: 100x50x16	
Versionsnummer:		<h1>Device</h1>	
Dateiname:			
	Datum	<h2>MTS</h2>	
	Name		
	Bearb.		
	Gez.		
	Norm.	NC-Programm-Nummer(n):	
Zust. Änderung	Datum	Name	Blatt v. Bl.
		Ers. f.	Ers. d.

4.8.3 Possible solution: Program: MTS-32.FNC

```
()
(( 16.11.2005 07:32
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+100.000 Y+100.000 Z+025.000
( PART POSITION X+200.000 Y+130.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+130.000 Z+130.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+015.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SHELL END MILL\MW-040 032 HSS ISO 2586"
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-06.0 043L HSS ISO 1641" FFFF80
( T03 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T04 "ISO SK 30\TAP\TA-M06.0 1.00 HSS ISO 2857"
( T05 "ISO SK 30\SLOT MILLING TOOL\MS-10.0 022K HSS ISO 1641"
( T06 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
(
( TOOL COMPENSATION
( D01 T01 R020.000 Z+115.500 N01
( D02 T02 R003.000 Z+105.000 N01
( D03 T03 R002.500 Z+097.900 N01
( D04 T04 R000.000 Z+090.000 N01
( D05 T05 R005.000 Z+087.000 N01
( D06 T06 R000.000 Z+065.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+130.000 Z+130.000
( G54 X+200.000 Y+130.000 Z+130.000
( G55 X+228.000 Y+172.000 Z+130.000
( G56 X+253.000 Y+178.000 Z+130.000
( G57 X+283.000 Y+178.000 Z+130.000
(
()
$G54
%
O11
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T1 M6
N0024 S1600 M3
N0026 G0 G43 Z50. H1
N0028 G0 X105. Y55.
N0030 G0 Z2.
N0032 G1 Z-3. F130 M8
N0034 G1 X101. Y60.
N0036 G1 Y55.
N0038 G1 Y8.
N0040 G2 X99.828 Y5.172 I-4. J0.
```

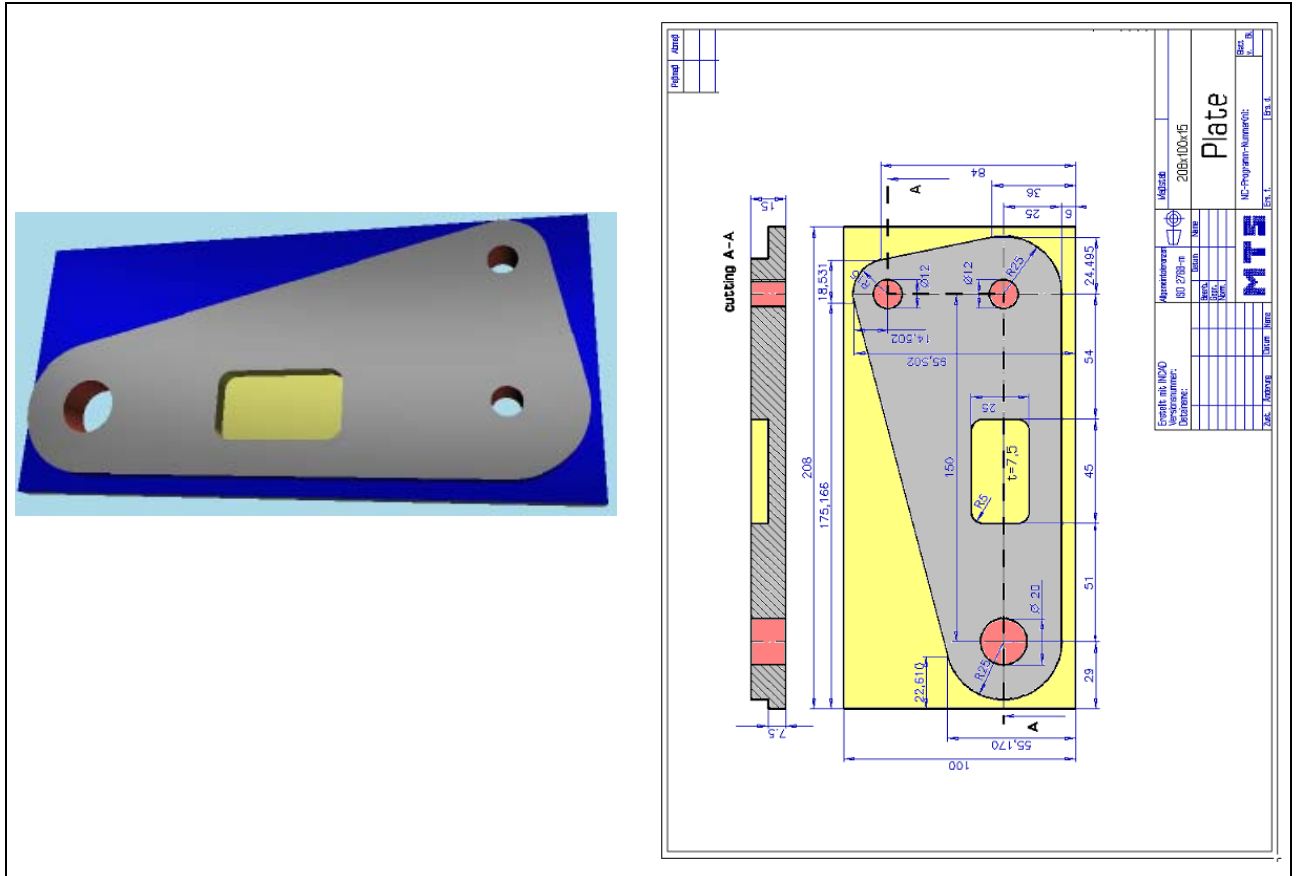
N0042 G1 X94.828 Y0.172
N0044 G2 X92. Y-1. I-2.828 J2.828
N0046 G1 X9.
N0048 G2 X-1. Y9. I0. J10.
N0050 G1 Y41.
N0052 G2 X9. Y51. I10. J0.
N0054 G1 X92.
N0056 G2 X94.828 Y49.828 I0. J-4.
N0058 G1 X99.828 Y44.828
N0060 G1 X110.435 Y34.222
N0062 G0 Z100.
N0064 M9
N0066 G0 X150. Y150.
N0068 M5
N0070 T2 M6
N0072 S2000 M3
N0074 G0 G43 Z50. H2
N0076 G0 X50. Y25.
N0078 G0 Z20.
N0080 G0 Z2.
N0082 G0 X47.5 Y20.67
N0084 G1 Z-3. F27
N0086 G1 X52.5 Y29.33 F90
N0088 G1 X54.375 Y32.578
N0090 G1 X57.623 Y30.703
N0092 G1 X48.873 Y15.547
N0094 G1 X42.377 Y19.297
N0096 G1 X51.127 Y34.453
N0098 G2 X56.25 Y35.825 I3.248 J-1.875
N0100 G1 X60.58 Y33.325
N0102 G2 X61.495 Y29.91 I-1.25 J-2.165
N0104 G1 X51.495 Y12.59
N0106 G2 X48.08 Y11.675 I-2.165 J1.25
N0108 G1 X39.42 Y16.675
N0110 G2 X38.505 Y20.09 I1.25 J2.165
N0112 G1 X48.505 Y37.41
N0114 G2 X51.92 Y38.325 I2.165 J-1.25
N0116 G1 X56.25 Y35.825
N0118 G2 X52.5 Y29.33 I-1.875 J-3.248 F270
N0120 G0 Z-2.
N0122 G0 Z20.
N0124 G0 X50. Y25.
N0126 G0 Z100.
N0128 G0 X150. Y150.
N0130 G0 Z50.
N0132 G0 X25. Y19. M8
N0134 G0 Z20.
N0136 G0 Z2.
N0138 G0 X30. Y10.34
N0140 G1 Z-3. F27
N0142 G1 X20. Y27.66 F90
N0144 G2 X18.75 Y29.825 I-0.625 J1.083
N0146 G1 X20.482 Y30.825
N0148 G2 X21.165 Y30.642 I0.25 J-0.433
N0150 G1 X33.165 Y9.858
N0152 G2 X32.982 Y9.175 I-0.433 J-0.25
N0154 G1 X29.518 Y7.175
N0156 G2 X28.835 Y7.358 I-0.25 J0.433
N0158 G1 X16.835 Y28.142
N0160 G2 X17.018 Y28.825 I0.433 J0.25
N0162 G1 X18.75 Y29.825
N0164 G2 X20. Y27.66 I0.625 J-1.083 F270
N0166 G0 Z-2.

Exercise 9: Punch plate

N0168 G0 Z20.
N0170 G0 X25. Y19.
N0172 G0 Z100.
N0174 M9
N0176 G0 X150. Y150.
N0178 M5
N0180 T3 M6
N0182 S2800 M3
N0184 G0 G43 Z50. H3
N0186 G0 X80. Y25. M8
N0188 F30
N0190 G0 X90.
N0192 G0 Z20.
N0194 G81 G98 Z-3. R2. K0
N0196 X90. Y25.
N0198 X87.071 Y32.071
N0200 X80. Y35.
N0202 X72.929 Y32.071
N0204 X70. Y25.
N0206 X72.929 Y17.929
N0208 X80. Y15.
N0210 X87.071 Y17.929
N0212 G80
N0214 G0 Z100.
N0216 M9
N0218 G0 X150. Y150.
N0220 M5
N0222 T4 M6
N0224 S1700 M3
N0226 G0 G43 Z50. H4
N0228 G0 X80. Y25. M8
N0230 F60
N0232 G0 X90.
N0234 G0 Z20.
N0236 G73 G98 Z-10. R2. Q10. K0
N0238 X90. Y25.
N0240 X87.071 Y32.071
N0242 X80. Y35.
N0244 X72.929 Y32.071
N0246 X70. Y25.
N0248 X72.929 Y17.929
N0250 X80. Y15.
N0252 X87.071 Y17.929
N0254 G80
N0256 G0 Z100.
N0258 M9
N0260 G0 X150. Y150.
N0262 M5
N0264 M30
%

4.8.4 Exercise 11: Plate

The punchplate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 208 x 100 x 15 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.



Learning Objective: The learner is in an exam-like situation. He is capable of milling a workpart of higher complexity He writes and tests an operable CNC program.

Special Training Elements: Cutter radius compensation, canned cycles. Use drilling cycle with repetition K0. K0 inside of the cycle only define the drilling cycle (not execution).

4.8.5 Possible solution: Program: MTS-33.FNC

```

()
(( 16.11.2005 13:06
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+208.000 Y+100.000 Z+015.000
( PART POSITION X+150.000 Y+100.000
(( Linke vordere obere Ecke des Werkstückes: X+150.000 Y+100.000 Z+129.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+006.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SLOT MILLING TOOL\MS-25.0 045K HSS ISO 1641"
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-08.0 047L HSS ISO 1641" FFFF80
( T03 "ISO SK 30\CORE DRILL\DC-12.5 090 HSS ISO 3294"
( T04 "ISO SK 30\DRILL\DR-20.00 130 HSS ISO 235"
( T05 "ISO SK 30\DRILL\DR-10.25 087 HSS ISO 235"
( T06 "ISO SK 30\REAMER\RE-D20.0 H7 HSS ISO 521"
(
( TOOL COMPENSATION
( D01 T01 R012.500 Z+136.000 N01
( D02 T02 R004.000 Z+109.000 N01
( D03 T03 R000.000 Z+075.000 N01
( D04 T04 R010.000 Z+182.900 N01
( D05 T05 R005.125 Z+132.900 N01
( D06 T06 R000.000 Z+170.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+150.000 Y+100.000 Z+129.000
( G54 X+150.000 Y+100.000 Z+129.000
( G55 X+228.000 Y+172.000 Z+130.000
( G56 X+253.000 Y+178.000 Z+130.000
( G57 X+283.000 Y+178.000 Z+130.000
(
()
$G54
%
O11
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T1 M6
N0024 S1600 M3
N0026 G0 G43 Z50. H1
N0028 G0 X105. Y55.
N0030 G0 Z2.
N0032 G1 Z-3. F130 M8
N0034 G1 X101. Y60.
N0036 G1 Y55.
N0038 G1 Y8.
N0040 G2 X99.828 Y5.172 I-4. J0.

```

Exercise 9: Punch plate

N0042 G1 X94.828 Y0.172
N0044 G2 X92. Y-1. I-2.828 J2.828
N0046 G1 X9.
N0048 G2 X-1. Y9. I0. J10.
N0050 G1 Y41.
N0052 G2 X9. Y51. I10. J0.
N0054 G1 X92.
N0056 G2 X94.828 Y49.828 I0. J-4.
N0058 G1 X99.828 Y44.828
N0060 G1 X110.435 Y34.222
N0062 G0 Z100.
N0064 M9
N0066 G0 X150. Y150.
N0068 M5
N0070 T2 M6
N0072 S2000 M3
N0074 G0 G43 Z50. H2
N0076 G0 X50. Y25.
N0078 G0 Z20.
N0080 G0 Z2.
N0082 G0 X47.5 Y20.67
N0084 G1 Z-3. F27
N0086 G1 X52.5 Y29.33 F90
N0088 G1 X54.375 Y32.578
N0090 G1 X57.623 Y30.703
N0092 G1 X48.873 Y15.547
N0094 G1 X42.377 Y19.297
N0096 G1 X51.127 Y34.453
N0098 G2 X56.25 Y35.825 I3.248 J-1.875
N0100 G1 X60.58 Y33.325
N0102 G2 X61.495 Y29.91 I-1.25 J-2.165
N0104 G1 X51.495 Y12.59
N0106 G2 X48.08 Y11.675 I-2.165 J1.25
N0108 G1 X39.42 Y16.675
N0110 G2 X38.505 Y20.09 I1.25 J2.165
N0112 G1 X48.505 Y37.41
N0114 G2 X51.92 Y38.325 I2.165 J-1.25
N0116 G1 X56.25 Y35.825
N0118 G2 X52.5 Y29.33 I-1.875 J-3.248 F270
N0120 G0 Z-2.
N0122 G0 Z20.
N0124 G0 X50. Y25.
N0126 G0 Z100.
N0128 G0 X150. Y150.
N0130 G0 Z50.
N0132 G0 X25. Y19. M8
N0134 G0 Z20.
N0136 G0 Z2.
N0138 G0 X30. Y10.34
N0140 G1 Z-3. F27
N0142 G1 X20. Y27.66 F90
N0144 G2 X18.75 Y29.825 I-0.625 J1.083
N0146 G1 X20.482 Y30.825
N0148 G2 X21.165 Y30.642 I0.25 J-0.433
N0150 G1 X33.165 Y9.858
N0152 G2 X32.982 Y9.175 I-0.433 J-0.25
N0154 G1 X29.518 Y7.175
N0156 G2 X28.835 Y7.358 I-0.25 J0.433
N0158 G1 X16.835 Y28.142
N0160 G2 X17.018 Y28.825 I0.433 J0.25
N0162 G1 X18.75 Y29.825
N0164 G2 X20. Y27.66 I0.625 J-1.083 F270
N0166 G0 Z-2.

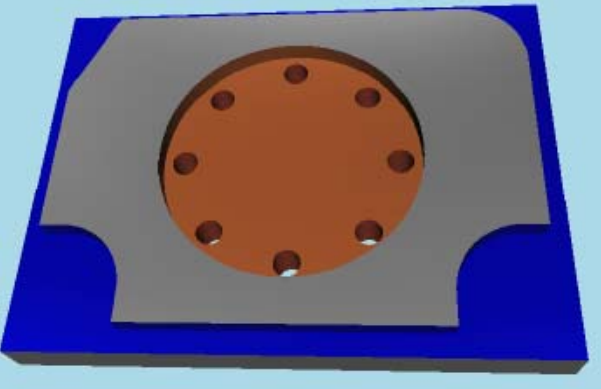
N0168 G0 Z20.
N0170 G0 X25. Y19.
N0172 G0 Z100.
N0174 M9
N0176 G0 X150. Y150.
N0178 M5
N0180 T3 M6
N0182 S2800 M3
N0184 G0 G43 Z50. H3
N0186 G0 X80. Y25. M8
N0188 F30
N0190 G0 X90.
N0192 G0 Z20.
N0194 G81 G98 Z-3. R2. K0
N0196 X90. Y25.
N0198 X87.071 Y32.071
N0200 X80. Y35.
N0202 X72.929 Y32.071
N0204 X70. Y25.
N0206 X72.929 Y17.929
N0208 X80. Y15.
N0210 X87.071 Y17.929
N0212 G80
N0214 G0 Z100.
N0216 M9
N0218 G0 X150. Y150.
N0220 M5
N0222 T4 M6
N0224 S1700 M3
N0226 G0 G43 Z50. H4
N0228 G0 X80. Y25. M8
N0230 F60
N0232 G0 X90.
N0234 G0 Z20.
N0236 G73 G98 Z-10. R2. Q10. K0
N0238 X90. Y25.
N0240 X87.071 Y32.071
N0242 X80. Y35.
N0244 X72.929 Y32.071
N0246 X70. Y25.
N0248 X72.929 Y17.929
N0250 X80. Y15.
N0252 X87.071 Y17.929
N0254 G80
N0256 G0 Z100.
N0258 M9
N0260 G0 X150. Y150.
N0262 M5
N0264 M30
%

Exercise 9: Punch plate

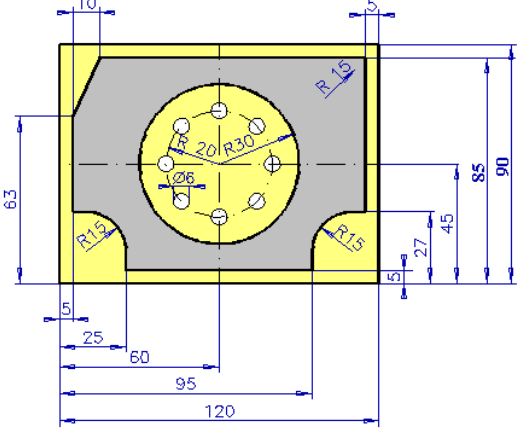
4.8.6 Exercise 12: Contour plate

The contour plate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 120 x 90 x 16 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.

Use the circular commands G02 or G03 and the cutter radius compensation.



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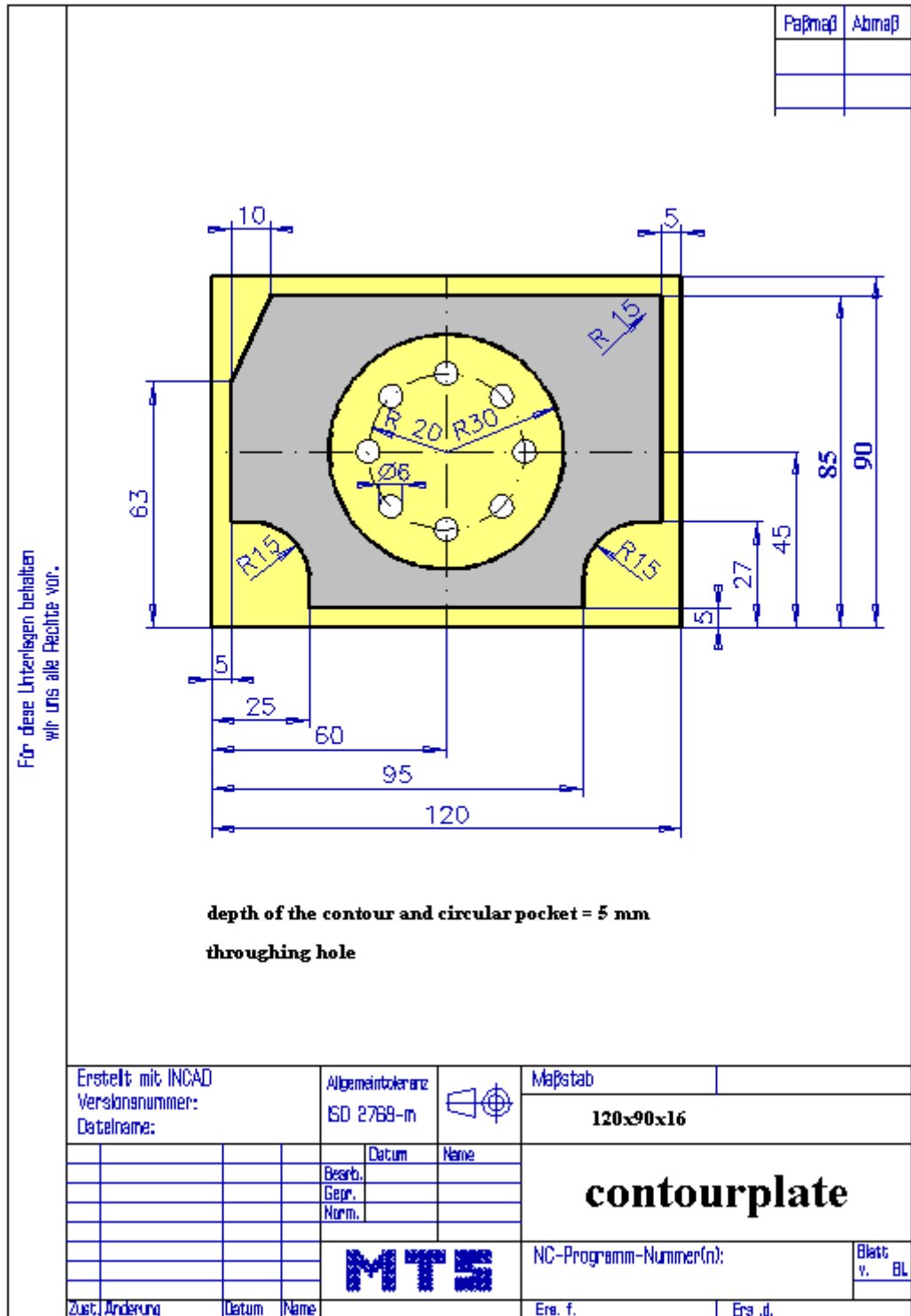


depth of the contour and circular pocket = 5 mm
throughing hole

Erstellt mit: INCAD		Allgemeintoleranz:		Maßstab:	
Versionsnummer:		ISO 2769-m		120x90x16	
Dateiname:		Datum		contourplate	
		Bereit.	Name		
		Gepr.			
		Nachr.			
		MTS		NC-Programm-Nummer(n):	
Zust./Änderung		Datum Name		Ers. f. / Ers. d.	

Learning Objective: The learner is able to solve a CNC milling task with systematic planning of the procedure and the application of existing system functions.

Special Training Elements: Cutter radius compensation, commands for circular arcs. Using of canned cycles for drilling with chip-breaking and chip removal and cycle invocation of a circle. Use drilling cycle G81 and G83 with repetition K0. K0 inside of the cycle only define the drilling cycle (not execution).



4.8.7 Possible solution: Program MTS-F28.FNC

```
()
(( 24.11.2005 15:13
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+120.000 Y+090.000 Z+016.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+128.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+008.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SLOT MILLING TOOL\MS-28.0 090L HSS ISO 1641"
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-18.0 032K HSS ISO 1641" FF8040
( T03 "ISO SK 30\DRILL\DR-06.00 063 HSS ISO 235"
( T04 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
( T05 "ISO SK 30\SLOT MILLING TOOL\MS-16.0 032K HSS ISO 1641"
( T06 "ISO SK 30\SLOT MILLING TOOL\MS-05.0 013K HSS ISO 1641"
( T07 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T08 "ISO SK 30\SIDEMILL\ME-20.0 038K HSS ISO 1641"
( T09 "ISO SK 30\SIDEMILL\ME-20.0 075L HSS ISO 1641"
( T10 "ISO SK 30\REAMER\RE-D10.0 H7 HSS ISO 521"
(
( TOOL COMPENSATION
( D01 T01 R014.000 Z+155.000 N01
( D02 T02 R009.000 Z+107.000 N01
( D03 T03 R003.000 Z+108.900 N01
( D04 T04 R000.000 Z+065.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+128.000
( G54 X+200.000 Y+150.000 Z+128.000
(
(
)
$G54
%
O28
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T1 M6
N0024 S1600 M3
N0026 G0 G43 Z50. H1
N0028 G0 X-10. Y-10.
N0030 G0 Z2.
N0032 G1 Z-5. F150 M8
N0034 G41 D1
N0036 G1 X-10. Y-10.
N0038 G1 X5.
N0040 G1 Y63.
N0042 G1 X15. Y85.
```

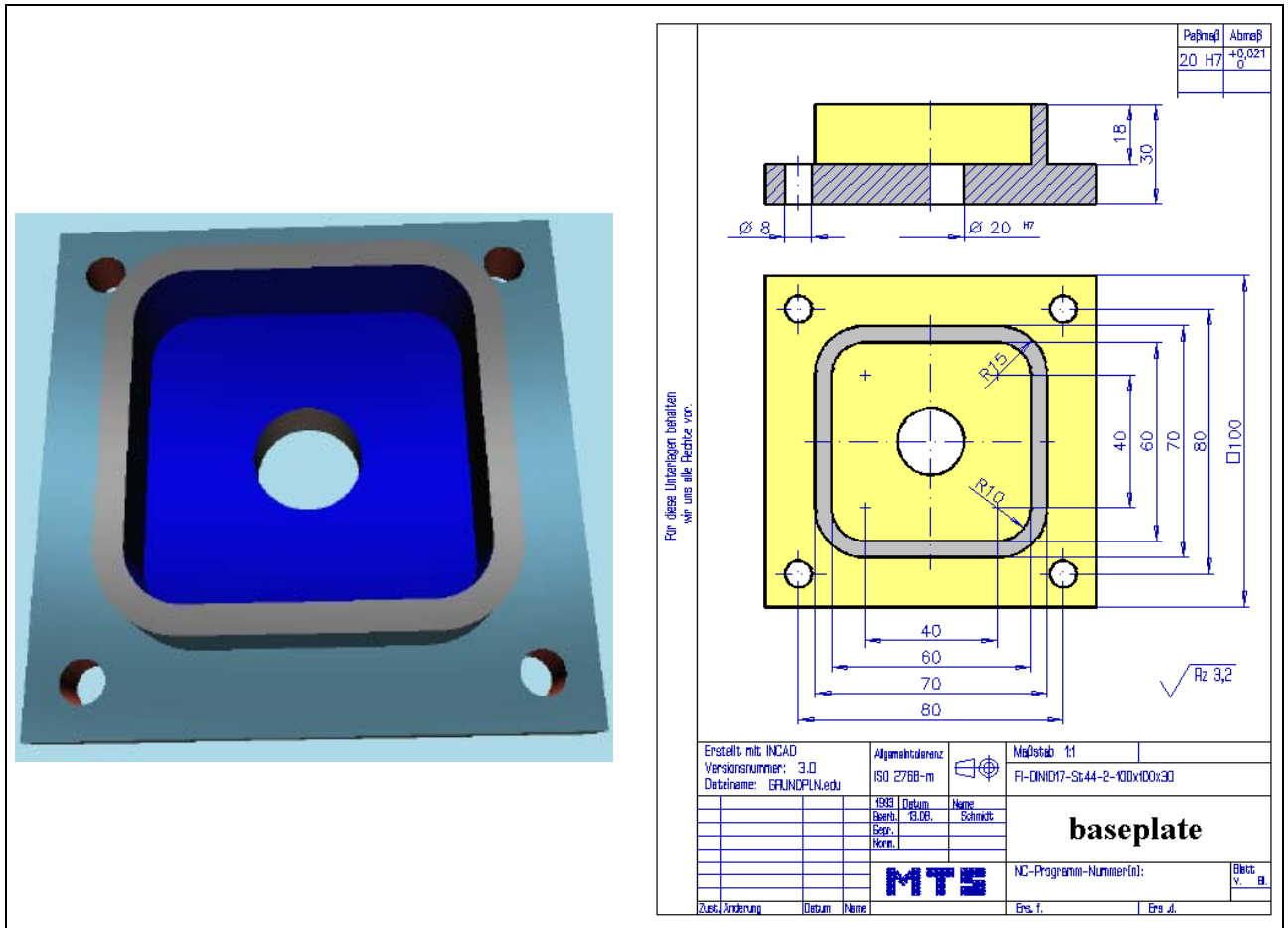
N0044 G1 X100.
N0046 G2 X115. Y70. I0. J-15.
N0048 G1 Y27.
N0050 G1 X110.
N0052 G3 X95. Y12. I0. J-15.
N0054 G1 Y5.
N0056 G1 X25.
N0058 G1 Y12.
N0060 G3 X10. Y27. I-15. J0.
N0062 G1 X-5.
N0064 G40
N0066 G0 Z100.
N0068 G0 X-5. Y13.
N0070 M9
N0072 G0 X150. Y150.
N0074 M5
N0076 T2 M6
N0078 S1600 M3
N0080 G0 G43 Z50. H2
N0082 G0 X60. Y45.
N0084 G0 Z2.
N0086 G1 Z0. F140
N0088 G1 Z-5. F42
N0090 G1 X70.5 F140
N0092 G2 X49.5 I-10.5 J0.
N0094 G2 X70.5 I10.5 J0.
N0096 G2 X81. I5.25 J0.
N0098 G2 X39. I-21. J0.
N0100 G2 X81. I21. J0.
N0102 G2 X60. I-10.5 J0. F420
N0104 G0 Z2.
N0106 G0 Z100.
N0108 G0 X150. Y150.
N0110 M5
N0112 T4 M6
N0114 S2000 M3
N0116 G0 G43 Z50. H4
N0118 G0 X60. Y45.
N0120 F30
N0122 G0 X85.
N0124 G0 Z20.
N0126 G81 G98 Z-8. R-4. K0
N0128 X85. Y45.
N0130 X77.678 Y62.678
N0132 X60. Y70.
N0134 X42.322 Y62.678
N0136 X35. Y45.
N0138 X42.322 Y27.322
N0140 X60. Y20.
N0142 X77.678 Y27.322
N0144 G80
N0146 G0 Z100.
N0148 G0 X150. Y150.
N0150 M5
N0152 T3 M6
N0154 S1200 M3
N0156 G0 G43 Z50. H3
N0158 G0 X60. Y45.
N0160 F60
N0162 G0 X85.
N0164 G0 Z20.
N0166 G83 G98 Z-20. R-4. Q12. K0
N0168 X85. Y45.

Exercise 9: Punch plate

N0170 X77.678 Y62.678
N0172 X60. Y70.
N0174 X42.322 Y62.678
N0176 X35. Y45.
N0178 X42.322 Y27.322
N0180 X60. Y20.
N0182 X77.678 Y27.322
N0184 G80
N0186 G0 Z100.
N0188 G0 X150. Y150.
N0190 M5
N0192 M30
%

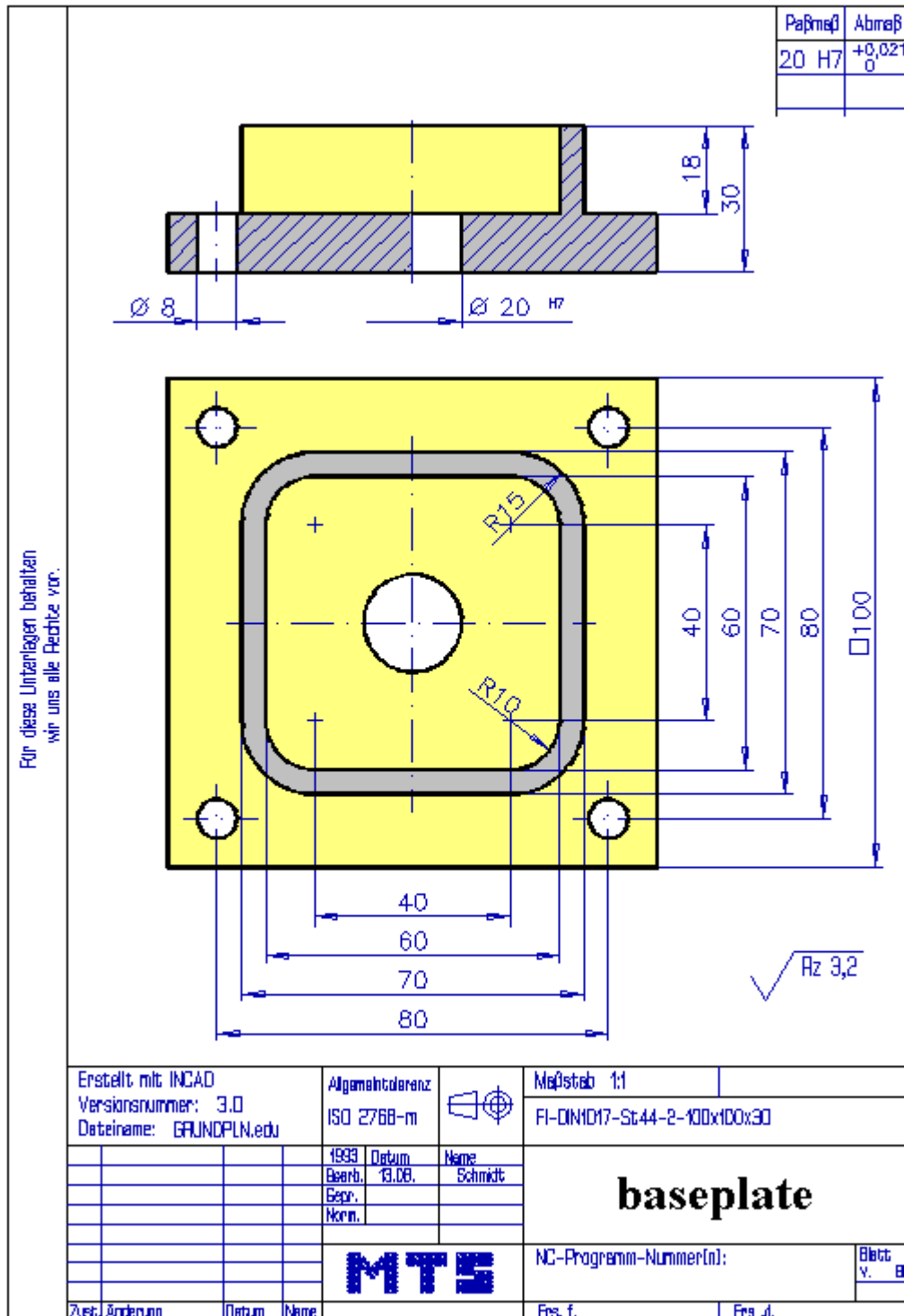
4.8.8 Exercise 13: Base plate Variante 1

The plate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 80 x 80 x 20 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.



Learning Objective: The learner is able to solve a CNC milling task with systematic planning of the procedure and the application of existing system functions.

Special Training Elements: Use canned cycles for drilling and reaming. Use drilling cycle with repetition K0. K0 inside of the cycle only define the drilling cycle (not execution). Work with different retraction commands (G98, G99).



4.8.9 Possible solution: Program PLATTE14.FNC

```

()
(( 10.11.2005 10:25
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+100.000 Y+100.000 Z+030.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+140.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+010.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SHELL END MILL\MW-040 032 HSS ISO 2586"
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-18.0 032K HSS ISO 1641"
( T03 "ISO SK 30\SPOTTING DRILL\DC-08.0 090 HSS ISO 3294"
( T04 "ISO SK 30\DRILL\DR-08.00 075 HSS ISO 235"
( T05 "ISO SK 30\DRILL\DR-19.80 128 HSS ISO 235"
( T06 "ISO SK 30\REAMER\RE-D20.0 H7 HSS ISO 521"
( T07 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T08 "ISO SK 30\SIDEMILL\ME-20.0 038K HSS ISO 1641"
( T09 "ISO SK 30\SIDEMILL\ME-20.0 075L HSS ISO 1641"
( T10 "ISO SK 30\REAMER\RE-D10.0 H7 HSS ISO 521"
(
( TOOL COMPENSATION
( D01 T01 R020.000 Z+115.500 N01
( D02 T02 R009.000 Z+107.000 N01
( D03 T03 R000.000 Z+065.000 N01
( D04 T04 R004.000 Z+120.900 N01
( D05 T05 R009.900 Z+181.900 N01
( D06 T06 R000.000 Z+170.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+140.000
( G54 X+250.000 Y+200.000 Z+140.000
(
()
$G54
%
O14
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0024 T1 M6
N0026 S980 M3
N0028 G0 G43 Z50. H1 M8
N0030 G0 X80. Y20.
N0032 G0 Z2.
N0034 (VORSCHUB)
N0036 G1 Z-10. F280
N0040 G1 X77. Y32.
N0042 G3 X55. Y10. I0. J-22.

```

Exercise 9: Punch plate

N0044 G1 Y-20.
N0046 G2 X20. Y-55. I-35. J0.
N0048 G1 X-20.
N0050 G2 X-55. Y-20. I0. J35.
N0052 G1 Y20.
N0054 G2 X-20. Y55. I35. J0.
N0056 G1 X20.
N0058 G2 X55. Y20. I0. J-35.
N0060 G1 Y5.
N0062 G3 X77. Y-17. I22. J0.
N0064 G0 X80. Y20.
N0066 G1 Z-18.
N0068 G1 X77. Y32.
N0070 G3 X55. Y10. I0. J-22.
N0072 G1 Y-20.
N0074 G2 X20. Y-55. I-35. J0.
N0076 G1 X-20.
N0078 G2 X-55. Y-20. I0. J35.
N0080 G1 Y20.
N0082 G2 X-20. Y55. I35. J0.
N0084 G1 X20.
N0086 G2 X55. Y20. I0. J-35.
N0088 G1 Y5.
N0090 G3 X77. Y-17. I22. J0.
N0092 G0 Z100.
N0094 G0 X100. Y70.
N0098 M5
N0100 M9
N0102 T2 M6
N0104 S1300 M3
N0106 G0 G43 Z50. H2 M8
N0108 G0 X0. Y0.
N0114 G0 Z20.
N0116 G0 Z2.
N0118 G1 Z-9. F60
N0120 G1 Y10.5 F200
N0122 G1 X10.5
N0124 G1 Y-10.5
N0126 G1 X-10.5
N0128 G1 Y10.5
N0130 G2 X0. Y21. I10.5 J0.
N0132 G1 X20.
N0134 G2 X21. Y20. I0. J-1.
N0136 G1 Y-20.
N0138 G2 X20. Y-21. I-1. J0.
N0140 G1 X-20.
N0142 G2 X-21. Y-20. I0. J1.
N0144 G1 Y20.
N0146 G2 X-20. Y21. I1. J0.
N0148 G1 X0.
N0150 G2 Y0. I0. J-10.5 F600
N0152 G0 Z-8.
N0154 G1 Z-18. F60
N0156 G1 Y10.5 F200
N0158 G1 X10.5
N0160 G1 Y-10.5
N0162 G1 X-10.5
N0164 G1 Y10.5
N0166 G2 X0. Y21. I10.5 J0.
N0168 G1 X20.
N0170 G2 X21. Y20. I0. J-1.
N0172 G1 Y-20.
N0174 G2 X20. Y-21. I-1. J0.

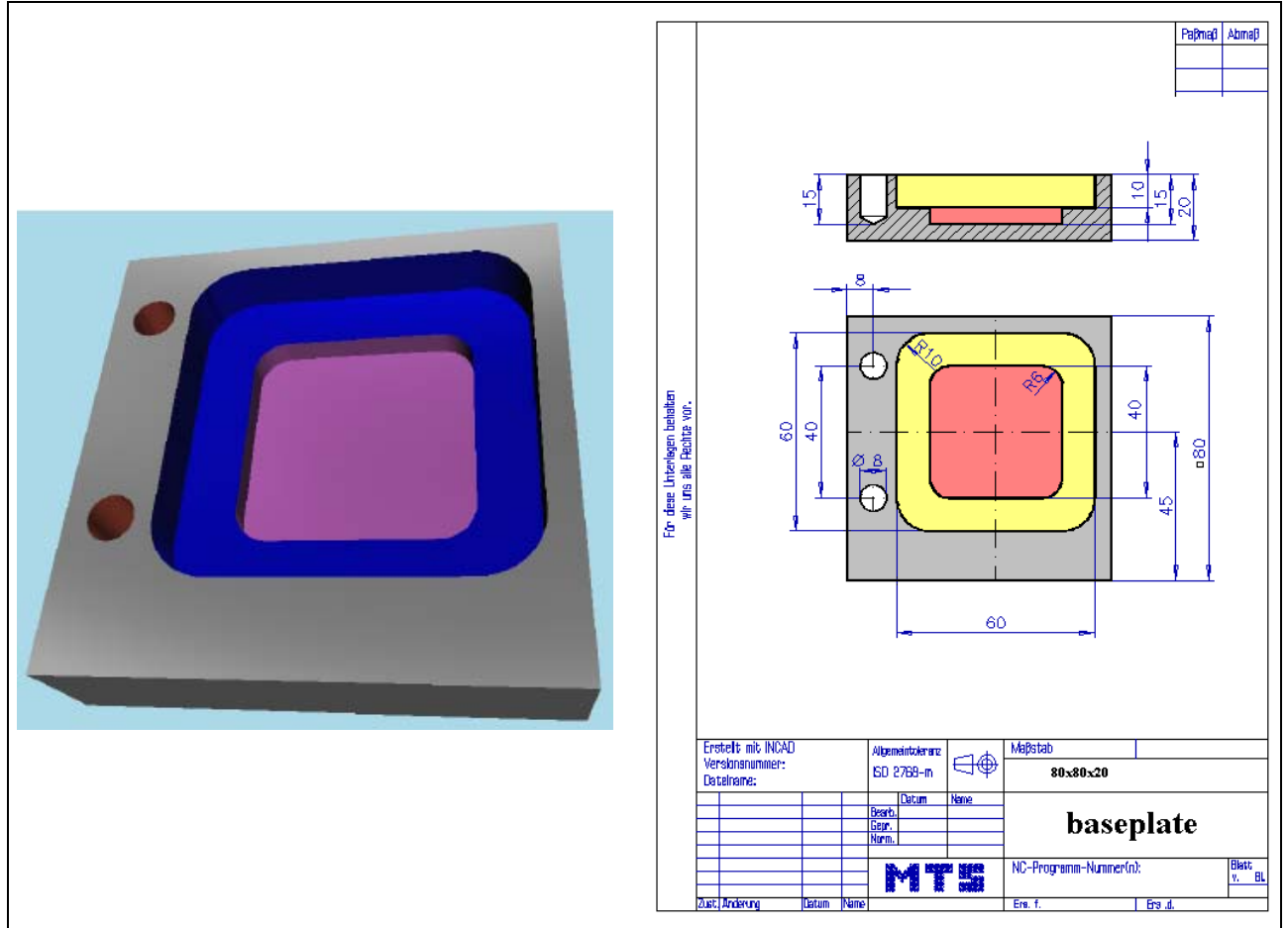
N0176 G1 X-20.
N0178 G2 X-21. Y-20. I0. J1.
N0180 G1 Y20.
N0182 G2 X-20. Y21. I1. J0.
N0184 G1 X0.
N0186 G2 Y0. I0. J-10.5 F600
N0188 G0 Z-17.
N0190 G0 Z20.
N0192 G0 Z100.
N0194 G0 X100. Y80.
N0196 M5
N0198 T3 M6
N0200 S2300 M3
N0202 G0 G43 Z50. H3 M8
N0204 G0 X40. Y40.
N0206 F70
N0208 G0 Z20.
N0210 G81 G99 Z-22. R-16. K0
N0212 X40. Y40.
N0214 X40. Y-40.
N0220 X-40. Y-40.
N0222 G98 X-40. Y40.
N0228 X0. Y0.
N0230 G80
N0232 G0 Z100.
N0234 M5
N0236 M9
N0238 G0 X100. Y70.
N0240 T4 M6
N0242 S1600 M3
N0244 G0 G43 Z50. H4 M8
N0246 G0 X40. Y40.
N0250 F80
N0252 G0 Z20.
N0254 G83 G99 Z-34. R-16. Q8. K0
N0256 X40. Y40.
N0258 X40. Y-40.
N0264 X-40. Y-40.
N0266 G98 X-40. Y40.
N0272 X0. Y0.
N0274 G80
N0276 G0 Z100.
N0278 M5
N0280 M9
N0282 G0 X100. Y70.
N0284 T5 M6
N0286 S800 M3
N0288 G0 G43 Z50. H5 M8
N0290 G0 X0. Y0.
N0294 F90
N0296 G0 Z20.
N0298 G83 G98 Z-38. R-16. Q8. K0
N0300 X0. Y0.
N0302 G80
N0304 G0 Z100.
N0306 M5
N0308 M9
N0310 G0 X100. Y70.
N0312 T6 M6
N0314 S300 M3
N0316 G0 G43 Z50. H6 M8
N0318 G0 X0. Y0.
N0320 G0 Z20.

Exercise 9: Punch plate

N0322 G85 G98 Z-36. R-16. K0
N0324 X0. Y0.
N0326 G80
N0328 G0 Z100.
N0330 M5
N0332 M9
N0334 G0 X100. Y70.
N0338 M30
%

4.8.10 Exercise 13: Base plate Variante 2

The plate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 100 x 100 x 30 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.



Learning Objective: The learner is able to solve a CNC milling task with systematic planning of the procedure and the application of existing system functions.

Special Training Elements: Use drilling cycle G81 and G83 with repetition K0. K0 only define the drilling cycle.

Exercise 9: Punch plate

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Paßmaß	Abmaß

Erstellt mit INCAD		Allgemeintoleranz		Maßstab	
Versionsnummer:		ISO 2768-m		80x80x20	
Dateiname:					
			Datum	baseplate	
			Bearb.		
			Gepr.		
			Norm.		
		MTS		NC-Programm-Nummer(n):	
				Blatt v. BL	
Zust./Änderung	Datum	Name	Ers. f.		Ers. d.

4.8.11 Possible solution: Program MTS-F36.FNC

```

()
(( 10.11.2005 11:28
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+080.000 Y+080.000 Z+020.000
( PART POSITION X+200.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+125.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+015.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SLOT MILLING TOOL\MS-18.0 032K HSS ISO 1641"
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-10.0 053L HSS ISO 1641"
( T03 "ISO SK 30\CORE DRILL\DC-12.5 090 HSS ISO 3294"
( T04 "ISO SK 30\DRILL\DR-08.00 075 HSS ISO 235"
( T05 "ISO SK 30\DRILL\DR-10.25 087 HSS ISO 235"
( T06 "ISO SK 30\REAMER\RE-D20.0 H7 HSS ISO 521"
( T07 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T08 "ISO SK 30\SIDEMILL\ME-20.0 038K HSS ISO 1641"
( T09 "ISO SK 30\SIDEMILL\ME-20.0 075L HSS ISO 1641"
( T10 "ISO SK 30\REAMER\RE-D10.0 H7 HSS ISO 521"
(
( TOOL COMPENSATION
( D01 T01 R009.000 Z+107.000 N01
( D02 T02 R005.000 Z+125.000 N01
( D03 T03 R000.000 Z+075.000 N01
( D04 T04 R004.000 Z+120.900 N01
( D05 T05 R005.125 Z+132.900 N01
( D06 T06 R000.000 Z+170.000 N01
( D07 T07 R002.500 Z+097.900 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+200.000 Y+150.000 Z+125.000
( G54 X+200.000 Y+150.000 Z+125.000
(
(
)
$G54
%
O36
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T1 M6
N0024 S1600 M3
N0026 G0 G43 Z50. H1
N0028 G0 X45. Y45.
N0030 G0 Z20.
N0032 G0 Z2.
N0034 G1 Z-5. F42
N0036 G1 Y55.5 F140

```

Exercise 9: Punch plate

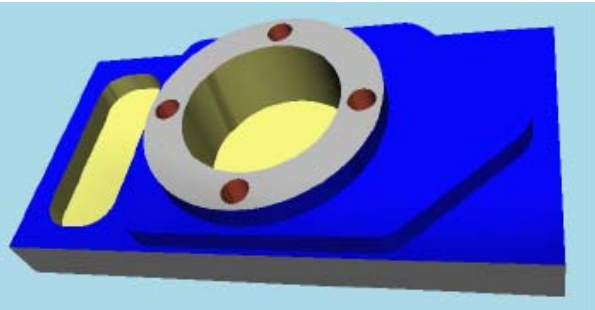
N0038 G1 X55.5
N0040 G1 Y34.5
N0042 G1 X34.5
N0044 G1 Y55.5
N0046 G2 X45. Y66. I10.5 J0.
N0048 G1 X65.
N0050 G2 X66. Y65. I0. J-1.
N0052 G1 Y25.
N0054 G2 X65. Y24. I-1. J0.
N0056 G1 X25.
N0058 G2 X24. Y25. I0. J1.
N0060 G1 Y65.
N0062 G2 X25. Y66. I1. J0.
N0064 G1 X45.
N0066 G2 Y45. I0. J-10.5 F420
N0068 G0 Z-4.
N0070 G1 Z-10. F42
N0072 G1 Y55.5 F140
N0074 G1 X55.5
N0076 G1 Y34.5
N0078 G1 X34.5
N0080 G1 Y55.5
N0082 G2 X45. Y66. I10.5 J0.
N0084 G1 X65.
N0086 G2 X66. Y65. I0. J-1.
N0088 G1 Y25.
N0090 G2 X65. Y24. I-1. J0.
N0092 G1 X25.
N0094 G2 X24. Y25. I0. J1.
N0096 G1 Y65.
N0098 G2 X25. Y66. I1. J0.
N0100 G1 X45.
N0102 G2 Y45. I0. J-10.5 F420
N0104 G0 Z-9.
N0106 G0 Z20.
N0108 G0 Z100.
N0110 G0 X150. Y150.
N0112 M5
N0114 T2 M6
N0116 S800 M3
N0118 G0 G43 Z50. H2
N0120 G0 X45. Y45. M8
N0122 G0 Z-8.
N0124 G1 Z-15. F33
N0126 G1 Y52.5 F110
N0128 G1 X52.5
N0130 G1 Y37.5
N0132 G1 X37.5
N0134 G1 Y52.5
N0136 G2 X45. Y60. I7.5 J0.
N0138 G1 X59.
N0140 G2 X60. Y59. I0. J-1.
N0142 G1 Y31.
N0144 G2 X59. Y30. I-1. J0.
N0146 G1 X31.
N0148 G2 X30. Y31. I0. J1.
N0150 G1 Y59.
N0152 G2 X31. Y60. I1. J0.
N0154 G1 X45.
N0156 G2 Y45. I0. J-7.5 F330
N0158 G0 Z-14.
N0160 G0 Z-8.
N0162 G0 Z100.

N0164 M9
N0166 G0 X150. Y150.
N0168 M5
N0170 T3 M6
N0172 S2800 M3
N0174 G0 G43 Z50. H3
N0176 G0 X8. Y25. M8
N0178 F30
N0180 G0 Z20.
N0182 G81 G98 Z-3.5 R2. K0
N0184 X8. Y25.
N0186 X8. Y65.
N0188 G80
N0190 G0 Z100.
N0192 M9
N0194 G0 X150. Y150.
N0196 M5
N0198 T4 M6
N0200 S1600 M3
N0202 G0 G43 Z50. H4
N0204 G0 X8. Y25. M8
N0206 F70
N0208 G0 Z20.
N0210 G83 G98 Z-15. R2. Q10. K0
N0212 X8. Y25.
N0214 X8. Y65.
N0216 G80
N0218 G0 Z100.
N0220 M9
N0222 G0 X150. Y150.
N0224 M5
N0226 M30
%

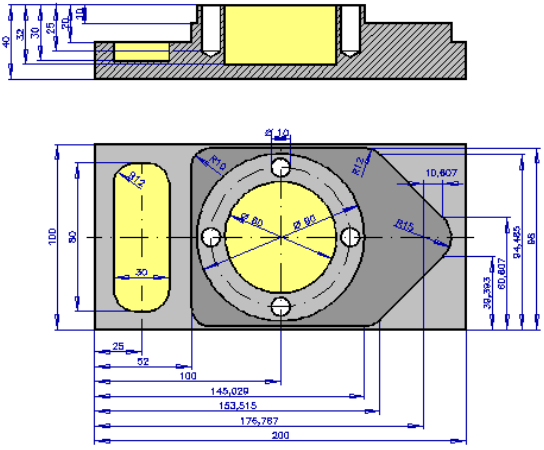
Exercise 9: Punch plate

4.8.12 Exercise 14: Pocket plate

The plate on the drawing is to be produced on a CNC vertical milling machine from a blank of AlMg1 dimensioned 200 x 100 x 40 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.



Paßmaß	Abmaß



Für diese Unterlagen behalten wir uns alle Rechte vor.

Erstellt mit: INCAD		Allgemeintoleranz: ISO 2768-m		Maßstab: 200x100x40	
Versionsnummer:				pocket plate	
Dateiname:					
		Beart.	Datum	NC-Programm-Nummer(n):	
		Gepr.			
		Norm.			
MTS			Blatt v. BL		
Zust.	Änderung	Datum	Name	Ers. f.	Ers. d.

Learning Objective: The learner is able to solve a CNC milling task with systematic planning of the procedure and the application of existing system functions.

Special Training Elements: Use drilling cycle G81 and G73 with repetition K0. K0 only define the drilling cycle.

4.8.13 Possible solution: Program MTS-F31.FNC

```
()
(( 24.11.2005 16:06
(
( CONFIGURATION
( MACHINE MTS VMC-024_ISO30_-0500-0400x0450
( CONTROL FANUC 21I
(
( BLANK DIMENSIONS X+200.000 Y+100.000 Z+040.000
( PART POSITION X+150.000 Y+150.000
(( Linke vordere obere Ecke des Werkstückes: X+150.000 Y+150.000 Z+142.000
( MATERIAL "AlMg1::Aluminium"
(
( VISE "Chuck Mill\Vise\RS 160"
( CHUCKING DEPTH E+018.000
( SHIFT V+000.000
( ORIENTATION A270°
(
( CURRENT TOOL T01
( TOOLS
( T01 "ISO SK 30\SLOT MILLING TOOL\MS-40.0 063K HSS ISO 1641"
( T02 "ISO SK 30\SLOT MILLING TOOL\MS-15.0 026K HSS ISO 1641" FFFF80
( T03 "ISO SK 30\CORE DRILL\DC-12.5 090 HSS ISO 3294"
( T04 "ISO SK 30\DRILL\DR-10.00 087 HSS ISO 235"
( T05 "ISO SK 30\DRILL\DR-19.80 128 HSS ISO 235"
( T06 "ISO SK 30\REAMER\RE-D20.0 H7 HSS ISO 521"
( T07 "ISO SK 30\DRILL\DR-05.00 052 HSS ISO 235"
( T08 "ISO SK 30\SIDEMILL\ME-20.0 038K HSS ISO 1641"
( T09 "ISO SK 30\SIDEMILL\ME-20.0 075L HSS ISO 1641"
( T10 "ISO SK 30\REAMER\RE-D10.0 H7 HSS ISO 521"
(
( TOOL COMPENSATION
( D01 T01 R020.000 Z+170.000 N01
( D02 T02 R007.500 Z+098.000 N01
( D03 T03 R000.000 Z+075.000 N01
( D04 T04 R005.000 Z+132.900 N01
( D09 T09 R010.000 Z+140.000 N01
( D10 T10 R000.000 Z+145.000 N01
(
( WORKPART ZEROPOINTS
(( Linke vordere obere Ecke des Werkstückes: X+150.000 Y+150.000 Z+142.000
( G54 X+150.000 Y+150.000 Z+142.000
(
(
)
$G54
%
O31
N0010 G91 G28 Z0.
N0012 G91 G28 X0. Y0.
N0014 G54 G98 G40 G80 G49 G90
N0016 G54
N0018 G90
N0020 G97
N0022 T1 M6
N0024 S1600 M3
N0026 G0 G43 Z50. H1
N0028 G0 X-15. Y-15.
N0030 G0 Z2.
N0032 G1 Z-10. F150 M8
N0034 G1 X10.
N0036 G1 Y98.
N0038 G1 X29.
```

N0040 G1 Y-15.
N0042 G41 D1
N0044 G1 X29. Y-15.
N0046 G1 X55.
N0048 G1 Y50.
N0050 G2 I45. J0.
N0052 G3 X0. I-27.5 J0.
N0054 G40
N0056 G0 Z2.
N0058 G0 X20. Y50.
N0060 G0 X173. Y-20.
N0062 G1 Z-10.
N0064 G1 Y98.
N0066 G1 X198.
N0068 G1 Y-20.
N0070 G0 Z2.
N0072 G0 X10.
N0074 G0 Z-20.
N0076 G1 Y98.
N0078 G1 X29.
N0080 G1 Y-20.
N0082 G1 X27. Y-25.
N0084 G3 X32. Y-20. I0. J5.
N0086 G1 Y88.
N0088 G2 X62. Y118. I30. J0.
N0090 G1 X145.029
N0092 G2 X167.657 Y108.627 I0.001 J-32.
N0094 G1 X201.536 Y74.749
N0096 G2 Y25.251 I-24.749 J-24.749
N0098 G1 X167.657 Y-8.627
N0100 G2 X145.029 Y-18. I-22.628 J22.628
N0102 G1 X62.
N0104 G2 X32. Y12. I0. J30.
N0106 G3 X17. I-7.5 J0.
N0108 G0 Z100.
N0110 M9
N0112 G0 X150. Y150.
N0114 M5
N0116 T2 M6
N0118 S1600 M3
N0120 G0 G43 Z50. H2
N0122 G0 X25. Y50.
N0124 G0 Z20. M8
N0126 G0 Z-16.
N0128 G0 Y25.
N0130 G1 Z-24. F42
N0132 G1 Y75. F140
N0134 G2 Y82.5 I0. J3.75
N0136 G1 X28.
N0138 G2 X32.5 Y78. I0. J-4.5
N0140 G1 Y22.
N0142 G2 X28. Y17.5 I-4.5 J0.
N0144 G1 X22.
N0146 G2 X17.5 Y22. I0. J4.5
N0148 G1 Y78.
N0150 G2 X22. Y82.5 I4.5 J0.
N0152 G1 X25.
N0154 G2 Y75. I0. J-3.75 F420
N0156 G0 Z-23.
N0158 G0 Y25.
N0160 G1 Z-30. F42
N0162 G1 Y75. F140
N0164 G2 Y82.5 I0. J3.75

Exercise 9: Punch plate

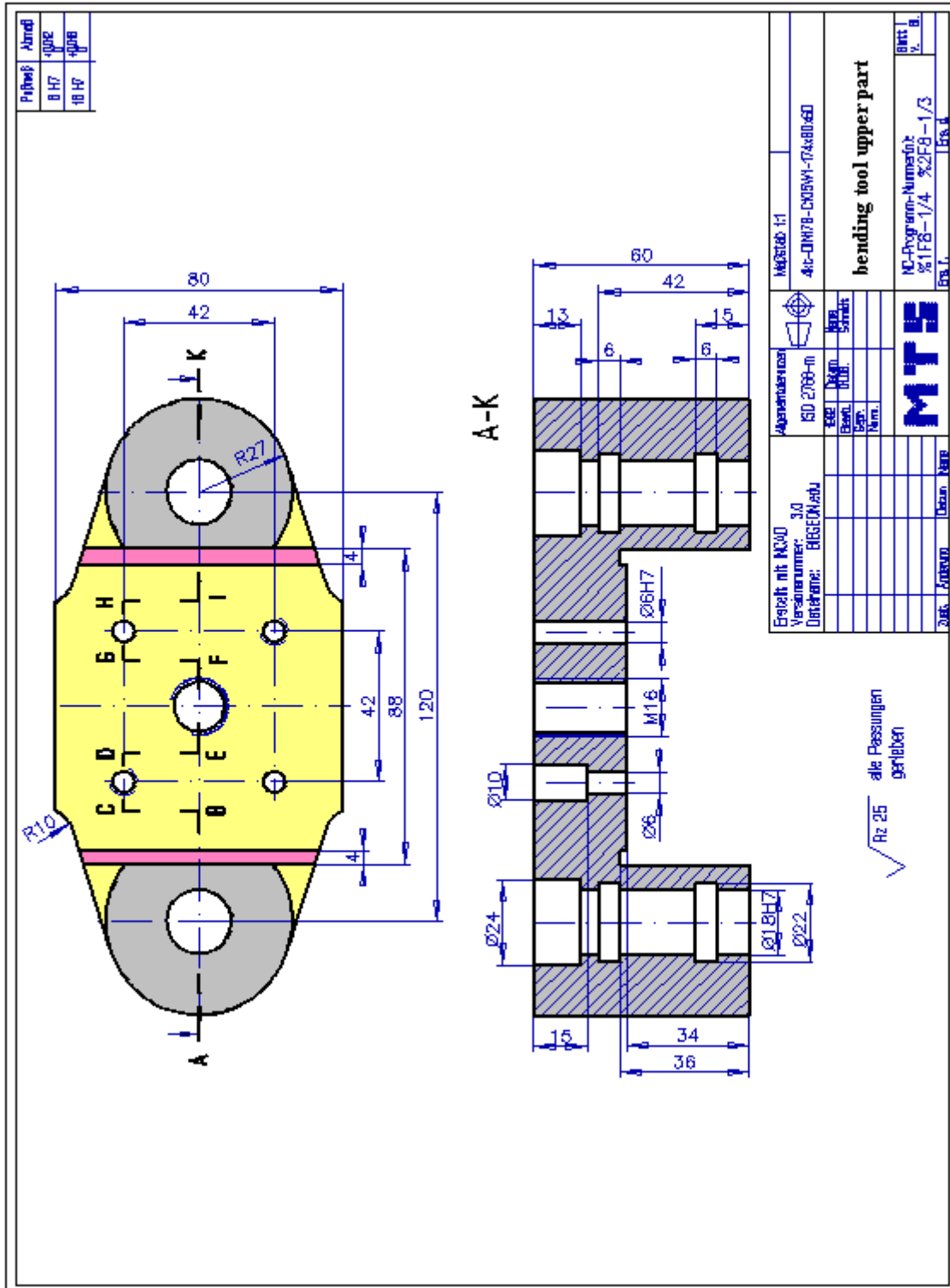
N0166 G1 X28.
N0168 G2 X32.5 Y78. I0. J-4.5
N0170 G1 Y22.
N0172 G2 X28. Y17.5 I-4.5 J0.
N0174 G1 X22.
N0176 G2 X17.5 Y22. I0. J4.5
N0178 G1 Y78.
N0180 G2 X22. Y82.5 I4.5 J0.
N0182 G1 X25.
N0184 G2 Y75. I0. J-3.75 F420
N0186 G0 Z-29.
N0188 G0 Z20.
N0190 G0 Y50.
N0192 G0 X100.
N0194 G0 Z2.
N0196 G1 Z0. F140
N0198 G1 Z-8. F42
N0200 G1 X111.25 F140
N0202 G2 X88.75 I-11.25 J0.
N0204 G2 X111.25 I11.25 J0.
N0206 G2 X122.5 I5.625 J0.
N0208 G2 X77.5 I-22.5 J0.
N0210 G2 X122.5 I22.5 J0.
N0212 G2 X100. I-11.25 J0. F420
N0214 G1 Z-16. F42
N0216 G1 X111.25 F140
N0218 G2 X88.75 I-11.25 J0.
N0220 G2 X111.25 I11.25 J0.
N0222 G2 X122.5 I5.625 J0.
N0224 G2 X77.5 I-22.5 J0.
N0226 G2 X122.5 I22.5 J0.
N0228 G2 X100. I-11.25 J0. F420
N0230 G1 Z-24. F42
N0232 G1 X111.25 F140
N0234 G2 X88.75 I-11.25 J0.
N0236 G2 X111.25 I11.25 J0.
N0238 G2 X122.5 I5.625 J0.
N0240 G2 X77.5 I-22.5 J0.
N0242 G2 X122.5 I22.5 J0.
N0244 G2 X100. I-11.25 J0. F420
N0246 G1 Z-32. F42
N0248 G1 X111.25 F140
N0250 G2 X88.75 I-11.25 J0.
N0252 G2 X111.25 I11.25 J0.
N0254 G2 X122.5 I5.625 J0.
N0256 G2 X77.5 I-22.5 J0.
N0258 G2 X122.5 I22.5 J0.
N0260 G2 X100. I-11.25 J0. F420
N0262 G0 Z20.
N0264 G0 Z100.
N0266 M9
N0268 G0 X150. Y150.
N0270 M5
N0272 T3 M6
N0274 S2000 M3
N0276 G0 G43 Z50. H3
N0278 G0 X100. Y50.
N0280 F30
N0282 G0 X137.5
N0284 G0 Z20.
N0286 G81 G98 Z-4. R2. K0
N0288 X137.5 Y50.
N0290 X100. Y87.5

N0292 X62.5 Y50.
N0294 X100. Y12.5
N0296 G80
N0298 G0 Z100.
N0300 G0 X150. Y150.
N0302 M5
N0304 T4 M6
N0306 S120 M3
N0308 G0 G43 Z50. H4
N0310 G0 X100. Y50.
N0312 F80
N0314 G0 X137.5
N0316 G0 Z20.
N0318 G73 G98 Z-28. R2. Q12. K0
N0320 X137.5 Y50.
N0322 X100. Y87.5
N0324 X62.5 Y50.
N0326 X100. Y12.5
N0328 G80
N0330 G0 Z100.
N0332 G0 X150. Y150.
N0334 M5
N0336 M30
%

4.9 Additional Exercises: Exercise 15: Bending tool upper part

The bending tool on the drawing is to be produced on a CNC vertical milling machine from a blank of C105 W1 dimensioned 174 x 80 x 60 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.

- Analyse the work shop drawing
- Compile the work plan
- Select the clamping device and the required tools
- Set the adequate zero point
- Write and test the CNC program



4.10 Exercise 16: Bending tool base part

The bending tool on the drawing is to be produced on a CNC vertical milling machine from a blank of C105 W1 dimensioned 110 x 60 x 60 mm. Prepare the production on the MTS CNC Simulator, work out the process layout and set-up form.

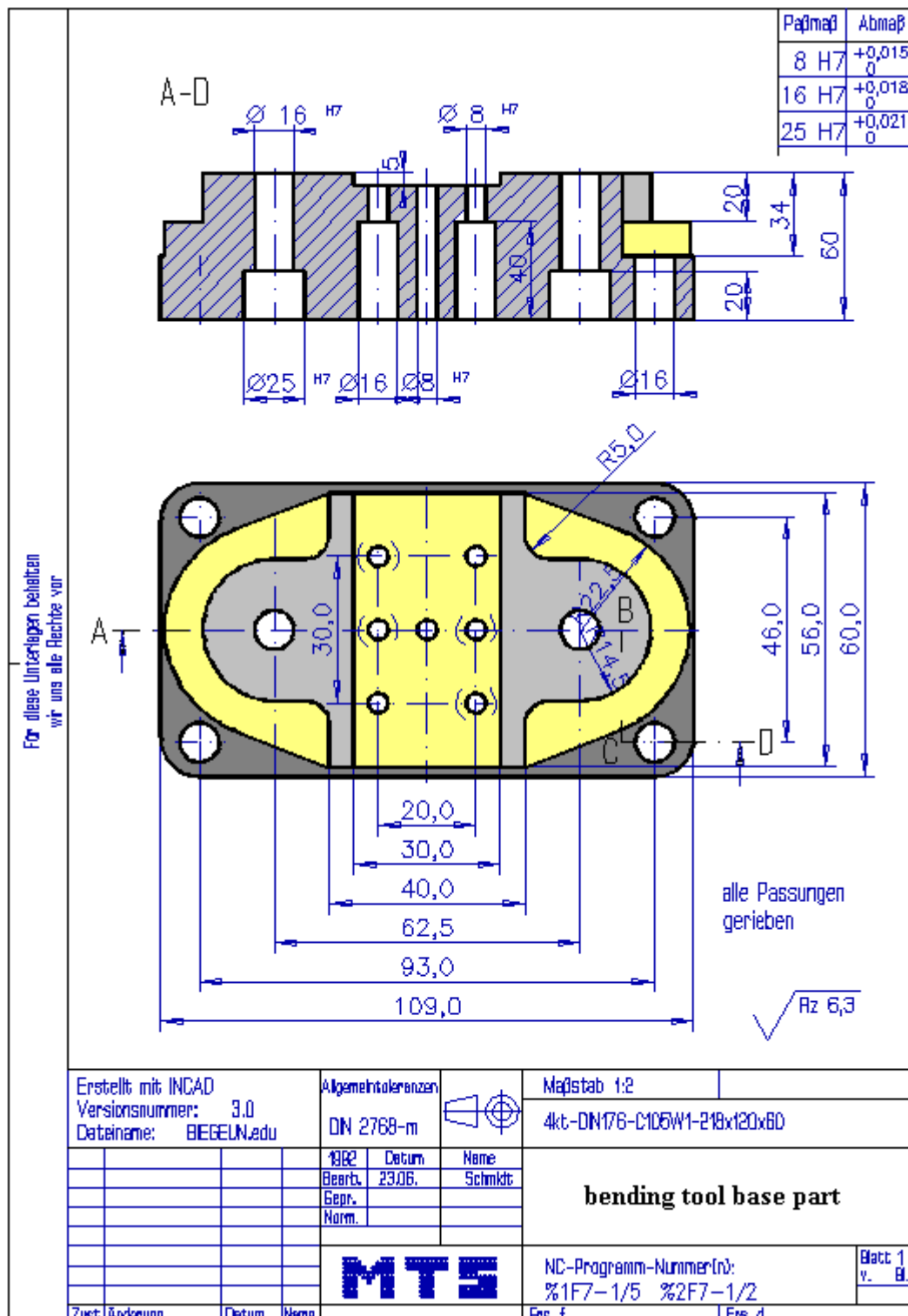
Analyse the work shop drawing

Compile the work plan

Select the clamping device and the required tools

Set the adequate zero point

Write and test the CNC program



5 Exercises CNC Turning

Revolverbelegung - Bestückung

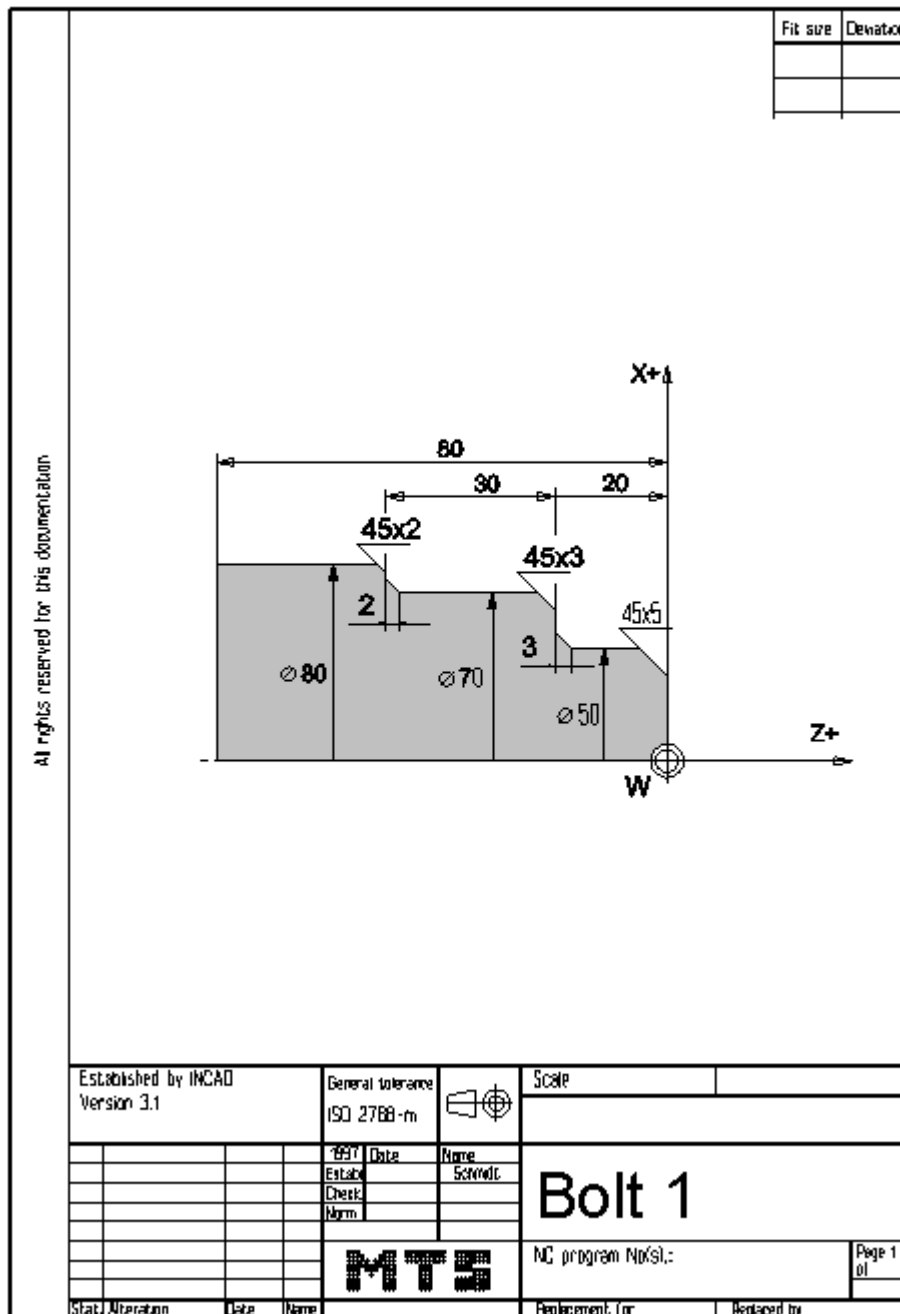
Datei Eintrag Ansicht Layout Grafik Hilfe

The screenshot displays a software window titled "Revolverbelegung - Bestückung" (Turntable Setup - Tooling). It features a menu bar (Datei, Eintrag, Ansicht, Layout, Grafik, Hilfe) and a toolbar with various icons for file operations, navigation, and tool management. A grid of 16 numbered tool options is shown on the left, with tool 2 selected. The main workspace shows a 3D model of a turning tool and a 2D diagram of the tool tip with parameters labeled: R , A_p , S , R_1 , and L . Below the workspace is a parameter table for the selected tool.

DIN69880 V 30\Eckdrehmeißel links\CL-SWJCL-2020 L 1604 IS...	
Name	CL-SWJCL-2020 L 1604 ISO 30
Gruppe	
Klasse	
Typ	Eckdrehmeißel links
Norm	DIN69880 V 30
Vorlage	
Parameter	
Seitenspanwinkel	Kr 93.000
Endwinkel	Kn 52.000
Effektiver Freiwinkel	Ae 12.713
Buchsennorm(en)	
1 -> 3	Wendeplatte AV
3: Wendeplatte AV\Form VWCMM 160604	
Spitzenwinkel	Ap 35.000
Freiwinkel	Af 7.000
Wendeplattenhöhe	S 6.640
Wendeplattenlänge	L 16.600

Bereit 2/16 NUM

Exercise 1: Bolt with outside machining



6.1.1 Possible Solution: Program BOLSG1.DNC:

```

()
(( 10.11.2005 13:21
(
( CONFIGURATION
( MACHINE MTS01 TM-016_-R1_-060x0646x0920
( CONTROL FANUC 21I CODE-A
(
( PART
( CYLINDER D080.000 L082.000
( MATERIAL "AlMg1::Aluminium"
( DENSITY 002.70
(
( MAIN SPINDLE WITH WORKPART
( CHUCK "Chuck Turn\Jaw chuck\KFD-HS 160"
( STEP JAW "Jaws\Step jaw\HM-110_130-02.001"
( TYPE OF CHUCK EXTERNAL CHUCK OUTSIDE STEP JAW
( CHUCKING DEPTH E18.000
(( Rechte Fläche des Werkstückes: Z+0206.000
(
(
( TAILSTOCK
( TAILSTOCK POSITION Z+1095.000
(
( CURRENT TOOL T01
( TOOLS
( T01 "DIN69880 V 30\LEFT CORNER TOOL\CL-SCLCL-2020 L 1208 ISO30"
( T02 "DIN69880 V 30\LEFT CORNER TOOL\CL-SVJCL-2020 L 1604 ISO30"
( T03 "DIN69880 V 30\LEFT THREADING TOOL\TL-LHTR-2020 R 60 1.00 ISO30"
( T04 "DIN69880 V 30\LEFT CORNER TOOL\CL-SCLCL-2020 L 1208 ISO30"
( T05 "DIN69880 V 30\LEFT CORNER TOOL\CL-SDJCL-2020 L 1204 ISO30"
( T06 "DIN69880 V 30\INSIDE TURNING TOOL POST\BI-SDQCL-1212 L 0704 ISO30"
(
( TOOL COMPENSATION
( D01 T01 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E005.005 I-000.800 K-000.800 A+004.375
L011.855 N01
( D02 T02 Q3 R000.400 X+070.000 Z+0045.000 G000.000 E052.393 I-000.400 K-000.400 A+002.372
L016.178 N01
( D03 T03 Q8 R000.144 X+070.000 Z+0042.600 G000.000 E000.000 I-000.144 K+000.000 A+000.000
L000.000 N01
( D04 T04 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E005.005 I-000.800 K-000.800 A+004.375
L011.855 N01
( D05 T05 Q3 R000.400 X+070.000 Z+0045.000 G000.000 E032.178 I-000.400 K-000.400 A+002.372
L011.185 N01
( D06 T06 Q2 R000.400 X-008.364 Z+0160.000 G000.000 E018.027 I+000.400 K-000.400 A+016.744
L007.029 N01
(
( WORKPART ZEROPOINTS
(( Rechte Fläche des Werkstückes: Z+0206.000
( G54 X+000.000 Z+0204.000
(
(
)
$G54
:1
N10 G40 G00
N20 G99
N30 M5
N40 M9
N60 T0101
N70 G50 S3500
N80 G96 S0240 M4
N90 G00 X82. Z0.

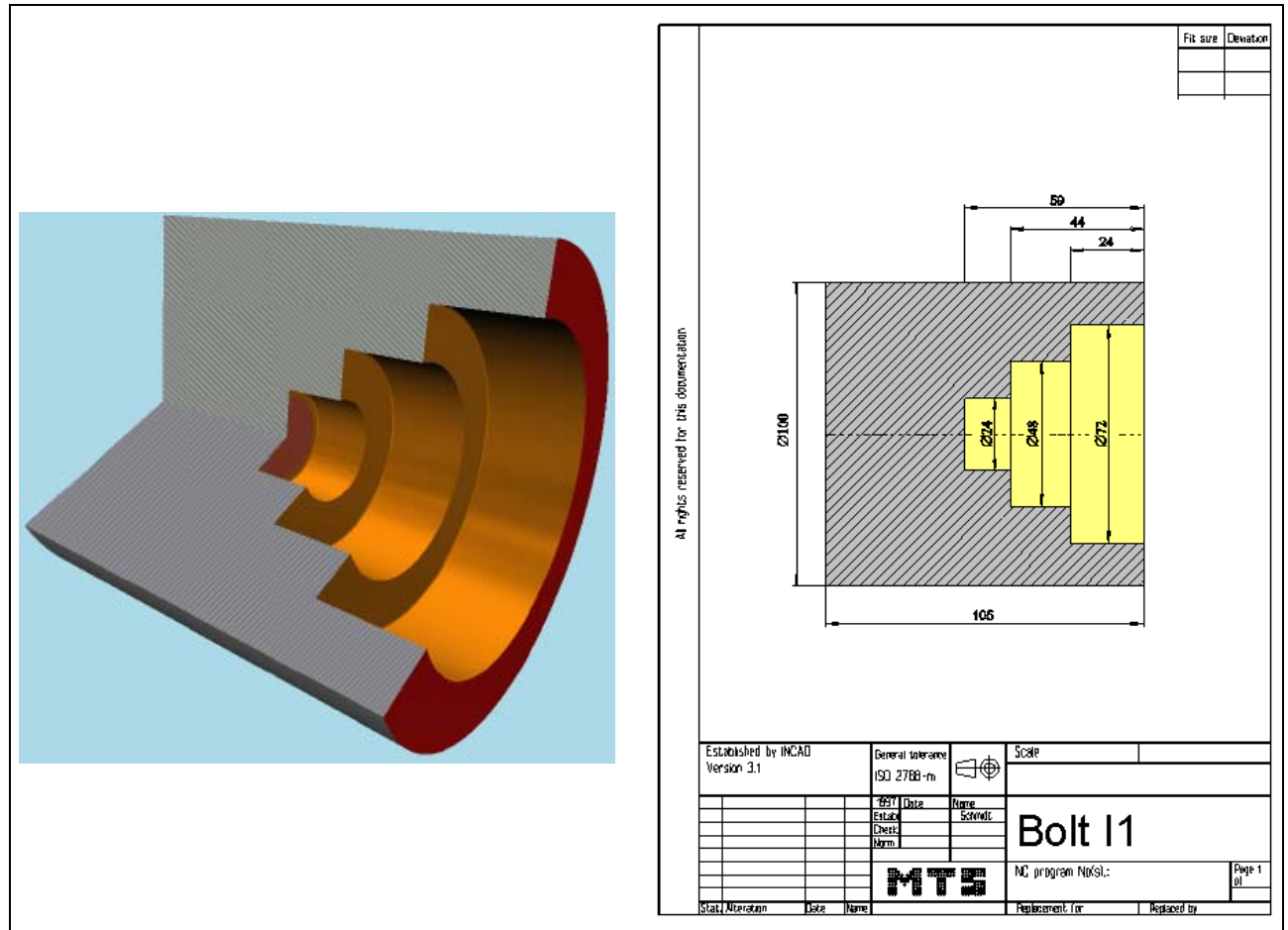
```

Exercise 1: Bolt with outside machining

N100 G01 X-2. F0.15 M7
N110 G00 Z2.
N120 G00 X71.
N130 G01 Z-47.8 F0.3
N140 G01 X74. Z-49.8
N150 G01 X77.
N160 G01 X81. Z-53.
N170 G00 Z2.
N180 G00 X60.
N190 G01 Z-19.8
N200 G01 X65.
N210 G01 X72. Z-24.
N220 G00 Z2.
N230 G00 X51.
N240 G01 Z-16.8
N250 G01 X57. Z-19.8
N260 G01 X65.
N270 G00 Z2.
N280 G00 X37.
N290 G01 X52. Z-6.
N300 G00 X150. Z100.
N310 T0202
N320 G50 S4500
N330 G96 S0380 M4
N340 G42 G00 X36. Z2.
N350 G01 X50. Z-5. F0.1
N360 G01 Z-17.
N370 G01 X56. Z-20.
N380 G01 X64.
N390 G01 X70. Z-23.
N400 G01 Z-48.
N410 G01 X74. Z-50.
N420 G01 X76.
N430 G01 X82. Z-53.
N440 G40
N450 G00 X150. Z100.
N460 M5
N470 M9
N480 M30

6.1.2 Exercise 2: Bolt with inside machining

The bolt on the drawing made of AIMg1 is to be made on a CNC lathe in higher batch quantity. Prepare the manufacturing process with the MTS CNC Simulator including following steps: define workpart zero, set up the processing sequence, determine tools, fixtures and technological data; generate, set up, test and correct the program at the CNC simulator. A bolt with an external diameter of $\varnothing 100$ mm and the length of 107 mm is to be clamped for the test.



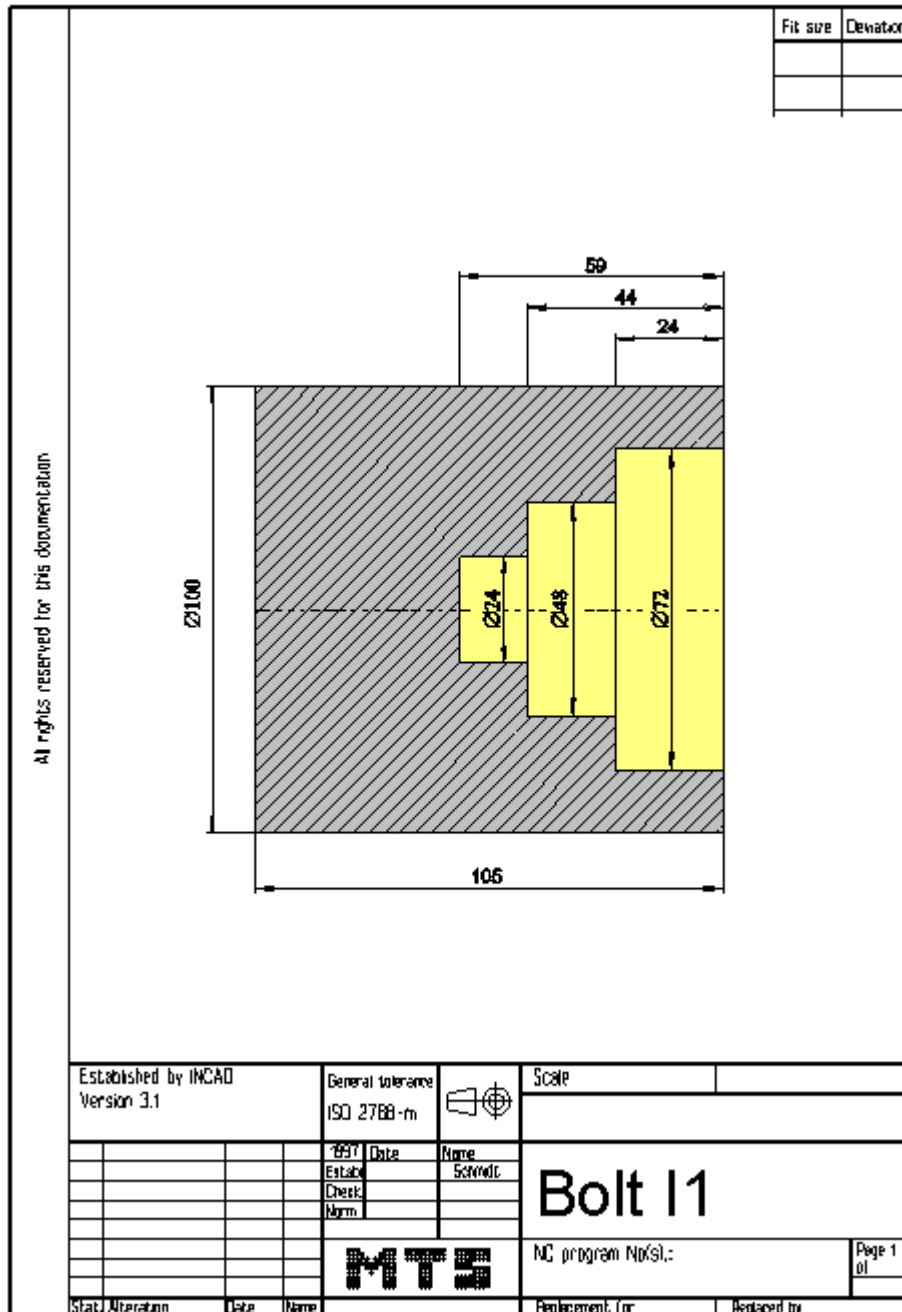
Learning Objective:

The learner can accomplish simple steps at the MTS CNC Simulator such as to start CNC simulation software, select operation modes, referencing, set up tools, define tool zeros, set up blank and fixture, generate, test and correct simple NC programs.

Special Training Elements:

Set up and machine a blank at the simulator; select and set up tools, movements with G00 and G01. Use G74 for deep drilling and the simple canned cycle G90. G90 is a modal cycle.

Exercise 1: Bolt with outside machining



6.1.3 Possible Solution: Program BOLZINN.DNC:

```

()
(( 10.11.2005 13:47
(
( CONFIGURATION
( MACHINE MTS01 TM-016_-R1_-060x0646x0920
( CONTROL FANUC 21I CODE-A
(
( PART
( CYLINDER D100.000 L107.000
( MATERIAL "AlMg1::Aluminium"
( DENSITY 002.70
(
( MAIN SPINDLE WITH WORKPART
( CHUCK "Chuck Turn\Jaw chuck\KFD-HS 160"
( STEP JAW "Jaws\Step jaw\HM-110_130-02.001"
( TYPE OF CHUCK EXTERNAL CHUCK OUTSIDE STEP JAW
( CHUCKING DEPTH E18.000
(( Rechte Fläche des Werkstückes: Z+0231.000
(
(
( TAILSTOCK
( TAILSTOCK POSITION Z+1095.000
(
( CURRENT TOOL T01
( TOOLS
( T01 "DIN69880 V 30\LEFT CORNER TOOL\CL-SCLCL-2020 L 1208 ISO30"
( T02 "DIN69880 V 30\LEFT CORNER TOOL\CL-SVJCL-2020 L 1604 ISO30"
( T05 "DIN69880 V 30\INSIDE TURNING TOOL POST\BI-SVQBL-1010 L 0702 ISO30"
( T07 "DIN69880 V 30\REVERSIBLE TIP DRL\DI-22.00 051 R HMT ISO30"
( T11 "DIN69880 V 30\INSIDE TURNING TOOL POST\BI-SVQBL-1212 L 0704 ISO30"
(
( TOOL COMPENSATION
( D01 T01 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E005.005 I-000.800 K-000.800 A+004.375
L011.855 N01
( D02 T02 Q3 R000.400 X+070.000 Z+0045.000 G000.000 E052.393 I-000.400 K-000.400 A+002.372
L016.178 N01
( D05 T05 Q2 R000.200 X-010.789 Z+0170.000 G000.000 E052.174 I+000.200 K-000.200 A+002.721
L007.540 N01
( D07 T07 Q7 R000.000 X+000.000 Z+0180.000 G022.000 E000.000 I+000.000 K+000.000 A+000.000
L000.000 N01
( D11 T11 Q2 R000.400 X-011.367 Z+0170.000 G000.000 E052.174 I+000.400 K-000.400 A+002.721
L007.340 N01
(
( WORKPART ZEROPOINTS
(( Rechte Fläche des Werkstückes: Z+0231.000
( G54 X+000.000 Z+0229.000
(
()
$G54
:4
N10 G40 G00
N20 G99
N30 M5
N40 M9
N60 T0101
N70 G50 S3500
N80 G96 S0240 M4
N90 G00 X102. Z0.
N100 G01 X-2. F0.15 M7
N110 G00 X150. Z150.

```

Exercise 1: Bolt with outside machining

N120 M9
N130 T0707
N140 G97 S0950 M3
N150 G00 Z3.
N160 G00 X0. M7
N170 G74 R1.0
N180 G74 X0.0 Z-59.0 Q15000 F0.18
N280 G00 X150. Z150.
N290 M9
N300 T0505
N310 G50 S3500
N320 G96 S0200 M4
N330 G00 X20. Z2.
N340 G90 X23.0 Z-58.9 F0.25 M7
N370 G90 X32.0 Z-43.9 F0.25
N410 X40.
N450 X47.
N470 G00 X47.
N500 G90 X55.0 Z-23.9 F0.25
N530 X63.
N570 X71.
N610 G00 X150. Z150.
N620 M9
N630 T1111
N640 G50 S4500
N650 G96 S0380 M4
N660 G41 G00 X72. Z2.
N670 G01 Z-24.
N680 G01 X48.
N690 G01 Z-44.
N700 G01 X24.
N710 G01 Z-59.
N720 G01 X20.
N730 G40
N740 G00 X20.8 Z2.
N750 G00 X200. Z150.
N760 M5
N770 M30

6.2.2 Possible Solution: Program BOLSG2.DNC:

```

()
(( 10.11.2005 13:59
(
( CONFIGURATION
( MACHINE MTS01 TM-016_-R1_-060x0646x0920
( CONTROL FANUC 21I CODE-A
(
( PART
( CYLINDER D100.000 L107.000
( MATERIAL "AlMg1::Aluminium"
( DENSITY 002.70
(
( MAIN SPINDLE WITH WORKPART
( CHUCK "Chuck Turn\Jaw chuck\KFD-HS 160"
( STEP JAW "Jaws\Step jaw\HM-110_130-02.001"
( TYPE OF CHUCK EXTERNAL CHUCK OUTSIDE STEP JAW
( CHUCKING DEPTH E18.000
(( Rechte Fläche des Werkstückes: Z+0231.000
(
(
( TAILSTOCK
( TAILSTOCK POSITION Z+1095.000
(
( CURRENT TOOL T01
( TOOLS
( T01 "DIN69880 V 30\LEFT CORNER TOOL\CL-SCLCL-2020 L 1208 ISO30"
( T02 "DIN69880 V 30\LEFT CORNER TOOL\CL-SVJCL-2020 L 1604 ISO30"
( TOOL COMPENSATION
( D01 T01 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E005.005 I-000.800 K-000.800 A+004.375
L011.855 N01
( D02 T02 Q3 R000.400 X+070.000 Z+0045.000 G000.000 E052.393 I-000.400 K-000.400 A+002.372
L016.178 N01
(
( WORKPART ZEROPOINTS
(( Rechte Fläche des Werkstückes: Z+0231.000
( G54 X+000.000 Z+0229.000
(
()
$G54
:2
N10 G40 G00
N20 G99
N30 M5
N40 M9
N60 T0101
N70 G50 S3500
N80 G96 S0240 M4
N90 G00 X102. Z0.
N100 G01 X-2. F0.15 M7
N110 G00 Z2.
N120 G00 X90.
N130 G01 Z-69.8 F0.3
N140 G01 X102. Z-49.8
N150 G00 Z2.
N160 G00 X80.
N170 G01 Z-69.8
N180 G01 X91.
N190 G01 X102. Z-76.
N200 G00 Z2.
N210 G00 X70.
N220 G01 Z-69.8

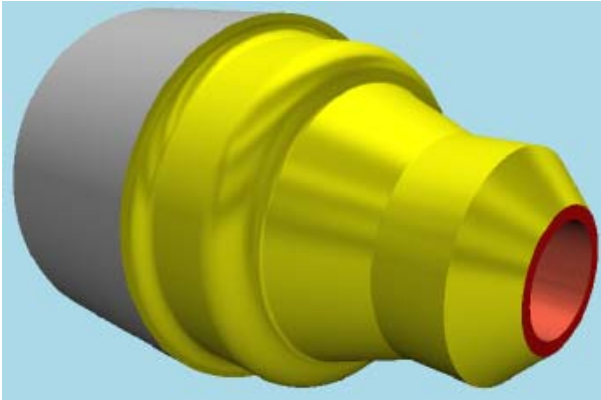
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NC programs using circular interpolation

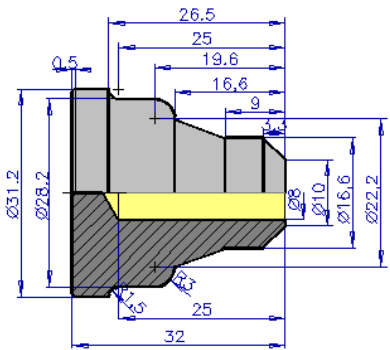
N230 G01 X78.
N240 G00 Z2.
N250 G00 X61.
N260 G01 Z-66.8
N270 G02 X67. Z-69.8 I3. K0.
N280 G01 X72.
N290 G00 Z2.
N300 G00 X51.
N310 G01 Z-46.8
N320 G02 X57. Z-49.8 I3. K0.
N330 G01 X62. Z-53.
N340 G00 Z2.
N350 G00 X40.
N360 G01 Z-29.8
N370 G01 X43.
N380 G01 X52. Z-34.
N390 G00 Z2.
N400 G00 X31.
N410 G01 Z-25.8
N420 G02 X39. Z-29.8 I4. K0.
N430 G01 X41.
N440 G00 Z2.
N450 G00 X18.
N460 G01 Z0.
N470 G01 X21.
N480 G03 X31. Z-5. I0. K-5.
N490 G01 X32.
N500 G00 X200. Z150.
N510 T0202
N520 G50 S4500
N530 G96 S0380 M4
N540 G42 G00 X16. Z2.
N550 G01 Z0. F1.
N560 G01 X20.
N570 G03 X30. Z-5. I0. K-5.
N580 G01 Z-26.
N590 G02 X38. Z-30. I4. K0.
N600 G01 X44.
N610 G01 X50. Z-33.
N620 G01 Z-47.
N630 G02 X56. Z-50. I3. K0.
N640 G01 X60. Z-52.
N650 G01 Z-67.
N660 G02 X66. Z-70. I3. K0.
N670 G01 X90.
N680 G01 X102. Z-76.
N690 G40
N700 G00 X200. Z150.
N710 M5
N720 M9
N730 M30

6.2.3 Exercise 4: Bolt with radii

The bolt on the drawing is to be manufactured on a CNC lathe using a blank made of AlMg1 dimensioned $\varnothing 32 \times 45$ mm. Work out all necessary documentation for the machining. Prepare, test and correct the process on the MTS CNC Simulator.



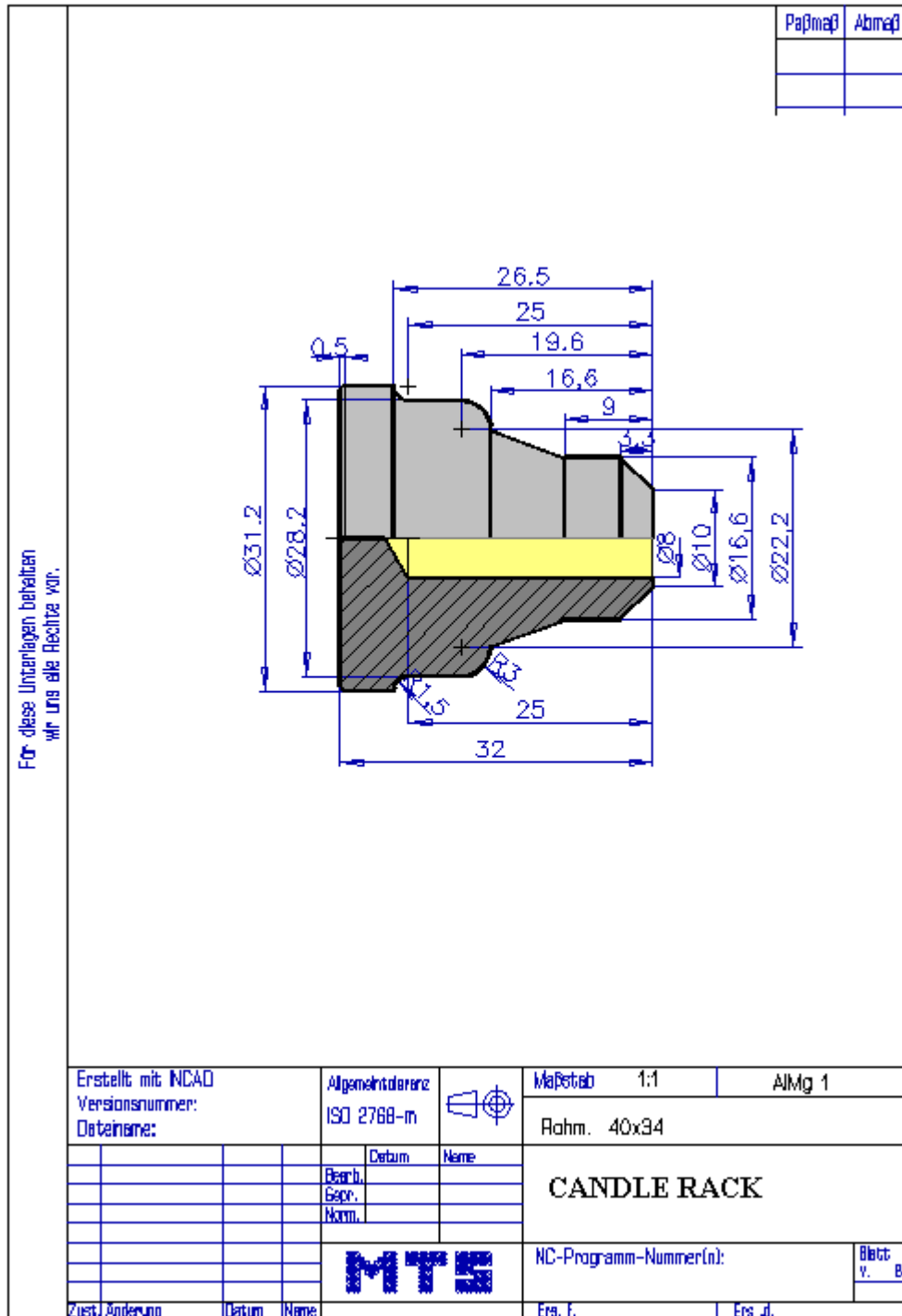
Für diese Umzeichnungen behalten wir uns alle Rechte vor.



Erstellt mit: NCAD		Allgemeintoleranz		Maßstab		1:1		AlMg 1	
Versionsnummer:		ISO 2768-m		Raum.		40x34			
Datum:		Name:		Kerzenständer		NC-Programm-Nummer(n):		Blatt v. Bl.	
Bearb.:		Datum:							
Zeich.:		Name:							
Norm.:		Name:							
MTS				Ers. f.:		Ers. d.:			

Learning Objective: The learner can describe circular traverse motions of the tool.

Special Training Elements: Use the cross roughing cycle G72 with finishing allowance and the cycle G74 for deep hole drilling. Finish the profil with cutter radius compensation.



6.2.4 Possible Solution: Program MTS35.DNC:

```

()
(( 11.11.2005 11:41
(
( CONFIGURATION
( MACHINE MTS01 TM-016_-R1_-060x0646x0920
( CONTROL FANUC 21I CODE-A
(
( PART
( CYLINDER D032.000 L045.000
( MATERIAL "AlMg1::Aluminium"
( DENSITY 002.70
(
( MAIN SPINDLE WITH WORKPART
( CHUCK "Chuck Turn\Jaw chuck\KFD-HS 110"
( STEP JAW "Jaws\Step jaw\MBS-110_130-02.006"
( TYPE OF CHUCK EXTERNAL CHUCK OUTSIDE STEP JAW
( CHUCKING DEPTH E6.000
(( Rechte Fläche des Werkstückes: Z+0156.000
(
(
( TAILSTOCK
( TAILSTOCK POSITION Z+1095.000
(
( CURRENT TOOL T01
( TOOLS
( T01 "DIN69880 V 30\LEFT CORNER TOOL\CL-SCLCL-2020 L 1208 ISO30"
( T02 EMPTY
( T03 "DIN69880 V 30\LEFT CORNER TOOL\CL-SVJAL-2020 L 1604 ISO30"
( T04 "DIN69880 V 30\CENTER DRILL\CD-03.15 050 R HSS ISO30"
( T05 "DIN69880 V 30\LEFT CORNER TOOL\CL-SDJCL-2020 L 1208 ISO30"
( T12 "DIN69880 V 30\TWIST DRILL\DR-08.00 075 R HSS ISO30"
(
( TOOL COMPENSATION
( D01 T01 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E005.005 I-000.800 K-000.800 A+004.375
L011.855 N01
( D02 T02 Q8 R000.800 X+070.000 Z+0032.000 G000.000 E060.000 I-000.800 K+000.000 A-030.000
L013.597 N01
( D03 T03 Q3 R000.400 X+070.000 Z+0045.000 G000.000 E052.393 I-000.400 K-000.400 A+002.372
L016.178 N01
( D04 T04 Q7 R000.000 X+000.000 Z+0070.000 G003.150 E000.000 I+000.000 K+000.000 A+000.000
L000.000 N01
( D05 T05 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E032.178 I-000.800 K-000.800 A+002.372
L010.785 N01
( D12 T12 Q7 R000.000 X+000.000 Z+0147.000 G008.000 E059.000 I+000.000 K+000.000 A+000.000
L000.000 N01
(
( WORKPART ZEROPOINTS
(( Rechte Fläche des Werkstückes: Z+0156.000
( G54 X+000.000 Z+0155.000
(
)
$G54
:8
N10 G40 G00
N20 G99
N30 M5
N40 M9
N60 T0101
N70 G97 S1000
N80 G00 X150. Z100.
N90 G50 S3500
N100 G96 S0200

```

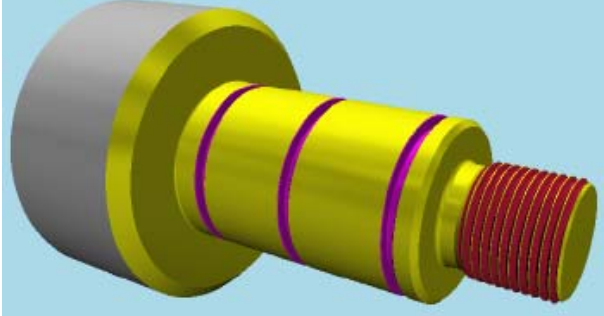
NC programs using circular interpolation

N110 G00 X33. Z0. M4
N120 G01 X-1.6 F0.25 M8
N130 G00 Z3.
N140 G00 X35.
N150 G72 W3. R1
N160 G72 P170 Q250 U0.5 W0.2 F0.25
N170 G41 G00 Z-26.5
N180 G01 X31.2
N190 G03 X28.2 Z-25. I0. K1.5
N200 G01 Z-19.6
N210 G02 X22.2 Z-16.6 I-3. K0.
N220 G01 X16.6 Z-9.
N230 G01 Z-3.3
N240 G01 X8. Z1.
N250 G40
N260 G00 X150. Z100.
N270 M9
N280 T0404
N290 G97 S2300 M3
N300 G00 Z3.
N310 G00 X0.
N320 G01 Z-5.8 F0.12 M8
N330 G00 Z3.
N340 G00 X200. Z50.
N350 M9
N360 T1212
N370 G97 S0900 M3
N380 G00 Z3.
N390 G00 X0.
N400 G74 R1.0
N410 G74 X0.0 Z-27 Q8000 F0.2
N480 G00 X200. Z50.
N490 T0303
N500 G50 S3500
N510 G96 S0280 M4
N520 G00 X7. Z1.
N530 G42 G01 Z0. F0.1
N540 G01 X10.
N550 G01 X16.6 Z-3.3
N560 G01 Z-9.
N570 G01 X22.2 Z-16.6
N580 G03 X28.2 Z-19.6 I0. K-3.
N590 G01 Z-25.
N600 G02 X31.2 Z-26.5 I1.5 K0.
N610 G01 X33.
N620 G40
N630 G00 X150. Z100.
N640 M30

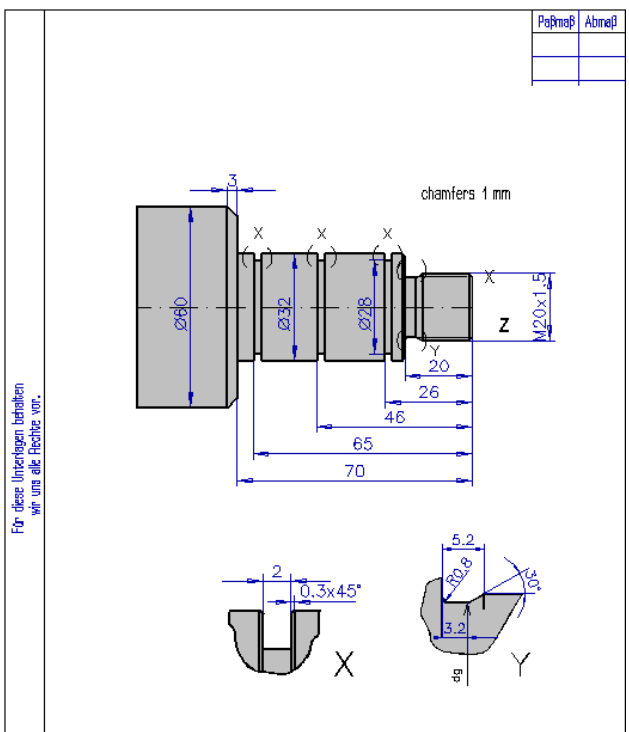
6.3 NC programs canned cycles

6.4 Exercise 5: Shaft with recess and thread

The shaft on the drawing is to be manufactured on a CNC lathe using a blank made of AlMg1 dimensioned $\varnothing 60 \times 101$ mm. The roughing is to be done manually. Work out all necessary documentation for the machining. Prepare, test and correct the process on the MTS CNC Simulator.



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Erstellt mit: INCAD		Allgemeintoleranz	Meßstab
Versionsnummer:		ISO 2768-m	
Dateiname:			
	Datum	Name	Shaft
Bearb.			
Gepr.			
Norm.			
MTS		NC-Programm-Nummer(n):	Blatz v. Bl.
Zust./Änderung	Datum	Name	Ers. f. Ers. d.

Learning Objective: The learner can describe the use of compound fixed cycle.

Special Training Elements: Simple programming. Program the recesses the incremental programming with U and W. Use for threading the cycle G76

Exercise 5: Shaft with recess and thread

Paßmaß	Abmaß

chamfers 1 mm

$\varnothing 60$

$\varnothing 32$

$\varnothing 28$

M20x1.5

Z

20

26

46

65

70

X

Y

5.2

R0.8

3.2

30°

2

0.3x45°

Für diese Unterlagen behalten wir uns alle Rechte vor.

6.4.1 Possible Solution: Program MTS47 DNC

```

()
(( 11.11.2005 11:41
(
( CONFIGURATION
( MACHINE MTS01 TM-016_-R1_-060x0646x0920
( CONTROL FANUC 21i CODE-A
(
( PART
( CYLINDER D032.000 L045.000
( MATERIAL "AlMg1::Aluminium"
( DENSITY 002.70
(
( MAIN SPINDLE WITH WORKPART
( CHUCK "Chuck Turn\Jaw chuck\KFD-HS 110"
( STEP JAW "Jaws\Step jaw\MBS-110_130-02.006"
( TYPE OF CHUCK EXTERNAL CHUCK OUTSIDE STEP JAW
( CHUCKING DEPTH E6.000
(( Rechte Fläche des Werkstückes: Z+0156.000
(
(
( TAILSTOCK
( TAILSTOCK POSITION Z+1095.000
(
( CURRENT TOOL T01
( TOOLS
( T01 "DIN69880 V 30\LEFT CORNER TOOL\CL-SCLCL-2020 L 1208 ISO30"
( T02 EMPTY
( T05 "DIN69880 V 30\LEFT CORNER TOOL\CL-SDJCL-2020 L 1208 ISO30"
(
( TOOL COMPENSATION
( D01 T01 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E005.005 I-000.800 K-000.800 A+004.375
L011.855 N01
( D02 T02 Q8 R000.800 X+070.000 Z+0032.000 G000.000 E060.000 I-000.800 K+000.000 A-030.000
L013.597 N01
( D05 T05 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E032.178 I-000.800 K-000.800 A+002.372
L010.785 N01
(
( WORKPART ZEROPOINTS
(( Rechte Fläche des Werkstückes: Z+0156.000
( G54 X+000.000 Z+0155.000
(
)
$G54
:10
N10 G40 G00
N20 G99
N30 M5
N40 M9
N60 T0101
N70 G97 S1000
N80 G00 X150. Z100.
N90 G50 S3500
N100 G96 S0200
N110 G00 X62. Z0.1 M4
N120 G01 X-1.6 F0.25 M8
N130 G00 Z1.
N140 G00 X61.
N150 G01 X55. Z0.919
N160 G01 Z0.719
N170 G01 X55.4
N180 G03 X56.531 Z0.485 I0. K-0.8

```

Exercise 5: Shaft with recess and thread

N190 G01 X58.531 Z-0.515
N200 G03 X59. Z-1.081 I-0.566 K-0.566
N210 G01 Z-14.881
N220 G03 X58.787 Z-15.28 I-0.8 K0.
N230 G01 X56.7 Z-17.095
N240 G01 Z-19.281
N250 G01 X61.
N260 G00 Z0.919
N270 G00 X55.
N280 G01 X49. Z0.838
N290 G01 Z0.638
N300 G01 X49.4
N310 G03 X50.531 Z0.404 I0. K-0.8
N320 G01 X52.531 Z-0.596
N330 G03 X53. Z-1.162 I-0.566 K-0.566
N340 G01 Z-14.962
N350 G03 X52.787 Z-15.361 I-0.8 K0.
N360 G01 X50.7 Z-17.175
N370 G01 Z-19.362
N380 G01 X61.
N390 G00 Z0.838
N400 G00 X49.
N410 G01 X43. Z0.757
N420 G01 Z0.557
N430 G01 X43.4
N440 G03 X44.531 Z0.323 I0. K-0.8
N450 G01 X46.531 Z-0.677
N460 G03 X47. Z-1.243 I-0.566 K-0.566
N470 G01 Z-15.043
N480 G03 X46.787 Z-15.441 I-0.8 K0.
N490 G01 X44.7 Z-17.256
N500 G01 Z-19.443
N510 G01 X55.4
N520 G03 X56.531 Z-19.677 I0. K-0.8
N530 G01 X58.531 Z-20.677
N540 G03 X59. Z-21.243 I-0.566 K-0.566
N550 G01 Z-69.443
N560 G01 X61.
N570 G00 Z0.757
N580 G00 X43.
N590 G01 X37. Z0.676
N600 G01 Z0.476
N610 G01 X37.4
N620 G03 X38.531 Z0.242 I0. K-0.8
N630 G01 X40.531 Z-0.758
N640 G03 X41. Z-1.324 I-0.566 K-0.566
N650 G01 Z-15.124
N660 G03 X40.787 Z-15.522 I-0.8 K0.
N670 G01 X38.7 Z-17.337
N680 G01 Z-19.524
N690 G01 X49.4
N700 G03 X50.531 Z-19.758 I0. K-0.8
N710 G01 X52.531 Z-20.758
N720 G03 X53. Z-21.324 I-0.566 K-0.566
N730 G01 Z-69.524
N740 G01 X61.
N750 G00 Z0.676
N760 G00 X37.
N770 G01 X31. Z0.596
N780 G01 Z0.396
N790 G01 X31.4
N800 G03 X32.531 Z0.161 I0. K-0.8
N810 G01 X34.531 Z-0.839

N820 G03 X35. Z-1.404 I-0.566 K-0.566
N830 G01 Z-15.204
N840 G03 X34.787 Z-15.603 I-0.8 K0.
N850 G01 X32.7 Z-17.418
N860 G01 Z-19.604
N870 G01 X43.4
N880 G03 X44.531 Z-19.839 I0. K-0.8
N890 G01 X46.531 Z-20.839
N900 G03 X47. Z-21.404 I-0.566 K-0.566
N910 G01 Z-69.604
N920 G01 X61.
N930 G00 Z0.596
N940 G00 X31.
N950 G01 X25. Z0.515
N960 G01 Z0.315
N970 G01 X25.4
N980 G03 X26.531 Z0.08 I0. K-0.8
N990 G01 X28.531 Z-0.92
N1000 G03 X29. Z-1.485 I-0.566 K-0.566
N1010 G01 Z-15.285
N1020 G03 X28.787 Z-15.684 I-0.8 K0.
N1030 G01 X26.7 Z-17.499
N1040 G01 Z-19.685
N1050 G01 X37.4
N1060 G03 X38.531 Z-19.92 I0. K-0.8
N1070 G01 X40.531 Z-20.92
N1080 G03 X41. Z-21.485 I-0.566 K-0.566
N1090 G01 Z-69.685
N1100 G01 X61.
N1110 G00 Z0.515
N1120 G00 X25.
N1130 G01 X19. Z0.434
N1140 G01 Z0.234
N1150 G01 X19.4
N1160 G03 X20.531 Z-0.001 I0. K-0.8
N1170 G01 X22.531 Z-1.001
N1180 G03 X23. Z-1.566 I-0.566 K-0.566
N1190 G01 Z-15.366
N1200 G03 X22.787 Z-15.765 I-0.8 K0.
N1210 G01 X20.7 Z-17.58
N1220 G01 Z-19.766
N1230 G01 X31.4
N1240 G03 X32.531 Z-20.001 I0. K-0.8
N1250 G01 X34.531 Z-21.001
N1260 G03 X35. Z-21.566 I-0.566 K-0.566
N1270 G01 Z-69.766
N1280 G01 X55.4
N1290 G03 X56.531 Z-70.001 I0. K-0.8
N1300 G01 X61. Z-72.235
N1310 G00 Z0.434
N1320 G00 X19.
N1330 G01 X16.5 Z0.4
N1340 G01 Z0.2
N1350 G01 X16.9
N1360 G03 X18.031 Z-0.034 I0. K-0.8
N1370 G01 X20.031 Z-1.034
N1380 G03 X20.5 Z-1.6 I-0.566 K-0.566
N1390 G01 Z-15.4
N1400 G03 X20.287 Z-15.799 I-0.8 K0.
N1410 G01 X18.2 Z-17.614
N1420 G01 Z-19.8
N1430 G01 X28.9
N1440 G03 X30.031 Z-20.034 I0. K-0.8

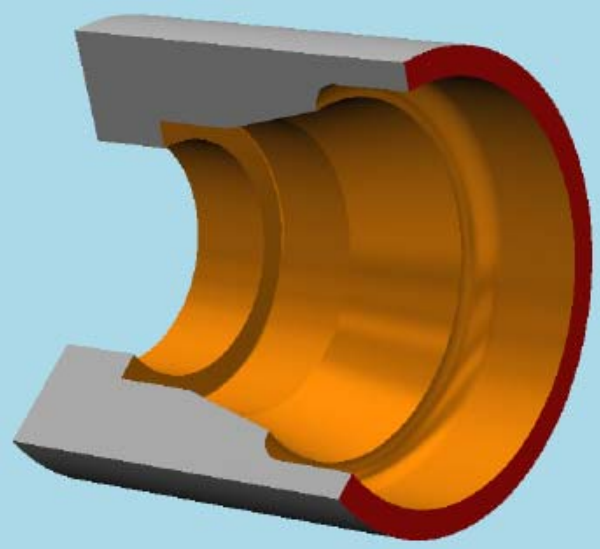
Exercise 5: Shaft with recess and thread

N1450 G01 X32.031 Z-21.034
N1460 G03 X32.5 Z-21.6 I-0.566 K-0.566
N1470 G01 Z-69.8
N1480 G01 X52.9
N1490 G03 X54.031 Z-70.034 I0. K-0.8
N1500 G01 X62.031 Z-74.034
N1510 G00 Z0.4
N1520 G00 X61.
N1530 G00 Z1.
N1540 G00 X150. Z100.
N1550 M9
N1560 T0303
N1570 G50 S3500
N1580 G96 S0300 M4
N1590 G00 X-0.8 Z1.
N1600 G42 G01 Z0. F0.1 M8
N1610 G01 X18.
N1620 G01 X20. Z-1.
N1630 G01 Z-14.8
N1640 G01 X17.7 Z-16.8
N1650 G01 Z-19.2
N1660 G02 X19.3 Z-20. I0.8 K0.
N1670 G01 X30.
N1680 G01 X32. Z-21.
N1690 G01 Z-70.
N1700 G01 X54.
N1710 G01 X62. Z-74.
N1720 G40
N1730 G00 X150. Z100.
N1740 T0404
N1750 G50 S3500
N1760 G96 S0140 M4
N1770 G00 X33. Z-26.
N1780 G01 U-5.
N1790 G04 X0.5
N1800 G01 U5. F0.3
N1810 G01 W-0.8
N1820 G01 U-1.6 W0.8 F0.05
N1830 G01 U1.6 F0.3
N1840 G01 W0.8
N1850 G01 U-1.6 W-0.8 F0.05
N1860 G01 U1.6
N1870 G00 Z-46.
N1880 G01 U-5. F0.1
N1890 G04 X0.5
N1900 G01 U5. F0.3
N1910 G01 W-0.8
N1920 G01 U-1.6 W0.8 F0.05
N1930 G01 U1.6 F0.3
N1940 G01 W0.8
N1950 G01 U-1.6 W-0.8 F0.05
N1960 G01 U1.6
N1970 G00 Z-65.
N1980 G01 U-5. F0.1
N1990 G04 X0.5
N2000 G01 U5. F0.3
N2010 G01 W-0.8
N2020 G01 U-1.6 W0.8 F0.05
N2030 G01 U1.6 F0.3
N2040 G01 W0.8
N2050 G01 U-1.6 W-0.8 F0.05
N2060 G01 U1.6
N2070 G00 X150. Z100.

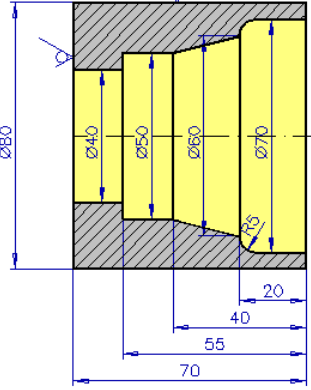
N2080 M9
N2090 T0505
N2100 G97 S1000 M3
N2110 G00 X22. Z5.
N2120 G76 P020000 Q14 R50
N2130 G76 X18.16 Z-18. R0. P920 Q92 F1.5
N2140 G00 X150. Z100.
N2150 M30

6.5 Exercise 6: Bush with inside machining

The bush on the drawing made of AlMg1 is to be made on a CNC lathe in higher batch quantity. Prepare the manufacturing process with the MTS CNC Simulator including following steps: define workpart zero, set up the processing sequence, determine tools, fixtures and technological data; generate, set up, test and correct the program at the CNC simulator. A blank with an external diameter of $\varnothing 80$ mm and the length of 71mm is to be clamped for the test.



Für diese Unterlagen behalten wir uns alle Rechte vor.



Erstellt mit: NCAD		Algemeintoleranz	Maßstab	
Versionsnummer:		ISO 2768-m		
Dateiname:				
		Bearb.	BUSH	
		Gepr.		
		Norm.		
		MTS	NC-Programm-Nummer(n):	
Zust./Änderung	Datum	Name	Ers. f.	Ers. d.

Learning Objective: The learners are capable of optimizing program runs by the use of machining cycles.

Special Training Elements: Use the straight roughing cycle G71 with finishing allowance and the cycle G74 for deep hole drilling. Finish the profil with cutter radius compensation.

	Peßmaß	Abmaß

Für diese Unterlagen behalten wir uns alle Rechte vor.

6.5.1 Possible Solution: Program MTS44.DNC

```
()
(( 14.11.2005 07:59
(
( CONFIGURATION
( MACHINE MTS01 TM-016_-R1_-060x0646x0920
( CONTROL FANUC 21I CODE-A
(
( PART
( CYLINDER D080.000 L071.000
( MATERIAL "AlMg1::Aluminium"
( DENSITY 002.70
(
( MAIN SPINDLE WITH WORKPART
( CHUCK "Chuck Turn\Jaw chuck\KFD-HS 110"
( STEP JAW "Jaws\Step jaw\HM-110_130-03.000"
( TYPE OF CHUCK EXTERNAL CHUCK OUTSIDE STEP JAW
( CHUCKING DEPTH E8.000
(( Rechte Fläche des Werkstückes: Z+0171.000
(
(
( TAILSTOCK
( TAILSTOCK POSITION Z+1095.000
(
( CURRENT TOOL T01
( TOOLS
( T01 "DIN69880 V 30\LEFT CORNER TOOL\CL-SCLCL-2020 L 1208 ISO30"
( T02 "DIN69880 V 30\LEFT CORNER TOOL\CL-SVJCL-2020 L 1604 ISO30"
( T05 "DIN69880 V 30\REVERSIBLE TIP DRL\DI-28.00 063 R HMT ISO30"
( T08 "DIN69880 V 30\INSIDE TURNING TOOL POST\BI-SCAAL-1010 L 0604 ISO30"
(
( TOOL COMPENSATION
( D01 T01 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E005.005 I-000.800 K-000.800 A+004.375
L011.855 N01
( D02 T02 Q3 R000.400 X+070.000 Z+0045.000 G000.000 E052.393 I-000.400 K-000.400 A+002.372
L016.178 N01
( D05 T05 Q7 R000.000 X+000.000 Z+0175.000 G028.000 E000.000 I+000.000 K+000.000 A+000.000
L000.000 N01
( D08 T08 Q2 R000.400 X-008.238 Z+0170.000 G000.000 E032.079 I+000.400 K-000.400 A+002.721
L005.992 N01
(
( WORKPART ZEROPOINTS
(( Rechte Fläche des Werkstückes: Z+0171.000
( G54 X+000.000 Z+0170.000
(
()
$G54
:9
N10 G40 G00
N20 G99
N30 M5
N40 M9
N60 T0101
N70 G50 S3500
N80 G96 S0200 M4
N90 G00 X82. Z0.
N100 G01 X20. F0.25 M8
N110 G00 X150. Z100.
N120 M9
N130 T0505
N140 G97 S0800 M3
N150 G00 Z4.
```

N160 G00 X0.
N170 G74 R1.0
N180 G74 X0.0 Z-73.0 Q18000 F0.2
N300 G00 X150. Z100.
N310 T1010
N320 G50 S3500
N330 G96 S0200 M4
N340 G00 X27. Z1.
N350 G71 U2. R1
N360 G71 P370 Q460 U-0.5 W0.1 F0.2
N370 G41 G00 X74.
N380 G01 X70. Z0.
N390 G01 Z-15.
N400 G03 X60. Z-20. I-5. K0.
N410 G01 X50. Z-40.
N420 G01 Z-55.
N430 G01 X40.
N440 G01 Z-71.
N450 G01 X27.
N460 G40
N470 G00 X150. Z100.
N480 T0808
N490 G50 S4000
N500 G96 S0300 M4
N510 G00 X74. Z1.
N520 G41 G01 X70. Z0. F0.1 M8
N530 G01 Z-15.
N540 G03 X60. Z-20. I-5. K0.
N550 G01 X50. Z-40.
N560 G01 Z-55.
N570 G01 X40.
N580 G01 Z-71.
N590 G01 X27.
N600 G01 X38.
N610 G40
N620 G00 X38.8 Z3.
N630 G00 X150. Z100.
N640 M9
N650 M30

	Fit size	Deviation

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Established by INCAD Version 3.1	General tolerance ISO 2768-m		Scale
	1997	Date	Name
	Estab		Schmitt
	Check		
	Norm		
MTS			NC program No(s):
Stat	Iteration	Date	Name
			Replacement for
			Replaced by

Page 1
of

6.5.3 Possible Solution: Program G85G82A.DNC:

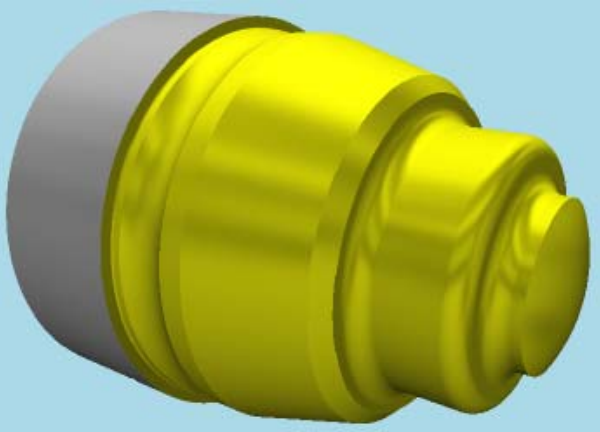
```
()
(( 11.11.2005 06:59
(
( CONFIGURATION
( MACHINE MTS01 TM-016_-R1_-060x0646x0920
( CONTROL FANUC 21I CODE-A
(
( PART
( CYLINDER D100.000 L061.000
( MATERIAL "AlMg1::Aluminium"
( DENSITY 002.70
(
( MAIN SPINDLE WITH WORKPART
( CHUCK "Chuck Turn\Jaw chuck\KFD-HS 160"
( STEP JAW "Jaws\Step jaw\HM-110_130-02.001"
( TYPE OF CHUCK EXTERNAL CHUCK OUTSIDE STEP JAW
( CHUCKING DEPTH E18.000
(( Rechte Fläche des Werkstückes: Z+0185.000
(
(
( TAILSTOCK
( TAILSTOCK POSITION Z+1095.000
(
( CURRENT TOOL T01
( TOOLS
( T01 "DIN69880 V 30\LEFT CORNER TOOL\CL-SCLCL-2020 L 1208 ISO30"
( T02 "DIN69880 V 30\LEFT CORNER TOOL\CL-MVJCL-KITA L 1604 IS030"
( T03 "DIN69880 V 30\LEFT THREADING TOOL\TL-LHTR-2020 R 60 1.00 ISO30"
( T04 "DIN69880 V 30\LEFT CORNER TOOL\CL-SCLCL-2020 L 1208 ISO30"
( T05 "DIN69880 V 30\LEFT CORNER TOOL\CL-MVJCL-KITA L 1604 IS030" FF0000
(
( TOOL COMPENSATION
( D01 T01 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E005.005 I-000.800 K-000.800 A+004.375
L011.855 N01
( D02 T02 Q3 R000.400 X+070.000 Z+0052.139 G000.000 E005.000 I-000.400 K-000.400 A+050.000
L010.413 N01
( D03 T03 Q8 R000.144 X+070.000 Z+0042.600 G000.000 E000.000 I-000.144 K+000.000 A+000.000
L000.000 N01
( D04 T04 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E005.005 I-000.800 K-000.800 A+004.375
L011.855 N01
( D05 T05 Q3 R000.400 X+070.000 Z+0052.139 G000.000 E005.000 I-000.400 K-000.400 A+050.000
L010.413 N01
(
( WORKPART ZEROPOINTS
(( Rechte Fläche des Werkstückes: Z+0185.000
( G54 X+000.000 Z+0184.000
(
(
)
$G54
:5
N10 G40 G00
N20 G99
N30 M5
N40 M9
N50 ( set new zero point 'G54': X0. Z0. )
N60 T0101
N70 G50 S4000
N80 G96 S0300 M4
N90 G00 X102. Z0.1
N100 G01 X-2. F0.15 M7
```


N110 G00 X150. Z100.
N120 M9
N130 T0505
N140 G50 S3500
N150 G96 S0240 M4
N160 G00 X102. Z2.
N170 G72 W2. R1
N180 G72 P190 Q300 U0.3 W0.5 F0.3
N190 G41 G00 X102. Z-30.
N200 G01 X100. Z-29.
N210 G01 X96. Z-27.
N220 G01 Z-12.
N230 G02 X78.929 Z-8.464 I-5. K0.
N240 G01 X63. Z-16.429
N250 G01 X30.
N260 G01 X20. Z-11.429
N270 G01 Z-2.
N280 G01 X16. Z0.
N290 G01 X14.
N300 G40
N310 G00 X150. Z100.
N320 T0202
N330 G50 S4000
N340 G96 S0380 M4
N350 G00 X102. Z-30.
N360 G41 G01 X100. Z-29. F0.1
N370 G01 X96. Z-27.
N380 G01 Z-12.
N390 G02 X78.929 Z-8.464 I-5. K0.
N400 G01 X63. Z-16.429
N410 G01 X30.
N420 G01 X20. Z-11.429
N430 G01 Z-2.
N440 G01 X16. Z0.
N450 G01 X-1.8
N460 G40
N470 G00 X150. Z100.
N480 M5
N490 M30

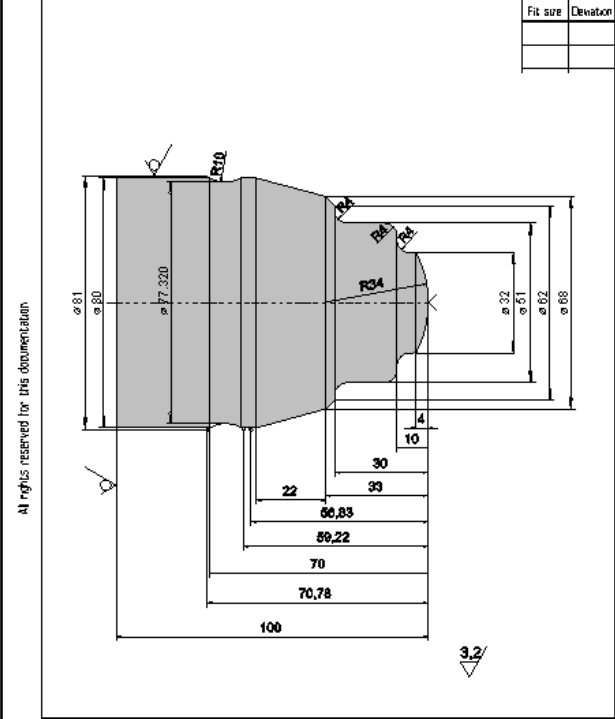
7 NC programs using subprogram technology

7.1 Exercise 8: Shape bolt

The shape bolt on the drawing made of AlMg1 is to be made on a CNC lathe in higher batch quantity. Prepare the manufacturing process with the MTS CNC Simulator including following steps: define workpart zero, set up the processing sequence, determine tools, fixtures and technological data; generate, set up, test and correct the program at the CNC simulator. A bolt with an external diameter of $\varnothing 85$ mm and the length of 102 mm is to be clamped for the test.



Fit size	Deviation



Established by INCAD
Version 3.1

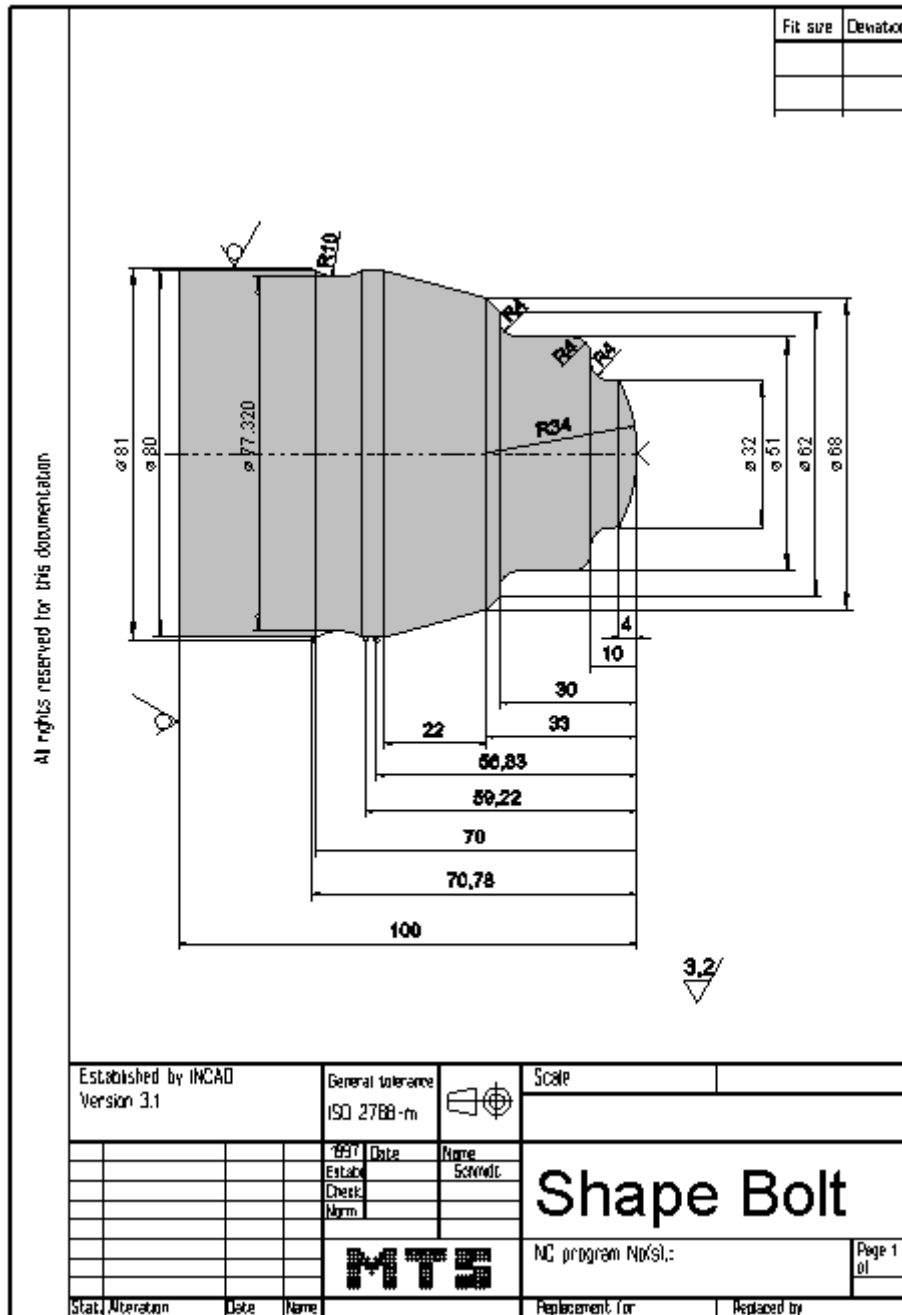
General tolerance	ISO 2768 -m		Scale
Year	Date	Name	<h1>Shape Bolt</h1>
Established		Sketcher	
Checked			
Approved			

MTS

NC program No(S):		Page 1	
Replacement for		of	
Replaced by			

Learning Objective: The learners are capable of optimizing program runs by the use of subprograms.

Special Training Elements: Use the straight roughing cycle G71 with finishing allowance. Finish the profil with cutter radius compensation



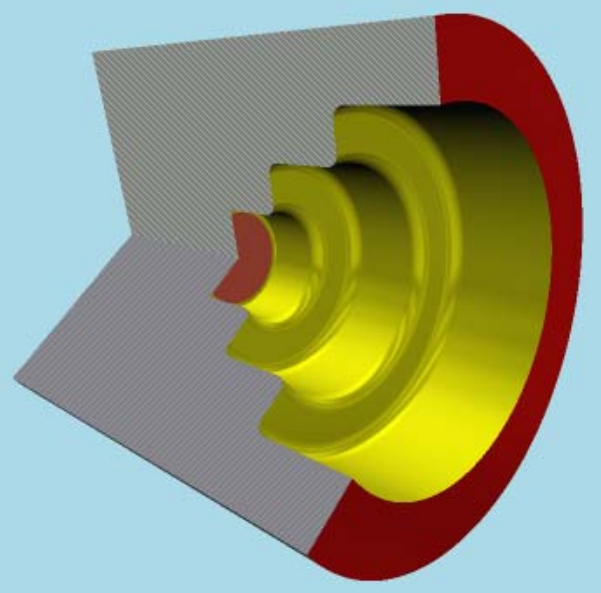
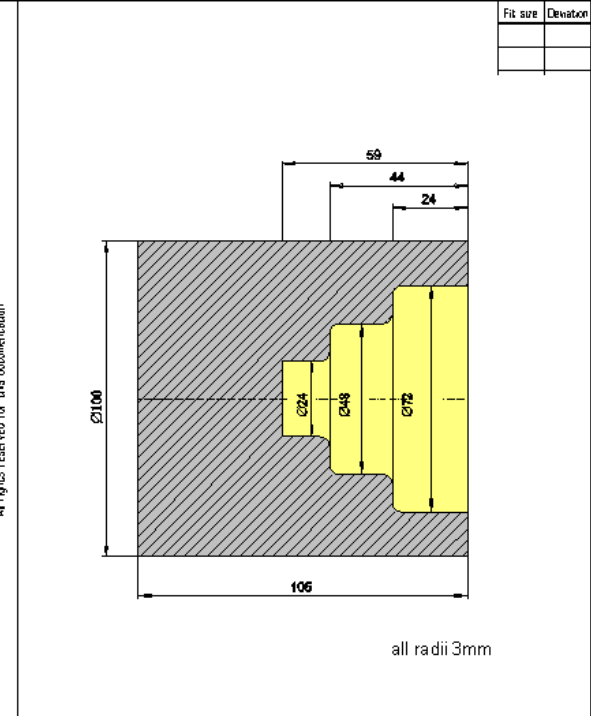
7.1.1 Possible solution: Program UNTFORM.DNC

```
()
(( 10.11.2005 16:25
(
( CONFIGURATION
( MACHINE MTS01 TM-016_-R1_-060x0646x0920
( CONTROL FANUC 21I CODE-A
(
( PART
( CYLINDER D085.000 L101.000
( DENSITY 002.70
(
( MAIN SPINDLE WITH WORKPART
( CHUCK "Chuck Turn\Jaw chuck\KFD-HS 160"
( STEP JAW "Jaws\Step jaw\HM-110_130-02.001"
( TYPE OF CHUCK EXTERNAL CHUCK OUTSIDE STEP JAW
( CHUCKING DEPTH E18.000
(( Rechte Fläche des Werkstückes: Z+0225.000
(
(
( TAILSTOCK
( TAILSTOCK POSITION Z+0800.000
(
( CURRENT TOOL T01
( TOOLS
( T01 "DIN69880 V 30\LEFT CORNER TOOL\CL-SCLCL-2020 L 1208 ISO30"
( T02 "DIN69880 V 30\LEFT CORNER TOOL\CL-SVJCL-2020 L 1604 ISO30"
( T05 "DIN69880 V 30\LEFT CORNER TOOL\CL-SDJCL-2020 L 1208 ISO30"
(
( TOOL COMPENSATION
( D01 T01 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E005.005 I-000.800 K-000.800 A+004.375
L011.855 N01
( D02 T02 Q3 R000.400 X+070.000 Z+0045.000 G000.000 E052.393 I-000.400 K-000.400 A+002.372
L016.178 N01
( D05 T05 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E032.178 I-000.800 K-000.800 A+002.372
L010.785 N01
(
( WORKPART ZEROPOINTS
(( Rechte Fläche des Werkstückes: Z+0225.000
( G54 X+000.000 Z+0224.000
(
)$G54
:13
N10 G40 G00
N20 G99
N30 M5
N40 M9
N60 T0505
N70 G50 S3500
N80 G96 S0240 M4
N90 G00 X87. Z0.2
N100 G01 X-2. F0.15 M7
N110 G00 X85. Z2.
N120 G71 U3. R1
N130 G71 P140 Q280 U0.5 W0.2 F0.3
N140 G42 G00 X-1.6
N160 G01 X0. Z0.
N170 G03 X32. Z-4. I0. K-34.
N180 G01 Z-6.
N190 G02 X40. Z-10. I4. K0.
N200 G01 X43.
```

N210 G03 X51. Z-14. I0. K-4.
N220 G01 Z-26.
N230 G02 X59. Z-30. I4. K0.
N240 G01 X62.
N250 G01 X68. Z-33.
N260 G01 X80. Z-55.
N270 G01 Z-72.
N280 G01 X87.
N290 G40
N300 G00 X81.5 Z-56.83
N310 G42 G01 Z-59.22 F0.3
N320 G02 Z-70.78 I8.16 K-5.78
N330 G01 X82.5
N340 G40
N350 G00 X150. Z150.
N360 M9
N370 T0202
N380 G50 S4500
N390 G96 S0380 M4
N400 G42 G00 X-1.6 Z2.
N410 G01 Z0.
N420 G01 X0.
N430 G03 X32. Z-4. I0. K-34.
N440 G01 Z-6.
N450 G02 X40. Z-10. I4. K0.
N460 G01 X43.
N470 G03 X51. Z-14. I0. K-4.
N480 G01 Z-26.
N490 G02 X59. Z-30. I4. K0.
N500 G01 X62.
N510 G01 X68. Z-33.
N520 G01 X80. Z-55.
N530 G01 Z-72.
N540 G01 X87.
N550 G40
N560 G00 X86.2 Z-56.83
N570 G42 G01 X81.
N580 G01 Z-59.22
N590 G02 Z-70.78 I8.16 K-5.78
N600 G01 X82.
N610 G40
N620 G00 X150. Z150.
N630 M5
N640 M30


7.2 Exercise 9: Bolt with inside machining

The bolt on the drawing made of AlMg1 is to be made on a CNC lathe in higher batch quantity. Prepare the manufacturing process with the MTS CNC Simulator including following steps: define workpart zero, set up the processing sequence, determine tools, fixtures and technological data; generate, set up, test and correct the program at the CNC simulator. A bolt with an external diameter of $\varnothing 100$ mm and the length of 107 mm is to be clamped for the test.

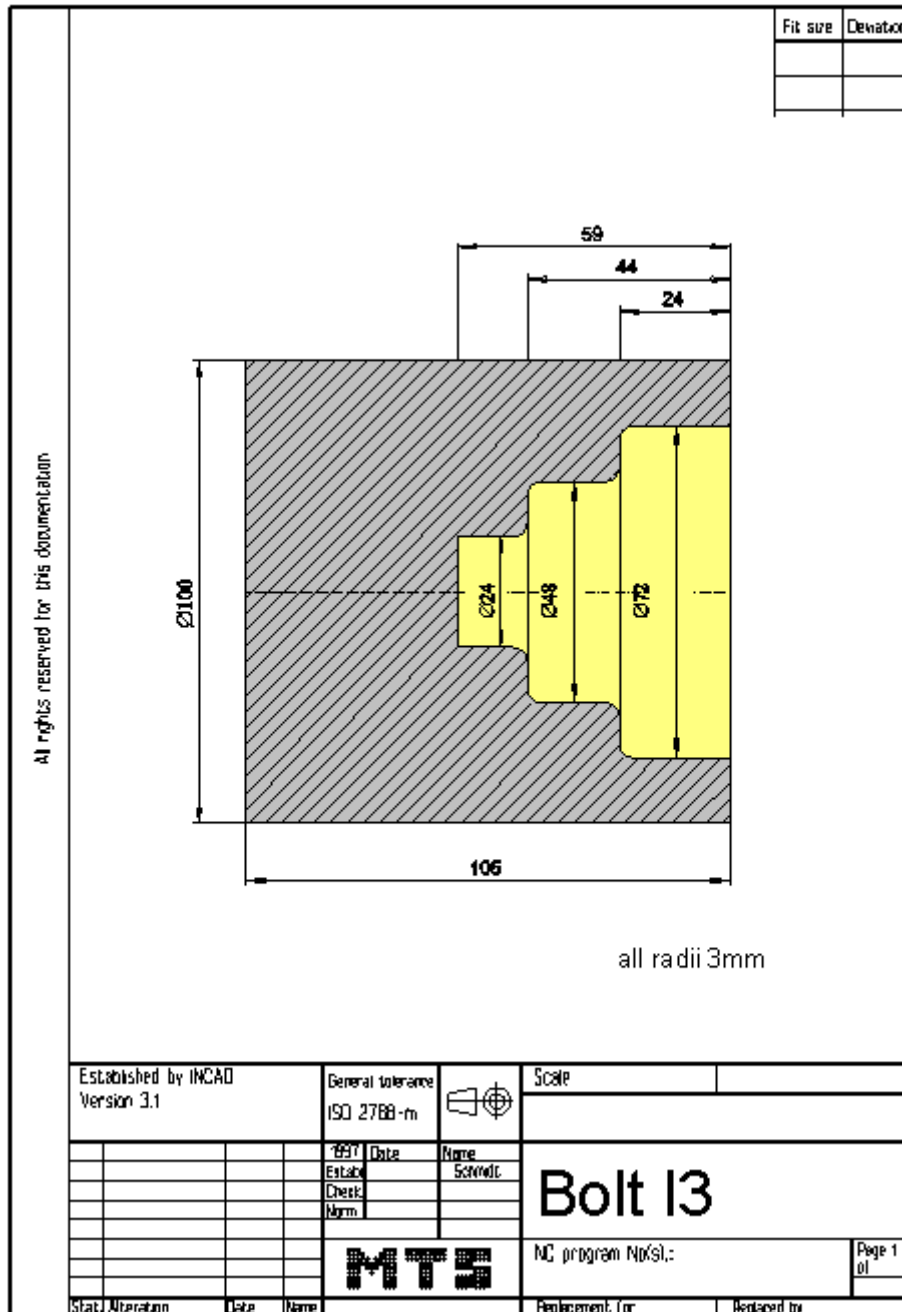
Fit	Deviation

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Established by INCAD Version 3.1		General tolerance ISO 2768 -m	Scale
			Bolt I3
		NC program MtkSl:-	Page 1 of 1
Stat., Mtksl., Date, Name	Replacement for	Replaced by	

Learning Objective: The learners are capable of optimizing program runs by the use the subprogram technology.

Special Training Elements: Use the cross straight roughing cycle G71 with finishing allowance for inside roughing. Put the profil for finishing into a subprogram.



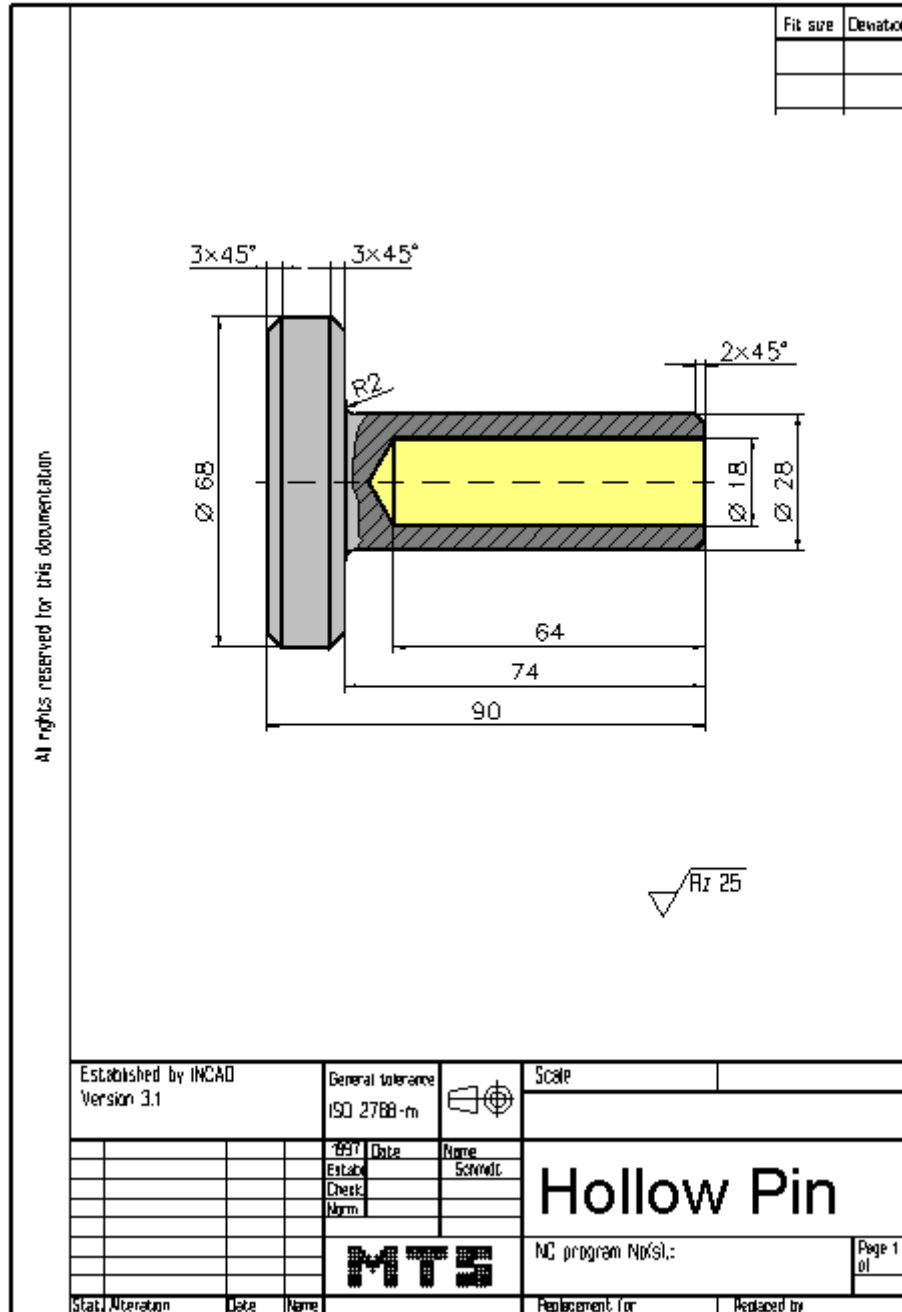
7.2.1 Possible Solution: Program UNTINN.DNC:

```
()
(( 11.11.2005 07:52
(
( CONFIGURATION
( MACHINE MTS01 TM-016_-R1_-060x0646x0920
( CONTROL FANUC 21I CODE-A
(
( PART
( CYLINDER D100.000 L107.000
( MATERIAL "AlMg1::Aluminium"
( DENSITY 002.70
(
( MAIN SPINDLE WITH WORKPART
( CHUCK "Chuck Turn\Jaw chuck\KFD-HS 160"
( STEP JAW "Jaws\Step jaw\HM-110_130-02.001"
( TYPE OF CHUCK EXTERNAL CHUCK OUTSIDE STEP JAW
( CHUCKING DEPTH E18.000
(( Rechte Fläche des Werkstückes: Z+0231.000
(
(
( TAILSTOCK
( TAILSTOCK POSITION Z+1095.000
(
( CURRENT TOOL T01
( TOOLS
( T01 "DIN69880 V 30\LEFT CORNER TOOL\CL-SCLCL-2020 L 1208 ISO30"
( T02 "DIN69880 V 30\LEFT CORNER TOOL\CL-SVJCL-2020 L 1604 ISO30"
( T05 "DIN69880 V 30\INSIDE TURNING TOOL POST\BI-SCAKL-1010 L 0604 ISO30"
( T07 "DIN69880 V 30\REVERSIBLE TIP DRL\DI-22.00 051 R HMT ISO30"
(
( TOOL COMPENSATION
( D01 T01 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E005.005 I-000.800 K-000.800 A+004.375
L011.855 N01
( D02 T02 Q3 R000.400 X+070.000 Z+0045.000 G000.000 E052.393 I-000.400 K-000.400 A+002.372
L016.178 N01
( D05 T05 Q2 R000.400 X-008.238 Z+0135.000 G000.000 E032.079 I+000.400 K-000.400 A+002.721
L005.992 N01
( D07 T07 Q7 R000.000 X+000.000 Z+0180.000 G022.000 E000.000 I+000.000 K+000.000 A+000.000
L000.000 N01
(
( WORKPART ZEROPOINTS
(( Rechte Fläche des Werkstückes: Z+0231.000
( G54 X+000.000 Z+0229.000
(
(
)
$G54
:14
N10 G40 G00
N20 G99
N30 M5
N40 M9
N60 T0101
N70 G50 S3500
N80 G96 S0240 M4
N90 G00 X102. Z0.
N100 G01 X-2. F0.15 M7
N110 G00 X150. Z150.
N120 M9
N130 T0707
N140 G97 S0950 M3
```


N150 G00 Z3.
N160 G00 X0.
N170 G74 R1.0
N171 G74 X0.0 Z-59.0 Q12000 R0.0 F0.2
N350 G00 X150. Z150.
N360 T0505
N370 G50 S3500
N380 G96 S0200 M4
N390 G00 X23. Z2.
N400 G71 U3. R1
N410 G71 P420 Q530 U-0.5 W0.2 F0.3
N420 G41 G00 X72.
N440 G01 Z-21.
N450 G03 X66. Z-24. I-3. K0.
N460 G01 X54.
N470 G02 X48. Z-27. I0. K-3.
N480 G01 Z-41.
N490 G03 X42. Z-44. I-3. K0.
N500 G01 X30.
N510 G02 X24. Z-47. I0. K-3.
N520 G01 Z-59.
N530 G01 X23.
N540 G40
N550 G00 X150. Z150. F0.3
N560 T1111
N570 G50 S4500
N580 G96 S0380 M4
N590 M98 P7000
N600 G00 X23.8 Z2.
N610 G00 X200. Z150.
N620 M5
N630 M30

O7000

N10 G41 G00 X72. Z2.
N20 G01 Z-21. F0.1
N30 G03 X66. Z-24. I-3. K0.
N40 G01 X54.
N50 G02 X48. Z-27. I0. K-3.
N60 G01 Z-41.
N70 G03 X42. Z-44. I-3. K0.
N80 G01 X30.
N90 G02 X24. Z-47. I0. K-3.
N100 G01 Z-59.
N110 G01 X23.
N120 G40
N130 M99



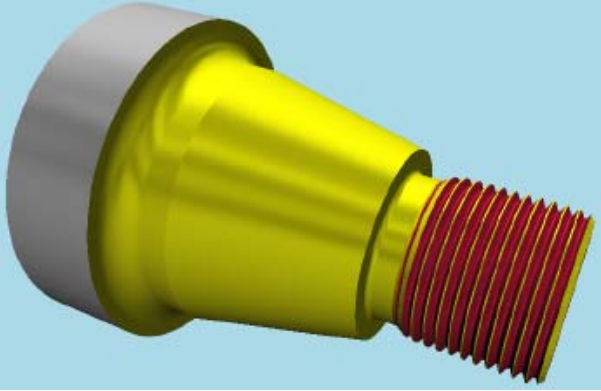
7.4 Possible Solution: Program HOLBG84.DNC

```
()
(( 10.11.2005 15:59
(
( CONFIGURATION
( MACHINE MTS01 TM-016_-R1_-060x0646x0920
( CONTROL FANUC 21I CODE-A
(
( PART
( CYLINDER D070.000 L120.000
( MATERIAL "AlMg1::Aluminium"
( DENSITY 002.70
(
( MAIN SPINDLE WITH WORKPART
( CHUCK "Chuck Turn\Jaw chuck\KFD-HS 160"
( STEP JAW "Jaws\Step jaw\HM-110_130-02.001"
( TYPE OF CHUCK EXTERNAL CHUCK OUTSIDE STEP JAW
( CHUCKING DEPTH E18.000
(( Rechte Fläche des Werkstückes: Z+0244.000
(
(
( TAILSTOCK
( LATHE CENTRE "Lathe Center\MK 2-9\170 MT1 000-024"
( QUILL DO NOT SET
( TAILSTOCK POSITION Z+1095.000
(
( CURRENT TOOL T01
( TOOLS
( T01 "DIN69880 V 30\LEFT CORNER TOOL\CL-SCLCL-2020 L 1208 ISO30"
( T02 "DIN69880 V 30\LEFT CORNER TOOL\CL-SVJCL-2020 L KITA ISO30" FFFF00
( T04 "DIN69880 V 30\LEFT CORNER TOOL\CL-SVJCL-2020 L KITA ISO30"
( T09 "DIN69880 V 30\CENTER DRILL\CD-03.15 050 R HSS ISO30"
( T11 "DIN69880 V 30\TWIST DRILL\DR-20.00 078 R HSS ISO30"
(
( TOOL COMPENSATION
( D01 T01 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E005.005 I-000.800 K-000.800 A+004.375
L011.855 N01
( D02 T02 Q3 R000.400 X+090.000 Z+0043.000 G000.000 E052.393 I-000.400 K-000.400 A+002.372
L016.178 N01
( D04 T04 Q3 R000.400 X+090.000 Z+0043.000 G000.000 E052.393 I-000.400 K-000.400 A+002.372
L016.178 N01
( D09 T09 Q7 R000.000 X+000.000 Z+0070.000 G003.150 E000.000 I+000.000 K+000.000 A+000.000
L000.000 N01
( D11 T11 Q7 R000.000 X+000.000 Z+0150.000 G020.000 E059.000 I+000.000 K+000.000 A+000.000
L000.000 N01
(
( WORKPART ZEROPOINTS
(( Rechte Fläche des Werkstückes: Z+0244.000
( G54 X+000.000 Z+0243.000
(
(
()
$G54
:6
N10 G40 G00
N20 G99
N60 T0101
N70 G50 S3500
N80 G96 S0240 M4
N90 G00 X72. Z0.1
N100 G01 X-1.6 F0.12 M7
N110 G00 X150. Z150.
N120 M5
```

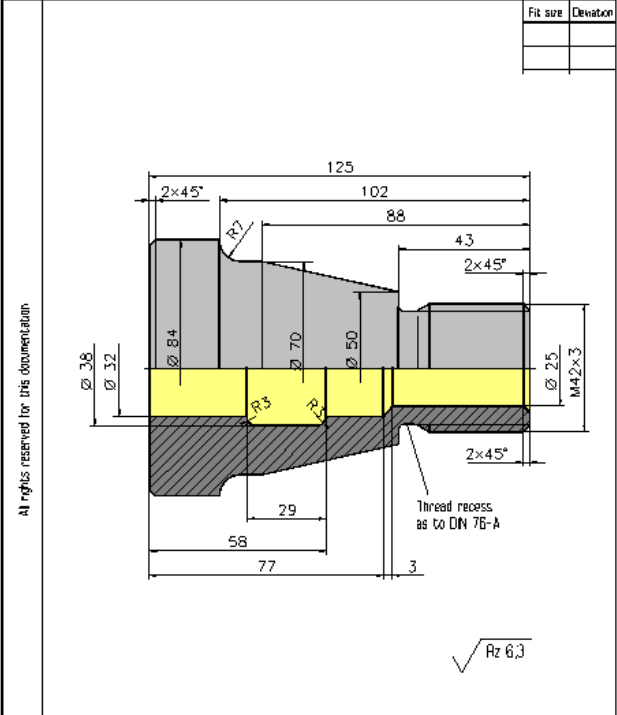
N130 M9
N140 T0303
N150 G97 S2500 M3
N160 G00 X0. Z3.
N170 G01 Z-6. F0.1 M7
N180 G00 Z2.
N190 G00 X150. Z150.
N210 T0707 M7
N220 G97 S0884 M3
N230 G00 Z3.
N240 G00 X0.
N250 G74 R1.0
N260 G74 X0.0 Z-68.326 Q18000 F0.22
N380 G00 X200.
N400 G00 Z100.
N410 T1111
N420 G97 S0530 M3
N430 G00 Z3.
N440 G00 X0.
N450 G01 Z-4.5 F0.16 M7
N460 G00 Z3.
N470 G00 X450.
N490 G00 Z150.
N500 T0404 M7
N510 G50 S3500
N520 G96 S0240 M4
N530 G00 Z1.
N540 G00 X70.
N550 G71 U4. R1
N560 G71 P570 Q650 U0.6 W0.2 F0.35
N570 G42 G00 X24.
N580 G01 Z0.
N590 G01 X28. Z-2.
N600 G01 Z-72.
N610 G02 X32. Z-74. I2. K0.
N620 G01 X62.
N630 G01 X68. Z-77.
N640 G01 X71. Z-78.5
N650 G40
N660 G00 X150.
N680 G00 Z70.
N690 T0202 M7
N700 G50 S4500
N710 G96 S0380 M4
N720 G00 X16. Z3.
N730 G42 G01 Z0. F0.1
N740 G01 X24.
N750 G01 X28. Z-2.
N760 G01 Z-72.
N770 G02 X32. Z-74. I2. K0.
N780 G01 X62.
N790 G01 X68. Z-77.
N800 G01 X71. Z-78.5
N810 G40
N820 G00 X150. Z150.
N830 M5
N840 M9
N850 M30

7.5 Exercise 11: Drill sleeve

The drill sleeve is to be produced on a CNC lathe as to the drawing from a blank made of AlMg1 dimensioned $\varnothing 90 \times 128$ mm. The manufacturing process is to be prepared with the MTS CNC Simulator including all planning documentation. Use the compound fixed cycle G71. Test, correct and print the NC program.



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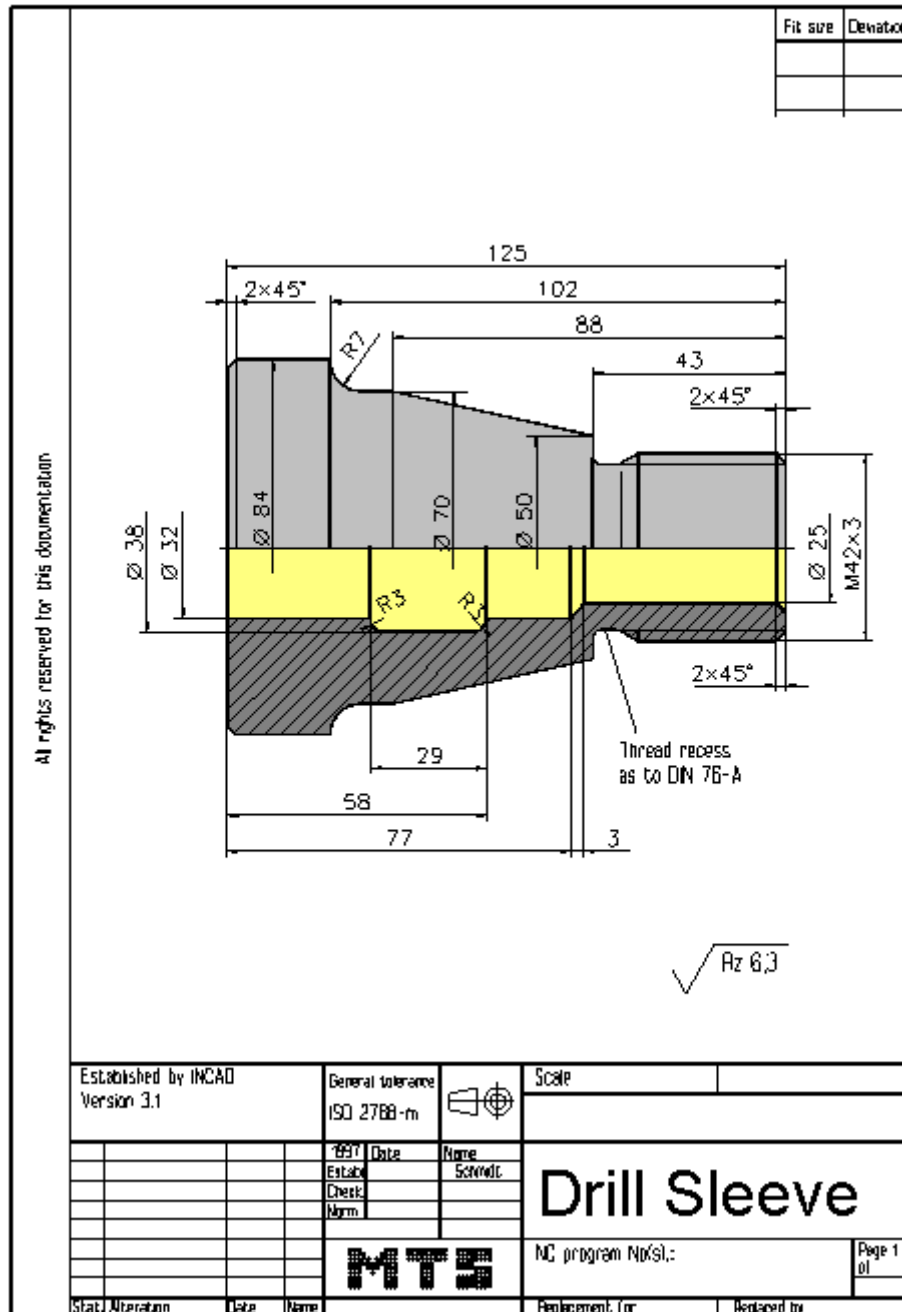


$\sqrt{Rz\ 6.3}$

Established by INCAD Version 3.1		General tolerance ISO 2768-m	Scale
2971	Date	Figure	Drill Sleeve
Estab.		Scale	
Check			
Norm.			
MTS		NC program Nix(Sl):	
Stat.	Iteration	Date	Name
		Replacement for	Replaced by

Special Training Elements:

Use G74 for deep drilling, the straight roughing cycle G71 with allowance and the tapping cycle G76..



7.5.1 Possible Solution: Program KEGELG31.DNC

```

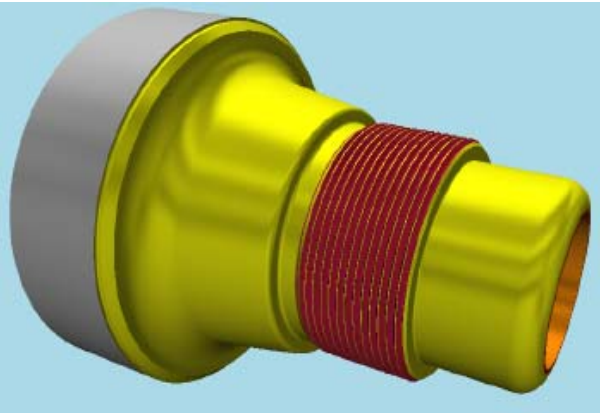
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(( 11.11.2005 07:38
(
( CONFIGURATION
( MACHINE MTS01 TM-016_R1_-060x0646x0920
( CONTROL FANUC CODE-A
(
( PART
( CYLINDER D090.000 L128.000
( MATERIAL "AlMg1::Aluminium"
( DENSITY 002.70
(
( MAIN SPINDLE WITH WORKPART
( CHUCK "Chuck Turn\Jaw chuck\KFD-HS 160"
( STEP JAW "Jaws\Step jaw\HM-110_130-02.001"
( TYPE OF CHUCK EXTERNAL CHUCK OUTSIDE STEP JAW
( CHUCKING DEPTH E18.000
(( Rechte Fläche des Werkstückes: Z+0252.000
(
(
( TAILSTOCK
( TAILSTOCK POSITION Z+1095.000
(
( CURRENT TOOL T01
( TOOLS
( T01 "DIN69880 V 30\LEFT CORNER TOOL\CL-SCLCL-2020 L 1208 ISO30"
( T02 "DIN69880 V 30\LEFT CORNER TOOL\CL-SVJCL-2020 L 1604 ISO30"
( T03 "DIN69880 V 30\LEFT THREADING TOOL\TL-LHTR-2020 R 60 3.00 ISO30"
( T04 "DIN69880 V 30\LEFT CORNER TOOL\CL-SCLCL-2020 L 1208 ISO30"
( T05 "DIN69880 V 30\LEFT CORNER TOOL\CL-SDJCL-2020 L 1204 ISO30" FF0000
( T06 "DIN69880 V 30\INSIDE TURNING TOOL POST\BI-SCAAL-1010 L 0604 ISO30"
( T07 "DIN69880 V 30\TWIST DRILL\DR-20.00 140 R HSS ISO30"
(
( TOOL COMPENSATION
( D01 T01 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E005.005 I-000.800 K-000.800 A+004.375
L011.855 N01
( D02 T02 Q3 R000.400 X+070.000 Z+0045.000 G000.000 E052.393 I-000.400 K-000.400 A+002.372
L016.178 N01
( D03 T03 Q8 R000.433 X+070.000 Z+0042.799 G000.000 E000.000 I-000.433 K+000.000 A+000.000
L000.000 N01
( D04 T04 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E005.005 I-000.800 K-000.800 A+004.375
L011.855 N01
( D05 T05 Q3 R000.400 X+070.000 Z+0045.000 G000.000 E032.178 I-000.400 K-000.400 A+002.372
L011.185 N01
( D06 T06 Q2 R000.400 X-008.238 Z+0170.000 G000.000 E032.079 I+000.400 K-000.400 A+002.721
L005.992 N01
( D07 T07 Q7 R000.000 X+000.000 Z+0225.000 G020.000 E059.000 I+000.000 K+000.000 A+000.000
L000.000 N01
(
( WORKPART ZEROPOINTS
(( Rechte Fläche des Werkstückes: Z+0252.000
( G54 X+000.000 Z+0251.000
(
(
)
$G54
:7
N10 G40 G00
N20 G99
N60 T0505
N70 G50 S3500

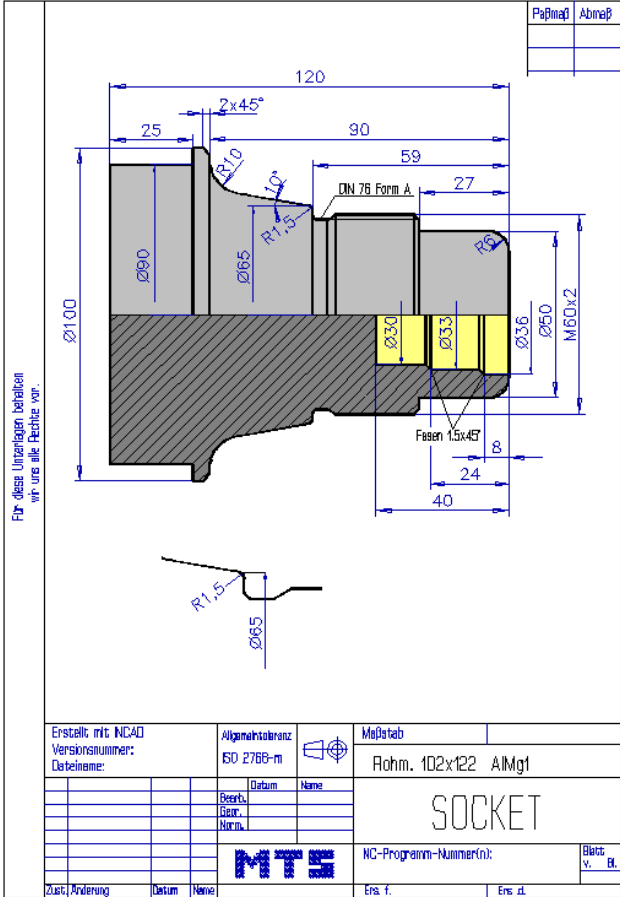
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N80 G96 S0240 M4
N90 G00 X92. Z0.
N100 G01 X-2. F0.15 M7
N110 G00 X90. Z2.
N120 G71 U3. R1
N130 G71 P140 Q270 U0.5 W0.2 F0.15
N140 G42 G00 X34. Z2.
N150 G01 X42. Z-2.
N160 G01 Z-31.
N170 G01 Z-32.5
N180 G01 X37.6 Z-36.311
N190 G01 Z-41.68
N200 G02 X40.24 Z-43. I1.32 K0.
N210 G01 X42.
N220 G01 X50.
N230 G01 X70. Z-88.
N240 G01 Z-95.
N250 G02 X84. Z-102. I7. K0.
N260 G01 X92.
N270 G40
N280 G00 X120. Z100.
N300 T0707
N310 G97 S1200 M3
N320 G00 Z3.
N330 G00 X0.
N340 G74 R1.0
N350 G74 X0.0 Z-134 Q16000 F0.22
N1070 G00 X200.
N1080 G00 Z100.
N1090 T0202 M7
N1100 G50 S4000
N1110 G96 S0380 M4
N1120 G42 G00 X34. Z2.
N1130 G01 X42. Z-2. F0.08
N1140 G01 Z-31.
N1150 G01 Z-32.5
N1160 G01 X37.6 Z-36.311
N1170 G01 Z-41.68
N1180 G02 X40.24 Z-43. I1.32 K0.
N1190 G01 X42.
N1200 G01 X50.
N1210 G01 X70. Z-88.
N1220 G01 Z-95.
N1230 G02 X84. Z-102. I7. K0.
N1240 G01 X92.
N1250 G40
N1260 G00 X200. Z100.
N1280 T0303
N1290 G97 S1000 M3
N1300 G00 X48. Z6.
N1310 G76 P020060 Q29 R50
N1320 G76 X38.32 Z-39. R0. P1840 Q184 F3.0
N1330 G00 X120. Z120.
N1340 M5
N1350 G28 U0. W0.
N1360 M30

7.6 Exercise 12: Socket with thread

The socket on the drawing is to be manufactured on a CNC lathe using a blank made of AlMg1 dimensioned $\varnothing 102 \times 122$ mm. Work out all necessary documentation for the machining. Prepare, test and correct the process on the MTS CNC Simulator.



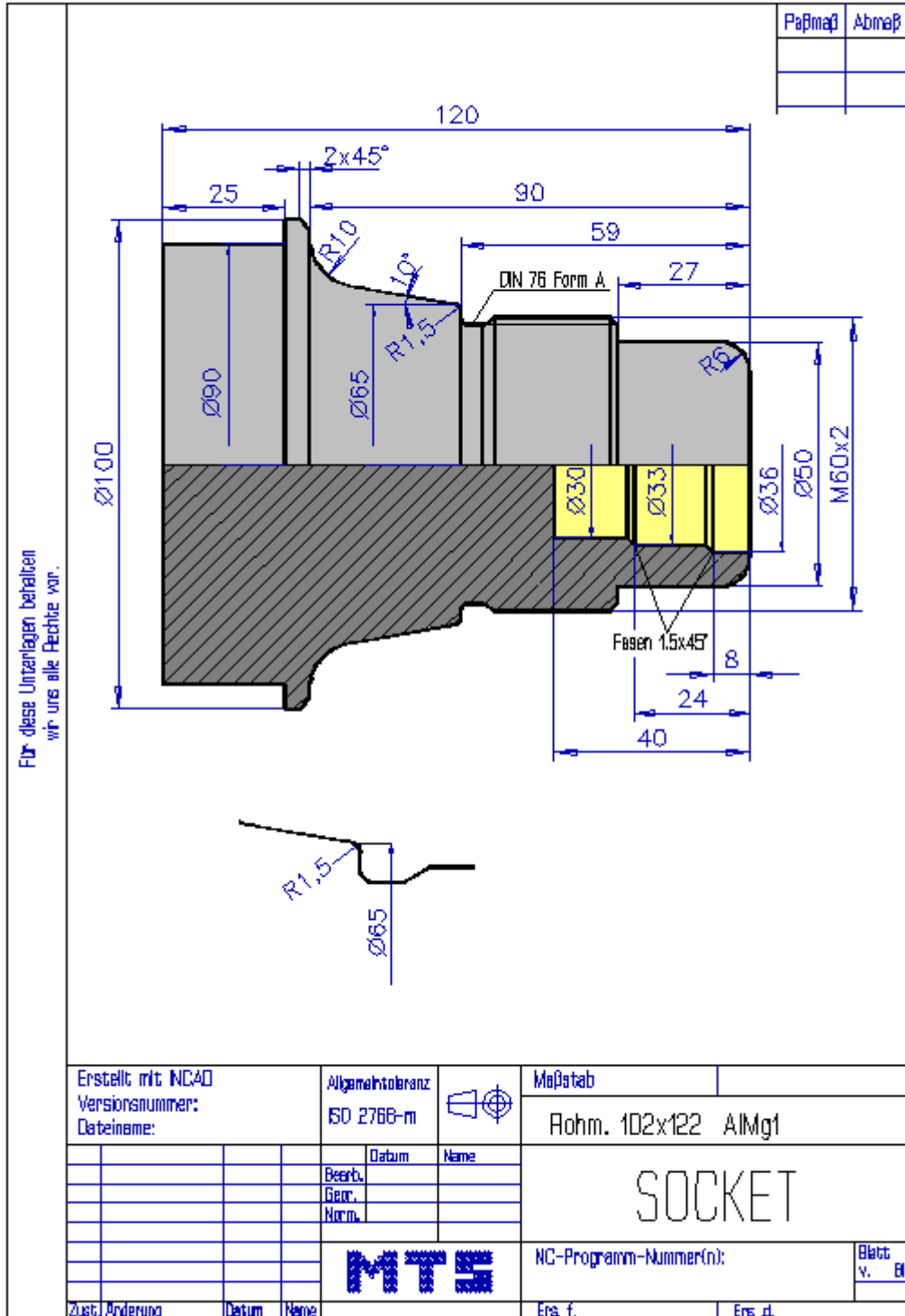


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Erstellt mit: NCAD		Allgemeintoleranz: ISO 2768-m		Maßstab	
Versionsnummer:				Rohm. 102x122 AlMg1	
Dateiname:				SOCKET	
		MTS		NC-Programm-Nummer(n):	
				Blatt v. Bl.	
Zust./Änderung	Datum	Name		Ers. f.	Ers. d.

Learning Objective: The learner can describe circular traverse motions of the tool.

Special Training Elements: Use the cross straight roughing cycle G71 with finishing allowance for inside and outside operations and cycle G76 for tapping. Put the inside and the outside profil into a subprogram.



7.6.1 Possible Solution: Program MTS62-2.DNC

```

()
(( 14.11.2005 08:45
(
( CONFIGURATION
( MACHINE MTS01 TM-016_-R1_-060x0646x0920
( CONTROL FANUC 21I CODE-A
(
( PART
( CYLINDER D102.000 L121.000
( MATERIAL "AlMg1::Aluminium"
( DENSITY 002.70
(
( MAIN SPINDLE WITH WORKPART
( CHUCK "Chuck Turn\Jaw chuck\KFD-HS 160"
( STEP JAW "Jaws\Step jaw\WM-160_200-25.000"
( TYPE OF CHUCK EXTERNAL CHUCK OUTSIDE STEP JAW
( CHUCKING DEPTH E25.000
(( Rechte Fläche des Werkstückes: Z+0241.000
(
(
( TAILSTOCK
( LATHE CENTRE "Lathe Center\MK 2-9\171 MT1 020-050"
( QUILL DO NOT SET
( TAILSTOCK POSITION Z+1095.000
(
( CURRENT TOOL T01
( TOOLS
( T01 "DIN69880 V 30\LEFT CORNER TOOL\CL-SDJCL-2020 L 1208 ISO30"
( T02 "DIN69880 V 30\LEFT CORNER TOOL\CL-SVJCL-2020 L 1604 ISO30"
( T03 "DIN69880 V 30\CENTER DRILL\CD-03.15 050 R HSS ISO30"
( T04 "DIN69880 V 30\LEFT THREADING TOOL\TL-LHTR-2020 R 60 2.00 ISO30"
( T06 "DIN69880 V 30\REVERSIBLE TIP DRL\DI-30.00 067 R HMT ISO30"
( T09 "DIN69880 V 30\INSIDE TURNING TOOL POST\BI-SCLCL-1010 L 0604 ISO30"
( T12 "DIN69880 V 30\INSIDE TURNING TOOL POST\BI-SCAAL-1010 L 0604 ISO30"
(
( TOOL COMPENSATION
( D01 T01 Q3 R000.800 X+070.000 Z+0045.000 G000.000 E032.178 I-000.800 K-000.800 A+002.372
L010.785 N01
( D02 T02 Q3 R000.400 X+070.000 Z+0045.000 G000.000 E052.393 I-000.400 K-000.400 A+002.372
L016.178 N01
( D03 T03 Q7 R000.000 X+000.000 Z+0070.000 G003.150 E000.000 I+000.000 K+000.000 A+000.000
L000.000 N01
( D04 T04 Q8 R000.288 X+070.000 Z+0042.699 G000.000 E000.000 I-000.288 K+000.000 A+000.000
L000.000 N01
( D06 T06 Q7 R000.000 X+000.000 Z+0175.000 G030.000 E000.000 I+000.000 K+000.000 A+000.000
L000.000 N01
( D09 T09 Q2 R000.400 X-005.843 Z+0160.000 G000.000 E005.002 I+000.400 K-000.400 A+004.723
L005.977 N01
( D12 T12 Q2 R000.400 X-008.238 Z+0170.000 G000.000 E032.079 I+000.400 K-000.400 A+002.721
L005.992 N01
(
( WORKPART ZEROPOINTS
(( Rechte Fläche des Werkstückes: Z+0241.000
( G54 X+000.000 Z+0240.000
(
(
)
$G54
:11
N10 G40 G00
N20 G99

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N30 M5
N40 M9
N60 T0101
N70 G97 S1000
N80 G00 X150. Z100.
N90 G50 S3500
N100 G96 S0200
N110 G00 X104. Z0. M4
N120 G01 X-1.6 F0.25 M8
N130 G00 X102. Z2.
N140 G71 U3. R1
N150 G71 P160 Q370 U0.5 W0.1 F0.25
N160 G42 G00 X34. Z2.
N170 G01 Z0.
N180 G01 X38.
N190 G03 X50. Z-6. I0. K-6.
N200 G01 Z-27.
N210 G01 X57.
N220 G01 X60. Z-28.5
N230 G01 Z-50.
N240 G01 Z-52.
N250 G01 X57. Z-54.598
N260 G01 Z-58.1
N270 G02 X58.8 Z-59. I0.9 K0.
N280 G01 X60.
N290 G01 X62.483
N300 G03 X65.437 Z-60.24 I0. K-1.5
N310 G01 X73.018 Z-81.736
N320 G02 X92.714 Z-90. I9.848 K1.736
N330 G01 X96.
N340 G01 X100. Z-92.
N350 G01 Z-93.
N360 G01 X102.
N370 G40
N380 G00 X150. Z100.
N390 M9
N400 T0606
N410 G97 S0600 M3
N420 G00 Z3.
N430 G00 X0. M8
N440 G74 R1.0
N450 G74 X0.0 Z-40.0 Q12000 F.22
N670 G00 X200. Z100.
N680 M9
N690 T0909
N700 G50 S3500
N710 G96 S0160 M4
N720 G00 X28. Z2.
N730 G71 U2. R1
N740 G71 P750 Q810 U-0.5 W0.1 F0.2
N750 G41 G00 X40.
N760 G01 X36.
N770 G01 Z-8.
N780 G01 X33. Z-9.5
N790 G01 Z-24.
N800 G01 X28. Z-26.5
N810 G40
N820 G00 X200. Z100.
N830 T1212
N840 G50 S4000
N850 G96 S0280 M4
N860 G00 X42. Z2.
N870 M98 P6203

Exercise 12: Socket with thread

N880 G00 X28.234 Z3.
N890 G00 X200. Z100.
N900 M9
N910 T0202
N920 G50 S4000
N930 G96 S0340 M4
N940 G00 X34. Z2.
N950 M98 P6202
N960 G00 X150. Z100.
N970 M9
N980 T0404 M8
N990 G97 S1000 M3
N1000 G00 X64. Z-21.
N1010 G76 P020060 Q19 R50
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N1040 M9
N1050 M30

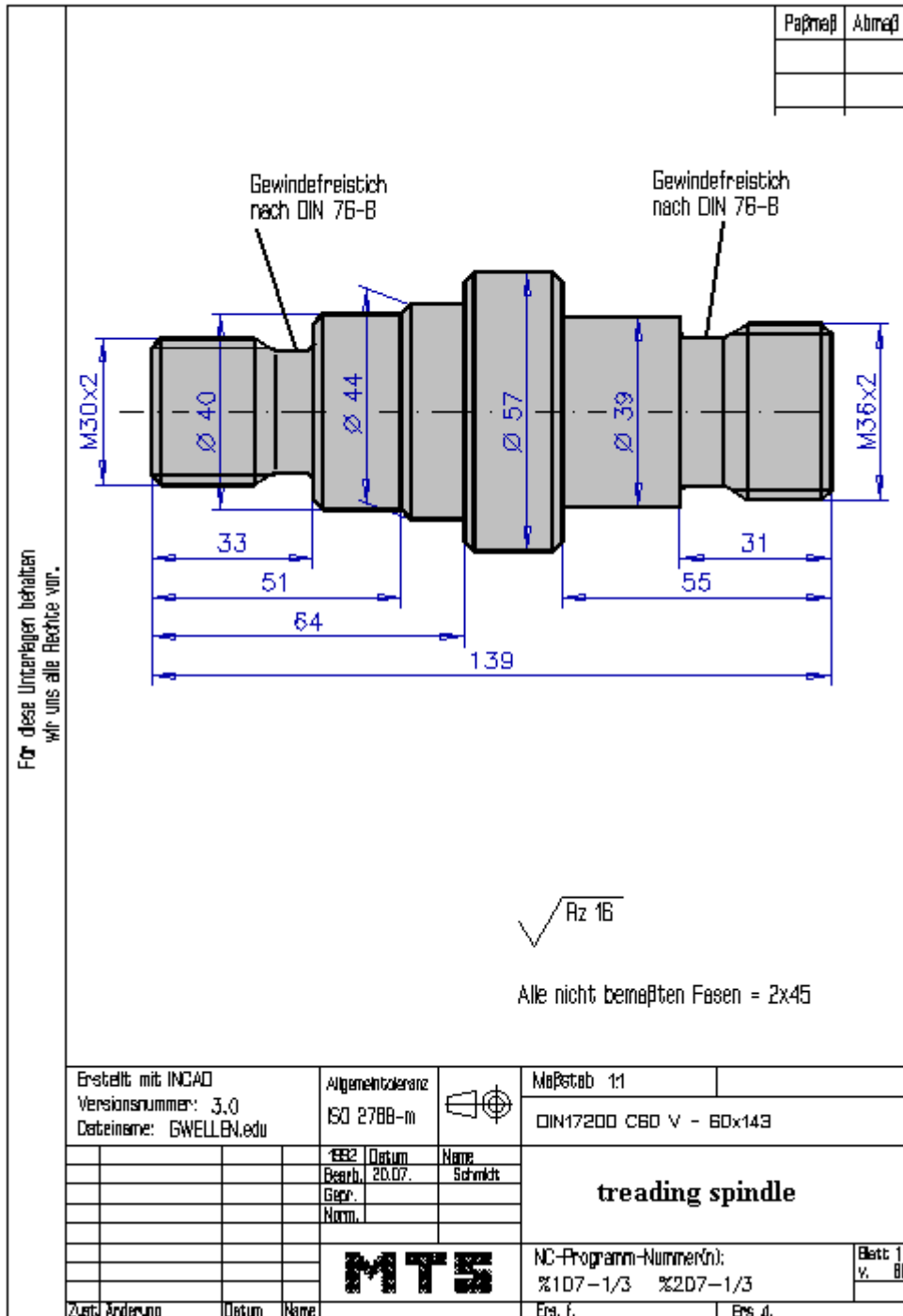
O6202
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N20 G01 X38.
N30 G03 X50. Z-6. I0. K-6.
N40 G01 Z-27.
N50 G01 X57.
N60 G01 X60. Z-28.5
N70 G01 Z-50.
N80 G01 Z-52.
N90 G01 X57. Z-54.598
N100 G01 Z-58.1
N110 G02 X58.8 Z-59. I0.9 K0.
N120 G01 X60.
N130 G01 X62.483
N140 G03 X65.437 Z-60.24 I0. K-1.5
N150 G01 X73.018 Z-81.736
N160 G02 X92.714 Z-90. I9.848 K1.736
N170 G01 X96.
N180 G01 X100. Z-92.
N190 G01 Z-93.
N200 G01 X102.
N210 G40
N220 M99

O6203
N10 G41 G01 X36. F0.1 M8
N20 G01 Z-8.
N30 G01 X33. Z-9.5
N40 G01 Z-24.
N50 G01 X28. Z-26.5
N60 G40
N70 M99

4.6 Additional Exercises: Exercise 13:

The spindle on the drawing is to be manufactured on a CNC lathe using a blank made of C45 dimensioned $\varnothing 60 \times 143$ mm. Work out all necessary documentation for the machining. Prepare, test and correct the process on the MTS CNC Simulator.

- Analyse the work shop drawing
- Compile the work plan
- Select the clamping device and the required tools (tooling sheet)
- Write and test the CNC program

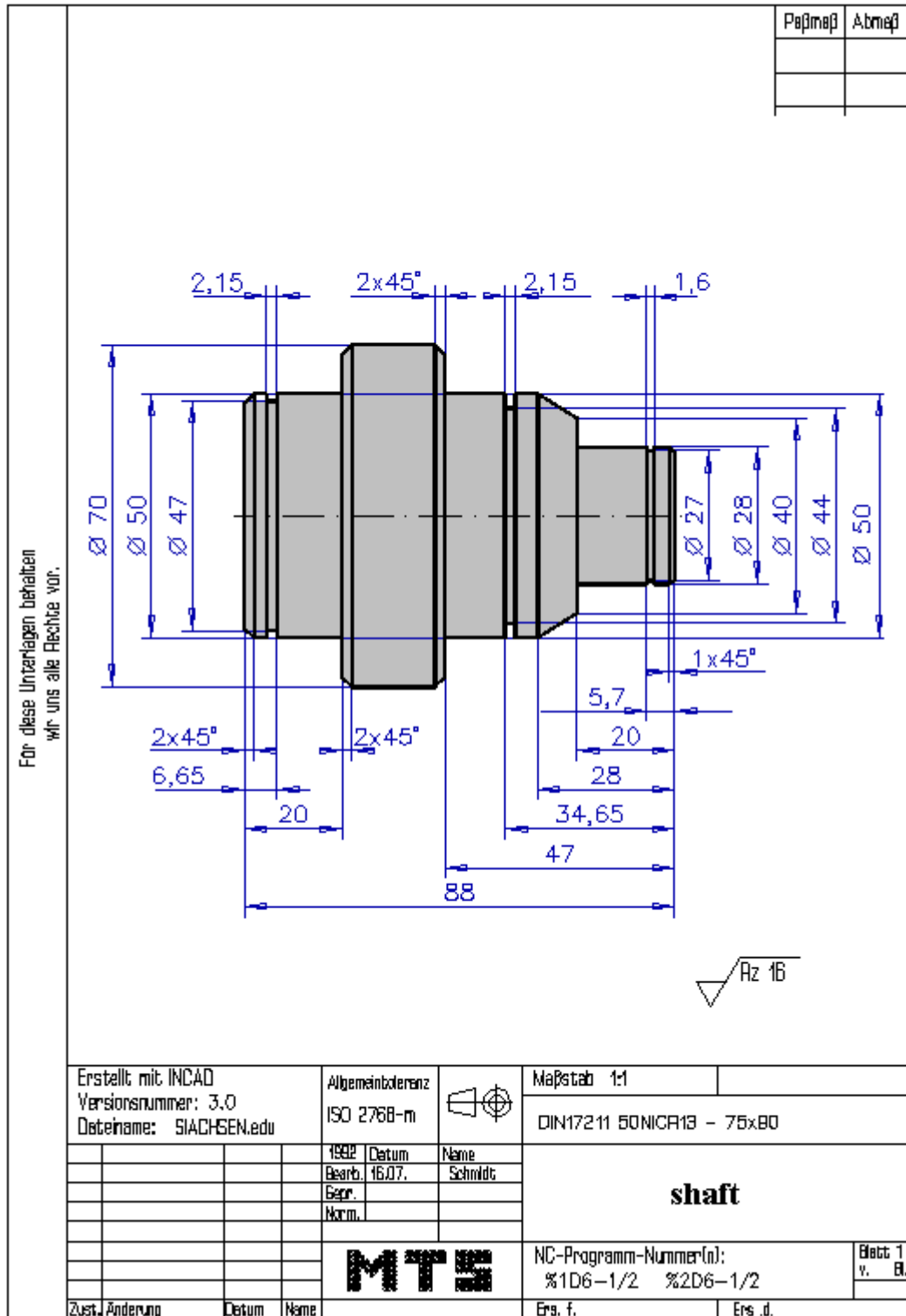


Exercise 12: Socket with thread

Additional Exercise 14:

The spindle on the drawing is to be manufactured on a CNC lathe using a blank made of C45 dimensioned $\varnothing 70 \times 143$ mm. Work out all necessary documentation for the machining. Prepare, test and correct the process on the MTS CNC Simulator.

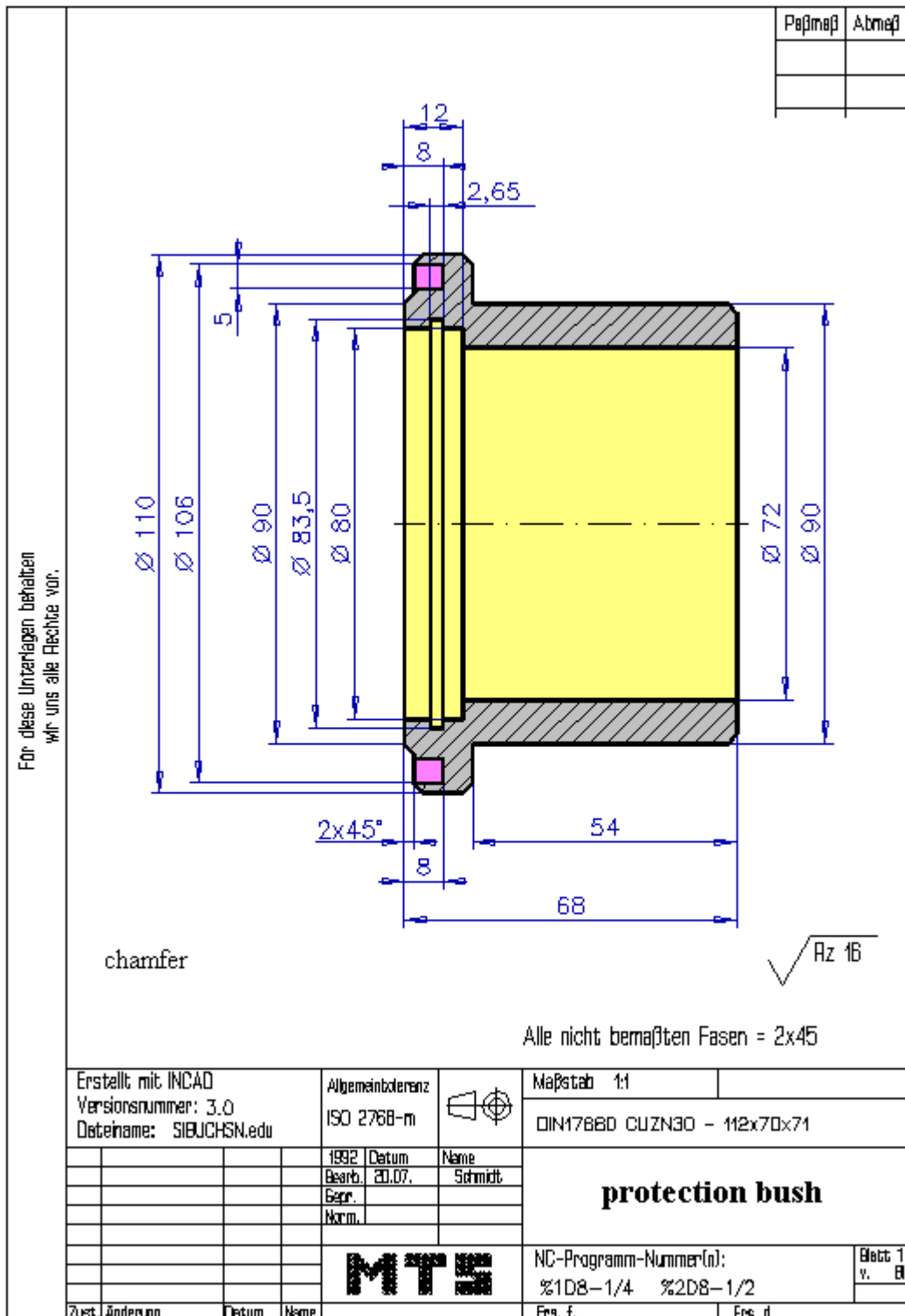
- Analyse the work shop drawing
- Compile the work plan
- Select the clamping device and the required tools (tooling sheet)
- Write and test the CNC program



Additional Exercise 15:

The bush on the drawing is to be manufactured on a CNC lathe using a blank made of Cu Sn 4 dimensioned $\varnothing 110 \times 71$ mm. Work out all necessary documentation for the machining. Prepare, test and correct the process on the MTS CNC Simulator.

- Analyse the work shop drawing
- Compile the work plan
- Select the clamping device and the required tools (tooling sheet)
- Write and test the CNC program

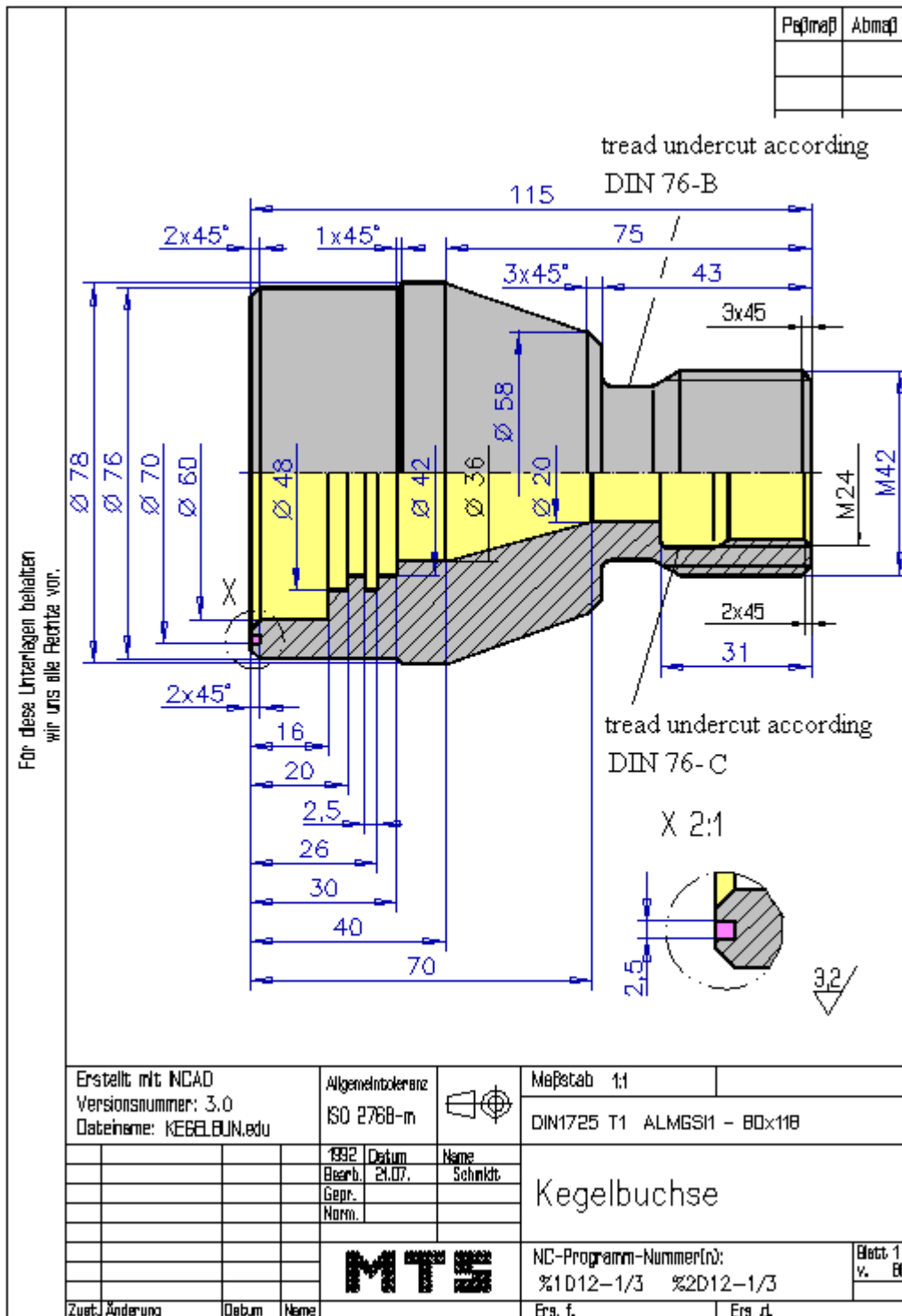


Exercise 12: Socket with thread


Additional Exercise 16:

The nipple on the drawing is to be manufactured on a CNC lathe using a blank made of S20 K dimensioned $\varnothing 80 \times 118$ mm. Work out all necessary documentation for the machining. Prepare, test and correct the process on the MTS CNC Simulator.

- Analyse the work shop drawing
- Compile the work plan
- Select the clamping device and the required tools (tooling sheet)
- Write and test the CNC program



Exercise 12: Socket with thread


CNC Milling	<h2 style="margin: 0;">Production Sheet</h2>				
Mathematisch Technische Software-Entwicklung GmbH			Date :		
Program No.: _____ Programmer: _____ Drawing No.: _____ Designation: _____ Material: _____ Raw part/blank: _____ CNC Control _____					
<h3 style="margin: 0;">Sequence of machining steps</h3>					
Nr.	Machining step	NC programming code	Tool position	Cutting data	
01				F	N V _c
02				F	N V _c
03				F	N V _c
04				F	N V _c
05				F	N V _c
06				F	N V _c
07				F	N V _c
08				F	N V _c
09				F	N V _c
10				F	N V _c
11				F	N V _c
12				F	N V _c
13				F	N V _c
14				F	N V _c
15				F	N V _c
16				F	n V _c
17				F	n V _c
18				F	n V _c
19				F	n V _c


CNC Turning	<h2>7.6.1.1 Production Sheet</h2>	
Mathematisch Technische Software-Entwicklung GmbH		Datum :

Program No. _____ Programmer _____ Drawing No. _____ Designation _____ Material _____ Raw part/blank _____ CNC control _____	
--	--

7.6.2 Sequence of machining steps

Nr.	Maching step	NC programming code	Tool position	Cutting data	
				F	N V _c
01				F	N V _c
02				F	N V _c
03				F	N V _c
04				F	N V _c
05				F	N V _c
06				F	N V _c
07				F	N V _c
08				F	N V _c
09				F	N V _c
10				F	N V _c
11				F	N V _c
12				F	N V _c
13				F	N V _c
14				F	N V _c
15				F	N V _c
16				F	n V _c
17				F	n V _c
18				F	n V _c
19				F	n V _c

CNC Turning	7.6.2.1 Programming Sheet							
Mathematisch Technische Software-Entwicklung GmbH		Datum :						
Program No. _____	Designation _____							
Programmer _____	Material _____							
Drawing No. _____	Raw part/blank _____							
7.6.3 NC-Code								
N	G	X	Z	I	7.6.3.1.1	F	M	T
05								
10								
15								
20								
25								
30								
35								
40								
45								
50								
55								
60								
65								
70								
75								
80								
85								
90								
95								
100								
105								
110								
115								

CNC Milling	<h2 style="margin: 0;">Programming Sheet</h2>								
Mathematisch Technische Software-Entwicklung GmbH							Datum :		
Program No.: _____				Designation: _____					
Programmer: _____				Material: _____					
Drawing No.: _____				Raw partl/blank: _____					
<h3 style="margin: 0;">NC-Code</h3>									
N	G	X	Y	Z	I	J	F	M	T
05									
10									
15									
20									
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