Content

Welcome to Tensor Cad/Cam

Tensor is an easy-in-use Cad/Cam system for Windows™ with a wide range of powerful 2, 3 & 4 Axis programming capabilities. From lathe, to 2D profile milling, simple and advanced pocket milling operations, hole drilling and engraving to toolpath generation for imported 3D-files. CNC-code can be generated for numerous controllers. Tensor Cad/Cam was specially developed for users of CNC-machines. This means that not only in the metal-cutting industry Tensor is being used, but also in the woodworking and plastics industry, Tensor is a fine solution in CNC-programming.

Experience
Tensor was introduced in 1996 in the industry and has since then been very succesful on the market. We work closely with our partners, being our users and CNC-machine vendors. For years we have listened carefully and learn from their ideas and proposals in improving the quality of Tensor. This probably is the main reason users are so satisfied working with Tensor. Tensor is available in several languages, at today these are English, German, French and Dutch.

Draw and program
By using the intelligent developed philosophy of drawing with Tensor, the user will construct profiles in no time. By then selecting an NC-job, Tensor will take you through a dialog and let you machine the profile any way you desire. Not only for milling and lathe, but also for Wire-Edm lasercutting and waterjet TensorCadCam is the perfect tool. By using the Dxf -and Iges-translator you will be able to import these files and convert them directly into CNC-code.

Simulation
All generated NC-programs for lathe and milling can be simulated and checked in the Tensor NC Simulator. Machiningtime will be presented. Programs not made with Tensor Cad/Cam can also be simulated making this a very strong part of the Tensor software. After all, Tensor NC Simulator simulates real CNC-code and not a Tensor related language as most of our competitors do.

Mechanical drawings
Tensor is equipped with several simple but very strong options to generate detailed mechanical drawings. Tensor is therefore a very suitable option making schemes, technical manuals and instructionbooks.

Internet
Please regularly visit our website www.tensorcadcam.com for the latest news and developments. You may also leave a note to be taken up in our mailinglist.

Use this manual!
This manual is the best place to take off with Tensor. Is was held as compact as possible to invite you to work through the entire manual. Don't think you will comprehend the philosophy behind Tensor by just clicking the mouse on your screen. Therefore: start working through this manual, you will not regret this decision !
It will learn you in a short period of time the basic notions and basic skills that are necessary to be productive with Tensor. After this you should be able to work with Tensor without much effort. You will then by simply using Tensor, learn more and more about the powerful capabilities Tensor can offer you when programming. By following a one-day-training may even accelerate this. For this contact your dealer.

In this manual we presume you are familiar in working with Windows™. This means you know how to use a mouse, open menus and know how to select/activate options in dialogboxes. You should also be able to open and close documents(drawings). Information about Windows™ you will find in manual provided by Microsoft or on-line Help information. If you need to do this, read chapter 1 and 2 in the Window manual where the basic skills are being explained.

We wish you good luck and a lot of fun using Tensor.

System requirements

What you need to use Tensor 4.0:

The minimum requirements are:

- Microsoft Windows™ 98 or ME
- Microsoft Windows NT/2000/XP
- PC with minimum of 300 Mhz processor or higher
  Intel Pentium™/Celeron-family, AMD™ K6/Athlon/Duron-family or compatible processor recommended
- Super VGA-screen and screen adaptor with minimum resolution of 800x600 or higher
- 32MB Ram memory (64 MB or higher recommended for a better performance)
- 1 Gigabyte free disk space
- CD Rom or DVD
- Keyboard and Mouse compatible with Windows™

Installation of Tensor

Follow procedure as is described here to install Tensor on your PC:

Installation-CD
If you want to install the software on a PC where previously Tensor has not been installed, you may put the Tensor installation-CD into your computer. If not first remove Tensor from your PC by using the *Start*-button in the lowerleft corner of your screen and then prodede with *Congifuration->Software*. Then select Tensor from the list and *Uninstall(Remove)* Tensor. During installation you will be asked to select a installation directory. If you don't have a particular reason to install in a different directory as presented, best leave it lake that.

Shortcuts
During installation a shortcut for Tensor will be made on your desktop:


Tensor 4.0

For Cad/Cam users:
Make your own shortcuts on your desktop for the Lathe- and Millsimulator. The program name for the mill-simulator is to be found in directory ncsimulatormill in the Tensor directory. It's called *Tensor_NC_Simulator_Mill.exe.* If you are also planning to program for lathe you can do the same. The name is *Tensor_NC_Simulator_Turn.exe* to be found in directory *ncsimulatorturn* also to be found in the Tensor directory.

The dongle
Insert the dongle in a USB-slot. Probably Windows will ask you if the driver should automatically be installed. If not, install this using *setupdrv.exe*. This file you may find in the Tensor directory. To check if this procedure is correctly being executed doubleclick on *DDlook.exe*. (to be found in the Tensor directory). This program will try to detect dongles inserted in USB-slots. If a dongle is recognized it means Tensor will also recognize this.

Startup procedure
The first time you start, Tensor may ask you to select the right license from a list. This is presented with a number. On your USB-dongle you can see a sticker with a number. Select the right number from the list. If you are not sure which number the dongle has you can use *DDlook.exe* to check the number. If you by accident activate the wrong license Tensor will not start. To solve this you do the following: in the Tensor directory you may find a file: *register.zip*. If you unzip this file you will find one or more *.reg* files preceded by numbers corresponding with you dongles. By double clicking on the .reg file with the same number as the dongle inserted in the USB-slot, you will activate the right license. Then retry to start Tensor.

Files referred to in the manual
In the Tensor directory you will find directory *documents*. By doubleclicking on file *OnyourwaywithTensor zip.exe* a list of Tensordrawings and video files will be unzipped into this directory. In this manual you will see that frequently is being referred to these drawings and videos.

To make CNC-programs with Tensor as fast as possible using the correct method, it is important that you work through this manual. You might prefer to make immediately drawings and programs, but please take the effort to understand the principle of Tensor well, you won't regret it. This principle is : "Order and direction of elements"

Starting with Tensor

Draw
This manual contains several chapters. First we will take you through how to draw geometry in *Drawing with Tensor*. After you worked through this part you van proceed by trying to make the 15 drawings to be found in chapter *Exercises*. For each exercise you will find a corresponding *.avi* file in the *documents* directory, which will show you the fastest and best way to make this drawing.

NC-programming for milling
If you want to generate NC-programs for milling- an drilling jobs you can work through chapter *NC-programming for milling*. Here we will explain step-by-step how to generate an NC-program for a profile and how to simulate the program in the Tensor NC Simulator. After this, other features for several NC-jobs will be explained.

As Tensor works in dialog with the user and therefore is quit easy, we will do this briefly. The dialog will avoid the user making errors. Also in this part references are made to files in the *documents* directory. Take the effort to take a close look at them.
For 3D-milling jobs, examples are worked out in *3D milling in Tensor*. It's however recommended first to concentrate on 2D-programming, before you start with this part!

NC-programming for lathe
Here you will learn how to generate code for lathe. We will demonstrate to machine a part using Roughing-, finishing- and a drillcycle. After this, the other features available will be explained in short. You will simulate the NC-program in the Tensor NC Simulator for lathe-programs. And of course you will find the accompanied *.avi* and *.ccd* files.

The .ccd en .avi files
By unzipping file *onyourwaywith zip.exe* (found in the *documents* directory) the *.avi* and *.ccd* files mentioned in this manual will be unzipped are to be found in the *documents* directory. As you are making the exercises you can watch the videos in Windows™ Media-player. You can use the Pause and Forward and Rewind-buttons for an optimal use.

And finally:

Remember the principle: "DIRECTION AND ORDER" . This is what Tensor is all about!

We wish you a lot fun working with Tensor Cad/Cam.

Drawing with Tensor

Open and close a drawing
To create a new drawing move to menu *File->New*. Then select Type *Drawing*, *Based on normal*. When opening a drawing you can move to *File->Open* and make your selection from *.ccd* files. Be sure that at the bottom of the dialogbox *Filetypes* says *Drawing files .ccd*. With *File->Close* you can close and if desired so, save a drawing.

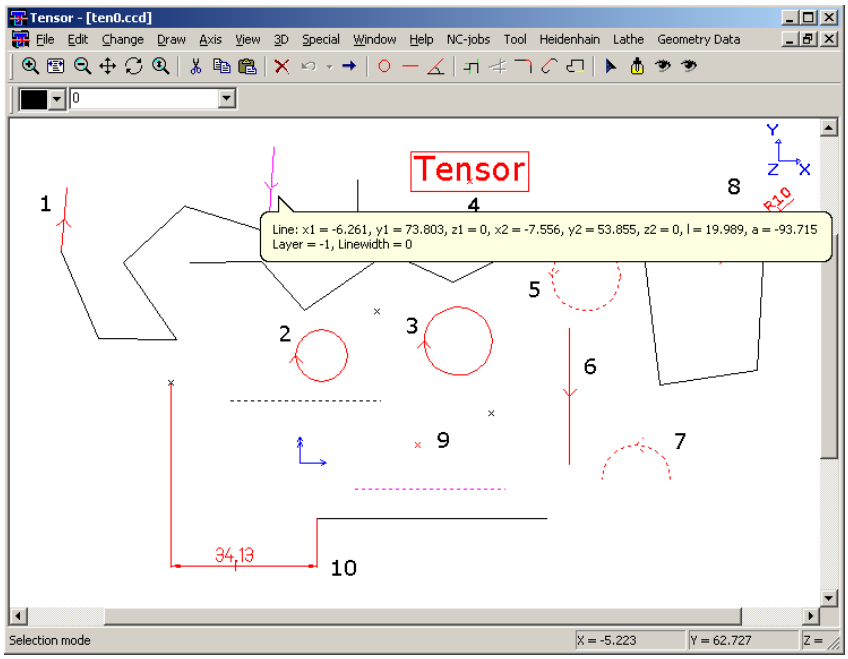
Object-Action
Tensor is based on the Object-Acton principle. This means: before Tensor executes an Action, the elements which the action is appled for, need to be selected. For example: to draw a parallel line, the original line first needs to be selected before option *Line-> Parallel* is used. We will now take you through a number of methods to select elements.

Elementtypes
Tensor contains a number of basic elementtypes. Except lines and arcs these are the other basic elements in Tensor: point, text, dimension, face and objects. Besides the geometrical data they contain some more attributes. For example a color and a layername. But we will come back to this later on.

Select elements

Exercise: Watch ten0.avi
In this recording a number of elements are being selected clicking the leftmousebutton. By "clicking" close to an element and release the button an element will be selected. It turns red and will have an arrow in the middle for a line and arc. To undo the selection you can click the leftmousebutton in the drawing-window not close to an element (empty space).

Exercise: Open drawing ten0.ccd.
We will now do the same as the recording:



pic.1

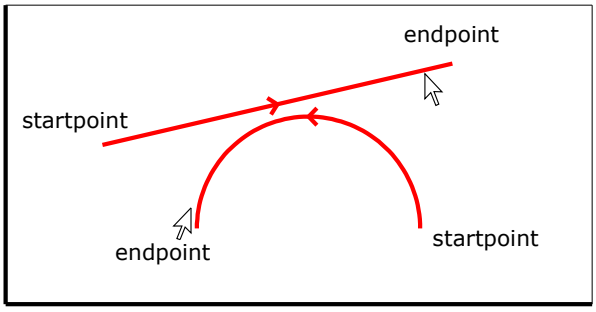
Selecting more elements
If one or more elements are already selected and you want to select more do the following: press the CTRL-button and keep it down as you select more elements using the leftmousebutton. All previous selected elements remain selected. If you are through selecting, release the CTRL-button. If you don't use the CTRL-button all selected elements will be deselected and only the last clicked element will remain selected. The numbers in pic.1 represent the order of selecting in this recording. The upper left line is

the first element in the *selection-order,* the linear dimension below is the last. Soon you will see why *selection-order* is so important.

Conclusion: To select extra elements you have to press the CTRL-button. If you click the left-mousebutton not close to an element, all selected elements will be *deselected***.** This therefore is the easiest way to deselect elements.

Remark: As you are just starting with Tensor it may occur that you by accident deselect all the elements without noticing this when clicking the the leftmousebutton not close to an element

Direction
The arcs and lines selected in the first exercise contain an arrow in the middle. This indicates the *direction* of these elements. This also implies that arcs and lines have a start- and endpoint.

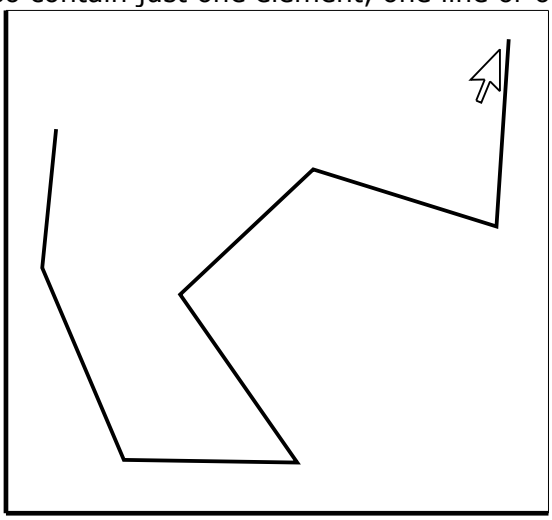


pic.2

In de selection in pic.2 the line and arc were selected on the side of the where you can see the cursor. The direction would have been reversed if they were selected on the other side. Elements such as text, dimensions and point however don't have a direction.

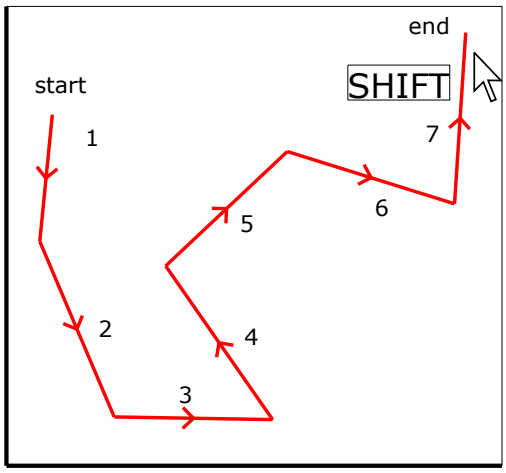
Remark: The direction and order of elements will eventually also determine how the NC-code will be generated.

Chains
A number of selected elements (lines and/or arcs) attached to one another we call a *chain*. A chain can also contain just one element, one line or one arc.


pic.3

The chain in pic.3 you may find in ten0.ccd. By clicking the leftmousebutton on the indicated position and at same time pressing the SHIFT-button you will not only select the line but also the elements "attached" to this line.

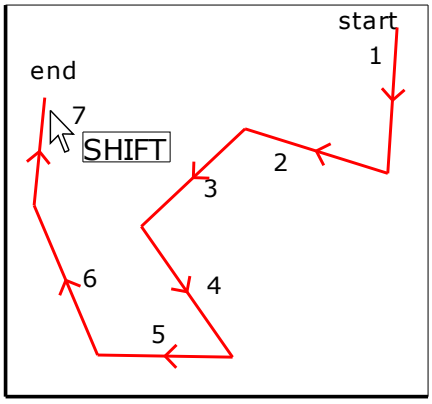
Exercise: Try to select this chain in drawing ten0.ccd.



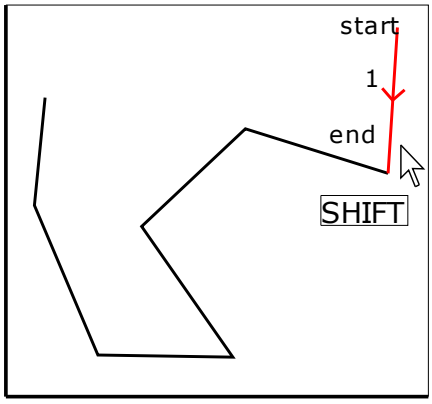
pic.4

The selection-order of elements is in accordance with the numbers in pic.4. This means that the line on which is being clicked, is the last element in the *selection-order*. You could say this is logical as the arrow of line 1 is pointing into direction of line 2 and line 2 into 3 , etc.

This also implies that if we had selected line 1 with the SHIFT-button on the top, the direction and selection-order would have been opposite to this situation. (pic.5)



pic.5



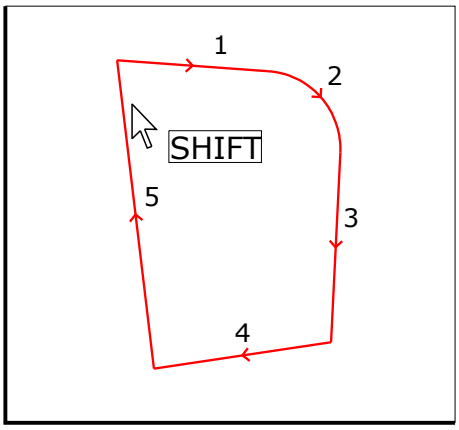
pic.6

The startpoint of the chain in pic.5 is the startpoint of element 1 and the endpoint of the chain is the endpoint of line 7.

If you click on the bottom of line 1 using the SHIFT-button, only line 1 will be selected as no elements are attached to its startpoint. (pic.6)

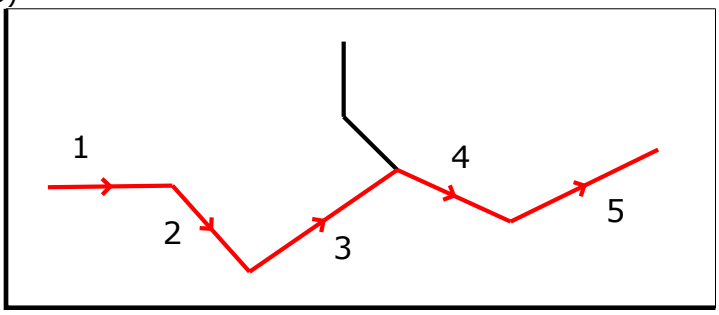
Tensor will keep on selecting when using the SHIFT-button, until there are no more elements attached to the last found element or it will "bump into" a already selected element. This occurs when selecting a closed chain.

Exercise: in drawing ten0.ccd select the closed chain on the upper right side with the leftmousebutton and pressing the SHIFT-button. See pic.7



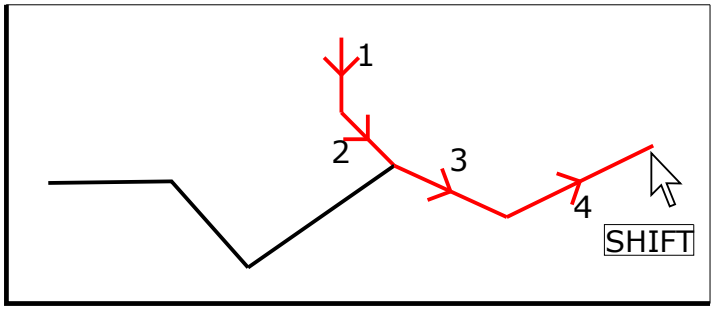
pic.7

We will do one more exercise selecting a chain. We want to select the chain also found in ten0.ccd. (pic.8)



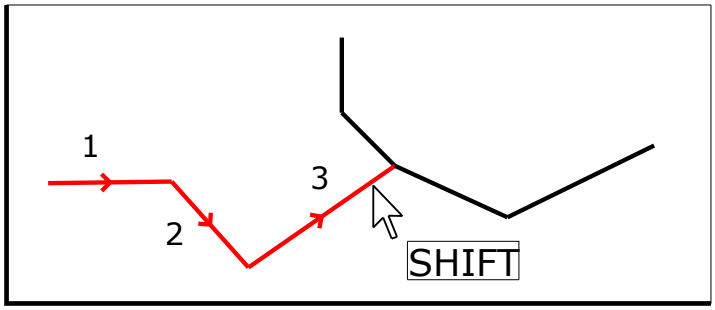
pic.8

If in this case we would click at the end of line 5 using the SHIFT –button, there is a chance that Tensor will continue in the wrong direction from the crossroad on, because there are 2 options to continue from that point and that the result could be like in pic.9:



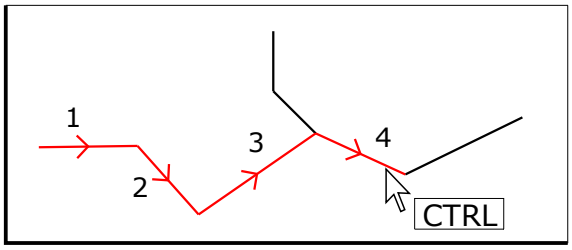
pic.9

To be sure to get the wanted result you can start selecting the first part of the chain by clicking on line 3 using the *SHIFT*-button. pic.10:



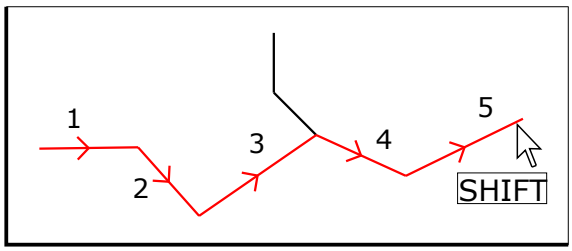
pic.10

To prevent selection going wrong, you can select line 4 by using the CTRL-button. pic.11



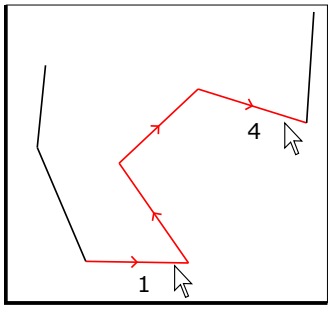
pic.11

To select the remaining element(s) you can click on the end of line 5 using the SHIFT-button. pic.12:



pic.12

This also means that it 's also possible to select a part of a chain:



pic.13

First select line 1 with the leftmousebutton. Then click at the end of line 4 using the SHIFT-button. Selecting will stop because we "bump into" a selected element. pic.13

***Exercise*: Watch ten01.avi .**
Here you can take a look at actions described above.

Selecting using a window-box
The advantage of selecting with a mouseclick or chain(SHIFT) is that the user can determine the direction and order of the elements. But suppose you like to select elements in order to delete them, the order and direction will not be relevant. The fastest way to select in this case would be to move the cursor to the upperleftcorner in your screen and while pressing the leftmousebutton, drag the cursor to the lowerright corner to indicate a box. (be sure that you do not start dragging close to an element because it will immediately be selected). Elements need be totally inside the box.

If you desire to select the elements which do not entirely lie inside the box, you can press the SHIFT-button while you are dragging the box.

Deselecting
Elements which are selected can ofcourse be *deselected*. The fastest way is by clicking the left-mousebutton *not close* to an element.

The other ways are exactly the same as *selecting elements*. For example, you can deselect a chain by clicking with leftmousebutton at the end of a chain and pressing the SHIFT-button. Or you can drag a box around selected elements. Another option is by using the function *Select* . This is to be found in the menu *Edit.* Here you can for example make a selection based on *Entity Type* or color , layername etc. or a combination of criteria. Try this out by defining your own criteria

So far the explanation of selecting elements. Remember well:

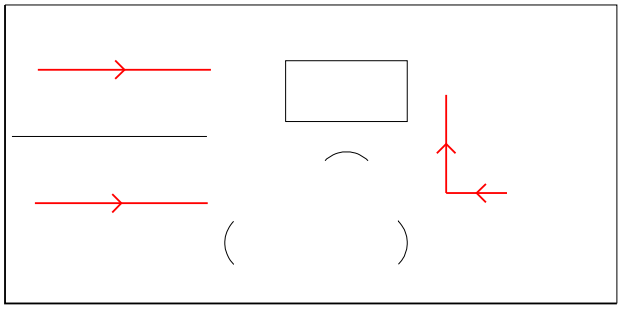
Direction and *Order* of elements are very important in Tensor.

Selecting and *deselecting* is being done in the same manner

If by any chance problems occur selecting elements when working in Tensor, do not hesitate to read this part again.

Execute an action
As said before, an element needs to be selected before an *action* takes place on that element. An action for example would be to draw a line under a given angle at the end of an element.

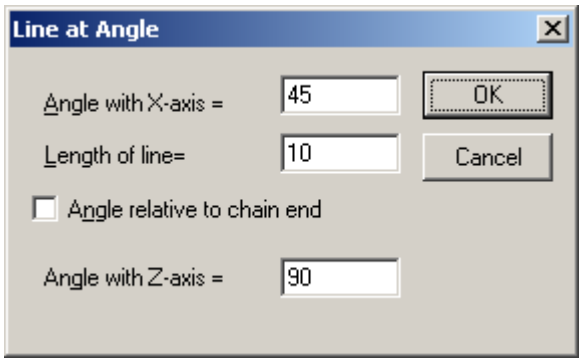
Exercise*: Open drawing *ten01.ccd



pic.14

Select the three chains as shown in pic.14

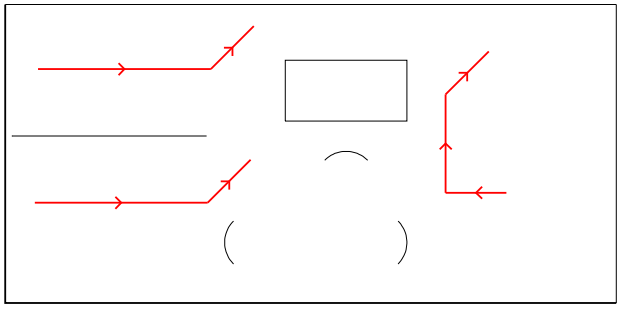
Move to menu *Draw->Line->Angle* or click on button  .
Enter the following values and click *OK:*



pic.15

The result will be as shown in pic.16. On all three chains the action has been executed. Three new lines are placed at the end(!) of the selected chains. This is an essential point in Tensor.

***Conclusion*:** An action is always being executed on selected elements(and/or chains)

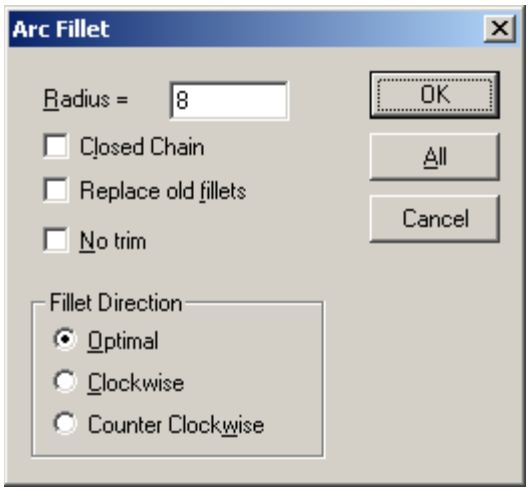


pic.16

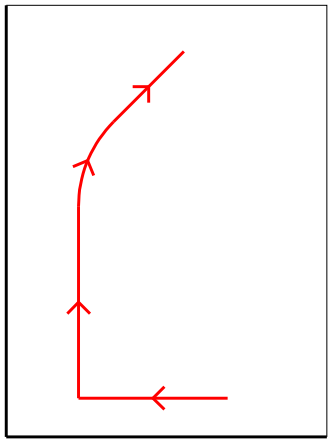
***Tip**:* When drawing in 2D always leave the value *Angle with Z-axis* at 90 degrees.

Deselect all elements by clicking with the left-mousebutton *not close* to elements
We will now fillet the chain in the upper corner. Select the chain in the same direction as we just did before. (The chain now contains 3 elements)

Move to *Draw-Arc-Fillet* (quickkey ***F***)or click on button  and enter the following values and then click *OK* :



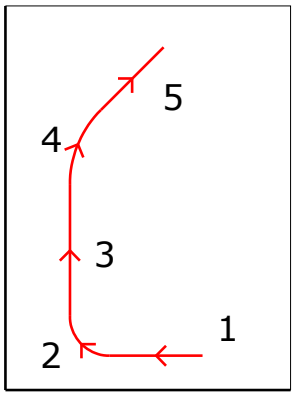
pic.17



pic.18

The result will be that the fillet will appear between the last 2 elements in the selection (as in pic.18) If you would have clicked option *All*, both corners would have been filleted with radius value 8. To *UNDO* the *action*(filleting) move to menu *Edit->Undo*
You will see the chain appear without fillet. You can also use this to undo the action:

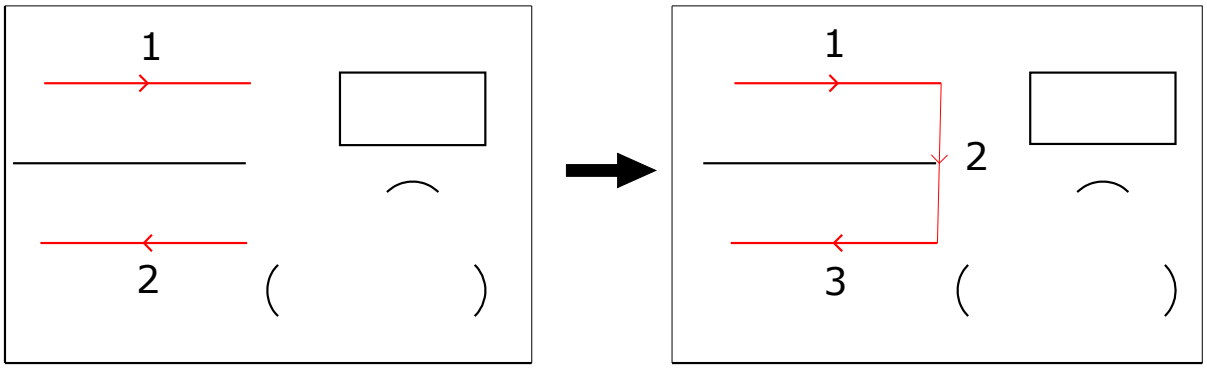

Now fillet again and click on the *All* button with the following result in pic.19:



pic.19

When filleting Tensor will automatically define a new order of elements in accordance with the numbers in pic.19 above.

Conclusion: Don't ever hesitate or be afraid to try out functions in Tensor. You can always *Undo* your action. The Undo-function is applied to all geometric changes being made in Tensor.



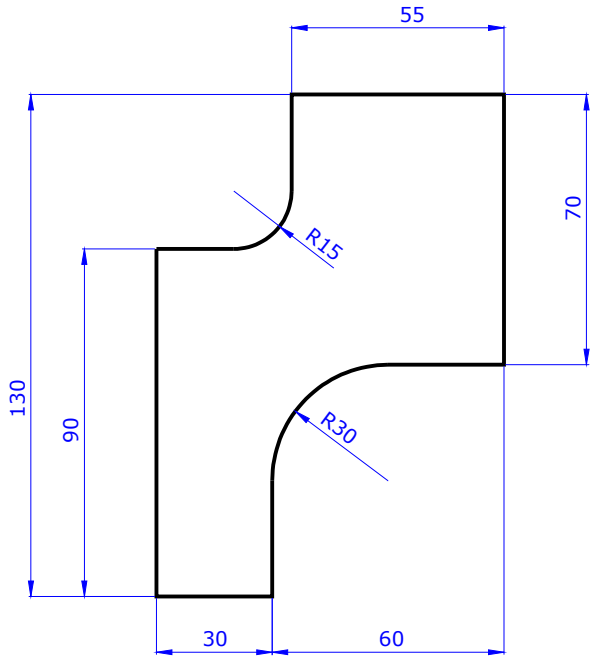
pic.20

In pic.20 two lines are selected which can be connected using the function *Draw-> Line->Connect* (quickkey ***J***). The order of selection will be like the numbers shown.

Conclusion: Tensor takes care for a logical order after geometric changes have been made in selected elements.

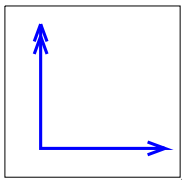
Drawing a profile

We will draw the profile in pic.21.



pic.21

If we take a closer look at the drawing it seems logical to define the startpoint of the profile on the lowerleft corner, as dimensioning starts from there. In the center of the drawing-window you can see blue axes:



pic.22

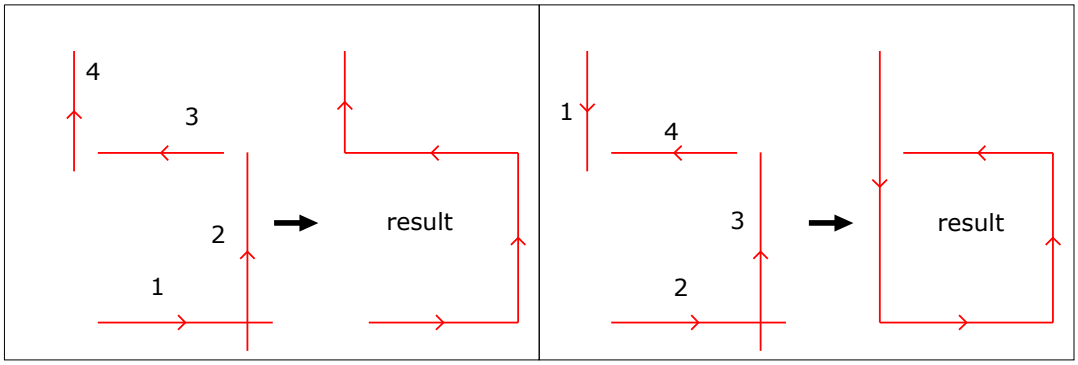
This is the absolute zeropoint of the drawing window. Direction of the X-axis is indicated by the line with one arrow, the Y-axis by the line with two arrows. For the Z-axis there is a line with 3 arrows, but as we are looking at the XY-plane, this is not visible. (Don't confuse these axes with those on the upperright corner. These represent the view-angle)

***Exercise*: Watch ten02.avi**

To create this shape (pic.21) it is good to have a zeropoint. This because the function *Draw-> Line->Sketch* (quickkey ***L***)is being used to draw horizontal and vertical lines with coordinates. By dragging the cursor with the left-mousebutton from left to right over the screen you can define a horizontal line by entering a value on which Y-value the lines should be. This Y-value is of course related to the zeropoint. In the same manner you can draw vertical lines by dragging the cursor from the bottom-to-top direction (or vice-versa) and entering an X-value. The Y-values you the enter to a vertical line represent the Y-start coordinate and Y-end coordinate of the line.

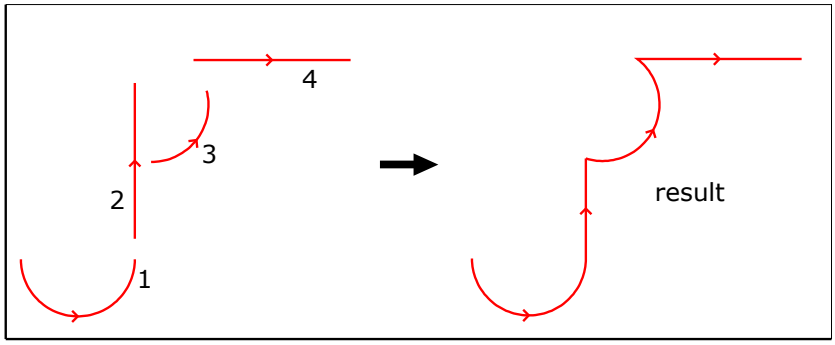
Trim

In this example you will have noticed the function *Change->Trim+extend->Chain* (quickkey ***T***) is also being used. This function is used very often while working with Tensor. You can extend or trim elements to create a chain. The order of selection will determine how they will be trimmed.



pic.23

In pic.23 we can see that a different order or direction of elements will have a different result. In this case only lines are trimmed, but of course it also applies to arcs (pic.24):



pic.24

***Exercise*: Try to make the profile in pic.21. Take a look at *Exercise 1* in chapter Exercises to see which functions you will need in this example**

Zoom-in and zoom-extend

In *ten02.avi* the view is frequently adjusted. Three buttons are mainly used for this (pic.24):

pic.25

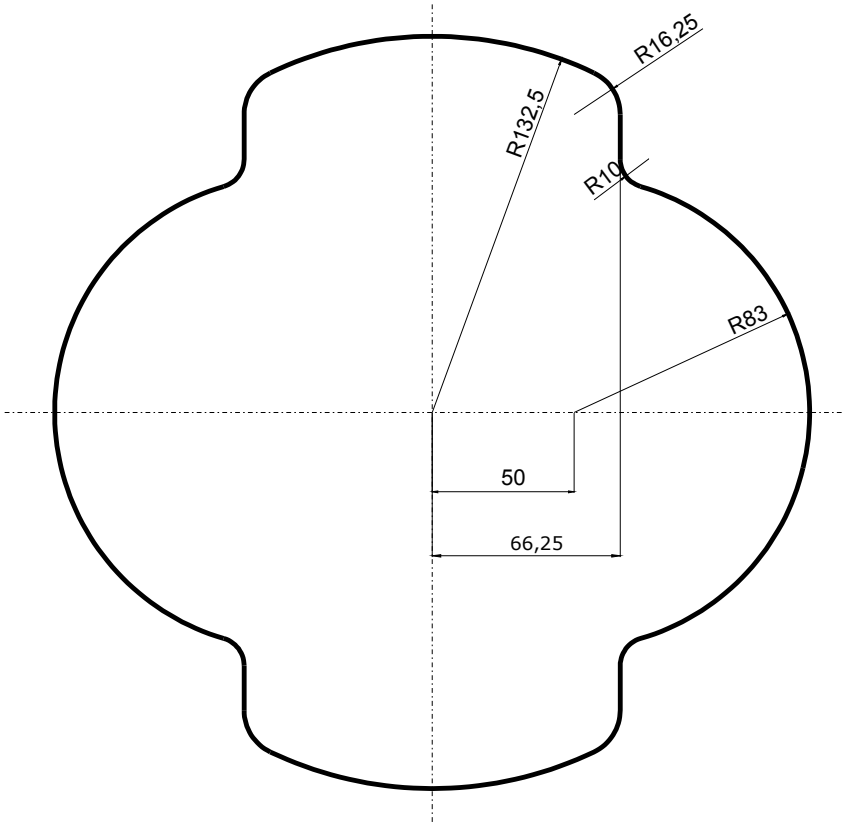
When clicking on the left button the scaleview is reduced half. The middle button will place all the geometry in a maximum screen (quickkey ***Z***). The right button allows you to enlarge a part of the drawing by *dragging* with the left-mousebutton a box around the desired part.

Closed chain

In ***ten02.avi*** *the Trim* function is several times being used. However during the last action
the button *Closed Chain* was activated. This option will ensure that while trimming not only the elements will be trimmed in the order they were selected, but also that the last element will be trimmed to the first element with a closed chain as result. The *Closed Chain* option is also often used by other functions in Tensor. For example, if you want to fillet all corners of a closed chain you also need a fillet between your first and last element. So remember: when you want to close a chain you can use the *Closed Chain* button.

***Exercise*: Now try to draw exercise2 from chapter Exercises (Also watch *exer2.avi*)**

Cut and Paste



pic.26

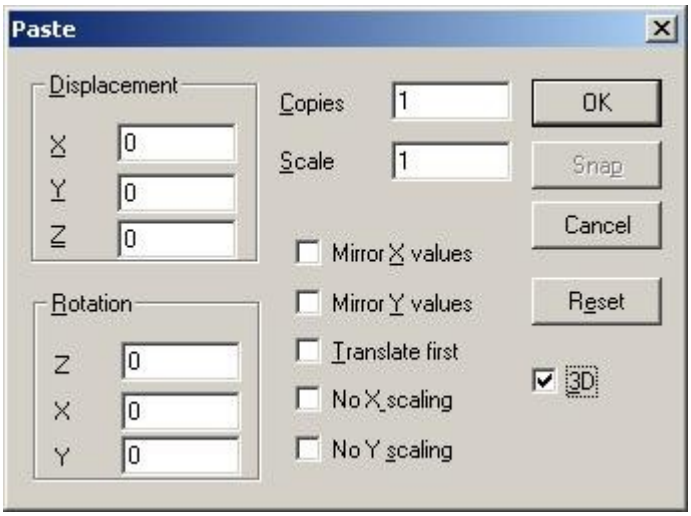
The profile in pic.26 is a symmetric shape. This means we should try to draw one quarter and then mirror this in X- and then in Y-axis.

***Exercise*: Watch *ten03.avi*.**

In this example Tensor will make use of the clipboard of Windows. If you are not familiar with this *Clipboard*: you can copy selected elements/objects (quickkey CTRL C)within Windows to the *Clipboard* and then paste these objects back on a different location within Windows.

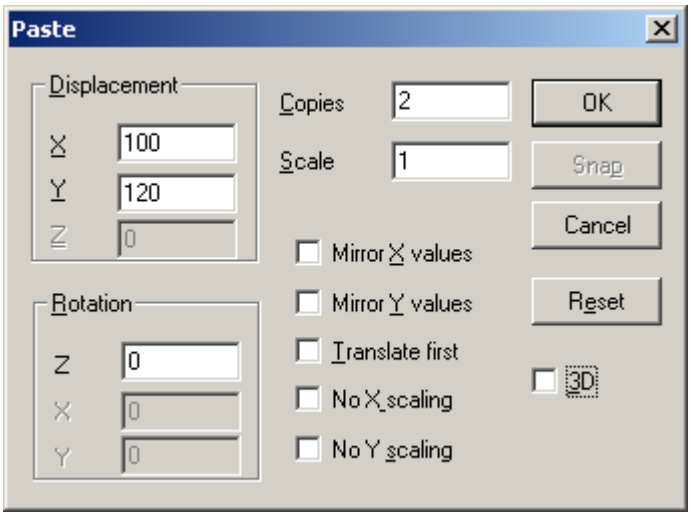
*Thus also in Tens*or: a quarter of the shape will be copied to the clipboard. When you want to paste this quarter, move to menu *Edit->Paste* (quickkey ***CTRL V***).The following

dialogbox will appear (pic.27):



pic.27

All the possible options to paste geometry back into the drawing are available: *Move*, *Rotate*, *Scale* and the number of *Copies*. If let's say you want two copies at a distance of each 50 mm in X, and 60 mm in Y, enter the following values (pic.28):



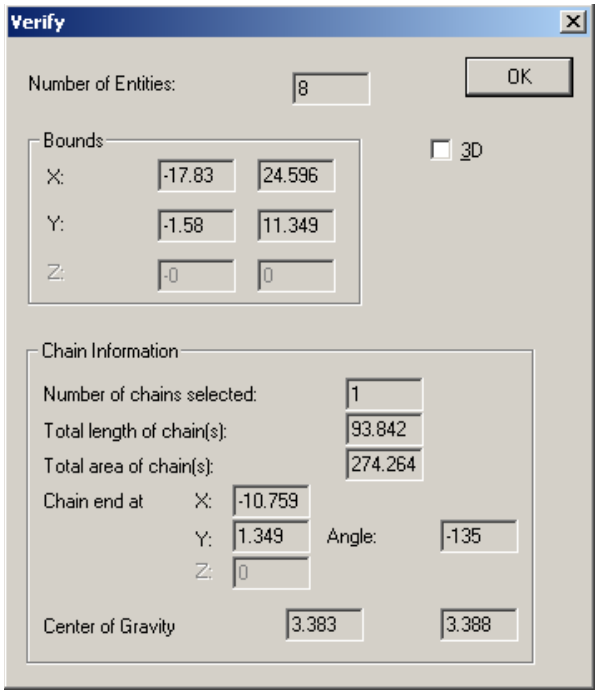
pic.28

You will notice the total distance of the two copies is entered X:100 (2*50) and Y:120 (2*60). As we entered 2 copies, Tensor will automatically divide the translation over the 2 copies. This of course also applies for Rotation. If you want 11 copies divided over 360 degrees, you can simply enter 360 at *Rotate-Z* and enter 11 as number of *Copies*. (In 2D you will always use the Z-axis as rotation-axis. This Z-axis after all, points at you from the screen). By deactivating the *3D* button in the lower rightcorner Z-displacement and Rotation in *X*- and *Y*-axis are switched off.

Conclusion : The user should mind that the axes are on the right place when rotating. This because that will be centerpoint of rotation.

Exercise*: Now draw the profile in pic.26. Take a look at Exercise 3 in chapter Exercises to see which functions you will need in this example and you can watch *exer3.avi

Verify



pic.29

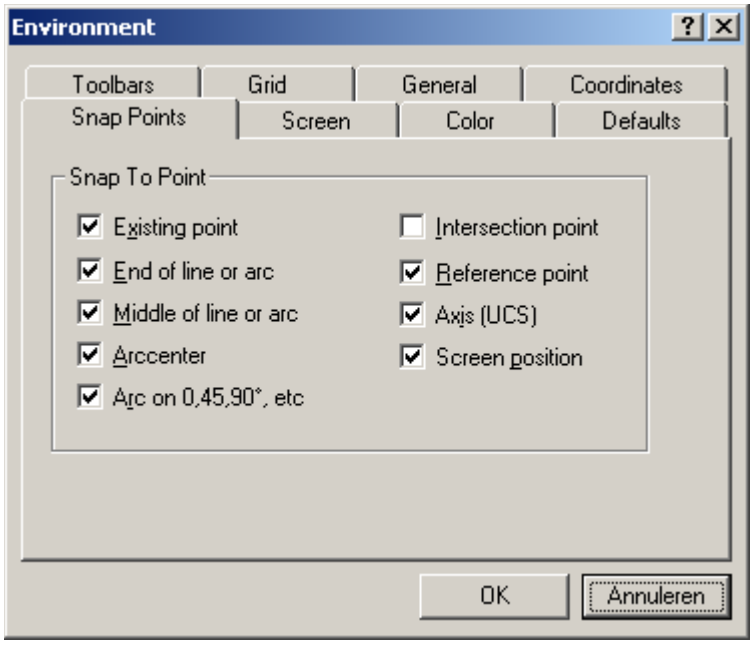
In option *Special->Verify* (quickkey ***W***)you will find all information about geometry present in your drawing (pic.29). This can be useful if you for example would like to check if a selected chain is closed. If the chain is closed the value of *Total Area of chains* there will be different than 0. *Number of entities* stands for the number of selected elements. If no elements are selected the value represents the total number of elements present in the drawing.

Conclusion: With *Special->Verify* you will be able check geometry of (selected) elements.
If nothing is selected the values apply to the entire drawing.

Calculator
If you for example would like to enter a value for Z-rotation of 135/4.67 you may enter this as *135/4.67*. Tensor will recognize this and calculate the proper value. You can also use expression as multiplying(13*7), subtracting(13-4.15), adding(45+12.7) and even sinus(sin 45), acosinus(acos(1)) etc.

Move Axes
Suppose: you want to rotate a number of elements but the point of rotation is not the zeropoint of the coordinate-system. As we can only rotate over (0,0) we will have to translate the axes to this point.
Exercise*: Watch *ten04.avi .

You will see in the menu *Axes* there are several options to move and rotate the axes. The first option is *Snap to* (quickkey ***P***). *Snap points* are positions whereto you can move the axes. In menu *Special->Options* in tab-page *snap points* you may see what kind of snap points are available and if they are activated or deactivated (pic.30):



pic.30

Exercise*:Watch *ten05.avi

In ***ten05.avi*** we run through all options in the *Axis*-menu. Especially *Align X* (quickkey ***X***) might be very useful to your needs. To draw the rectangle 5x5 inside the big rectangle,
requires a lot of effort if the *axes* are in their original position. This option can save you some time calculating the displacement and rotation.
Exercise*: Now draw the profile in Exercise 4. (Watch if necessary video *exer4.avi)

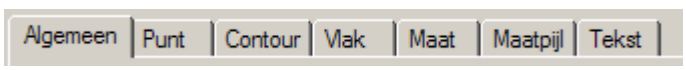
Exercise*:Watch *ten06.avi

Another often used option is the *snap point.* In *ten06.avi* a copy of a chain is made in such manner that the lower left point is in coordance with the upper right point. Without knowing what the distance in *X* and *Y* between points is, we can make a copy by simply moving the *axes* and enter values for translation (0,0). The experienced Tensor-user very(!) often uses this method of moving the *axes* from one *snap point* to another. With option *Axis-> Reset* (quickkey ***R***) you can reset your axes back to the original position.

Attributes
Each element has its *Attributes* (quickkey ***A***). They are more or less properties.
To start: each element has a layername . You might for example give a number of elements which are related in some way, the same *layername* (for example a chain). The default value of the layername is 0. The default layername is visible in the box in the upper right corner of the screen (just as the default color is) pic31:

pic.31

Also in this case, you first need to select element(s) before you can adjust its attributes. Move to menu *Edit->Attributes* to open the *Attributes* dialogbox. This box contains a number of tab-pages, one for each elementtype. pic.32



pic.32

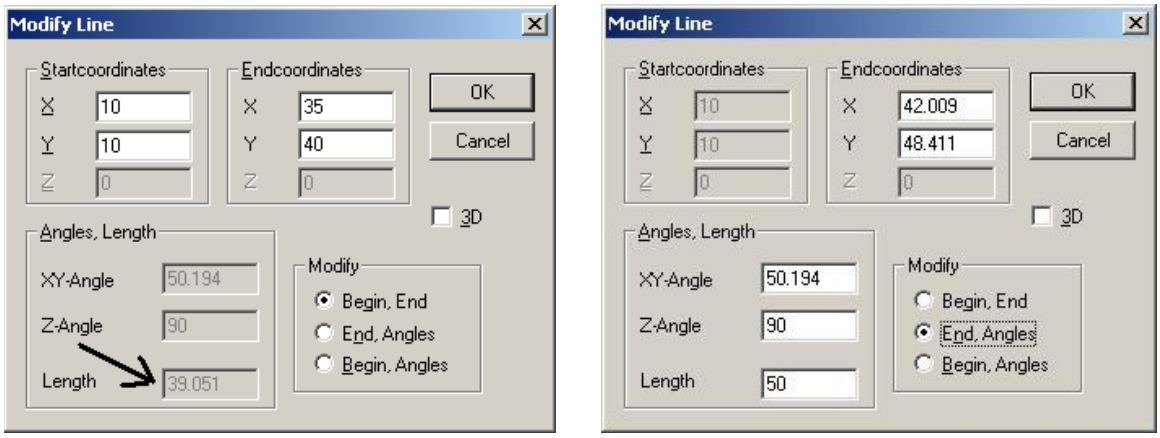
In *General* the layername can be adjusted and you can temporary make an element Invisible*(Blank)*. (In menu *Change->Unblank* they can be made visible again).

In tab-page *Contour* attributes of lines and arcs can be altered. The names of the other tab-pages speak for themselves. Especially tab-page *Dimension* is extended in options. In menu *Draw->Dimensions->Setup* more settings for dimensions can be made

***Attention**:* If no elements are selected and the *Attributes* are being changed in the dialogbox, they will automatically turn into the default attributes.

Change

Open drawing *ten0.ccd.*
In the *Change*-menu you will find item *Modify*. If you have selected one or more elements the geometric data of the last selected element will be shown, which can then also be adjusted. For example the length of a line can be changed at the lower end of the dialogbox. Because the button in *End,Angles* is activated only the endcoordinates will be adjusted. (pic.33)



pic.33

For an arc you might want to change the centerpoint or the radius and total angle in the *Modify* dialogbox.

Modify Mode

In the *Change* menu you will find the *Modify mode* option. This option is also present in the toolbar. By clicking on the button it will be activated. The cursor will change into a black arrow. If you now double-click with the left-mousebutton on an element in your drawing, Tensor will present you it's geometric data.

By activating this arrow you can also move an element or lengthen/trim a line or arc
If you for example move the cursor to the end of a line and keep the left-mousebutton pressed, you can drag the cursor and change the length of the element. If you drag the cursor from the middle of an element, you will change its position. If you while dragging also press the *CTRL*-button, you will be able to adjust the element as it was an elastic. If you by accident made the wrong adjustment you can Undo this by clicking on:

If geometry needs to be changed accurately you might not want to use this option as it's not very accurate dragging the mouse. By clicking on the *Modify mode* button it is been deactivated.

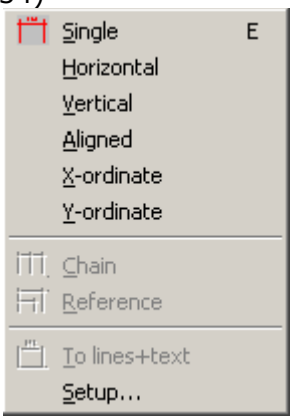
Tip:
When the *Modify mode* is activated you will be able to drag a copy into your drawing by clicking the left-mousebutton close to an element and pressing the *CTRL*-button. This ofcourse is not accurate but sometimes might come in handy " to make a quick copy" .

Exercise: Make exercises Exer5 and Exer6 in chapter Exercises. Watch if needed video *exer5.avi* and *exer6.avi*.

Dimensions

As Tensor is also a CAD-system dimensioning-functions must be available. Actually, they are very easy in use.

In het *Draw*-menu you will find submenu *Dimensions*. In this menu there are several options of dimensioning. (pic.34)



pic.34

Open drawing *ten0.ccd*. (if not already opened)

Exercise*:Watch *ten07.avi
In this video all options in the menu are being showed. The *Single* dimension is the most common used. If one or more elements are selected you can full automatically dimension the elements by just moving to *Draw->Dimension->Single* (quickkey ***E***). This of course is a very fast manner to dimension a drawing but not always what you would like to do. If no elements are selected you can activate the option and Tensor will in this case ask you to indicate two snappoints where after Tensor will place a dimension.
You will notice that Tensor can both generate horizontal as well as vertical dimensions. This depends on the X- or Y-distance between the two indicated points.

In ***ten07.avi*** you can see that if the *Modify mode* button is activated you can place the cursor in the center of the dimension(at the little cross) and then drag this through a circle which will appear. You can then change the orientation of the dimension as desired. The *Horizontal* and *Vertical* options in this menu speak for themselves.

As described earlier, you can change *Attributes* of dimensions in the *Attributes* dialog box in tab-page *Dimension*. The quickkey for Attributes is **A**. Here you will find a wide variety of attributes you can define.

Draw Menu
Inmenu *Draw* menu you will practically find all functions available to define geometry like Line angle, tangent lines to arcs, all kind of options to define points etc. In the sub-menu *Other curves* there are some more powerful options to make geometry also to be used to generate CAM geometry. For example feature *Pocketing* and *Rectangle* are available. So you don't have to draw 4 lines to have a rectangle on your screen.

***Exercise*: Make exercises *Exer9* and *Exer10* in chapter Exercises. Watch if needed video *exer9.avi* and *exer10.avi*.**

Exercises
In chapter exercises there are 15 exercises. You can watch the accompanied .avi files These can be played with Windows Media Player™. The videos will take you step-by-step through drawing the profiles of the exercises. In the Windows Media Player™ it's possible to *Pause* during playing go *Forward* and *Backwards*. This will help you to study the .avi files even better. Practically all functions available in Tensor are being used in these exercises and it's therefore very(!) useful to try to make these drawing yourself .
If you however are anxious to make your first NC-program in Tensor you can proceed to the next chapter.

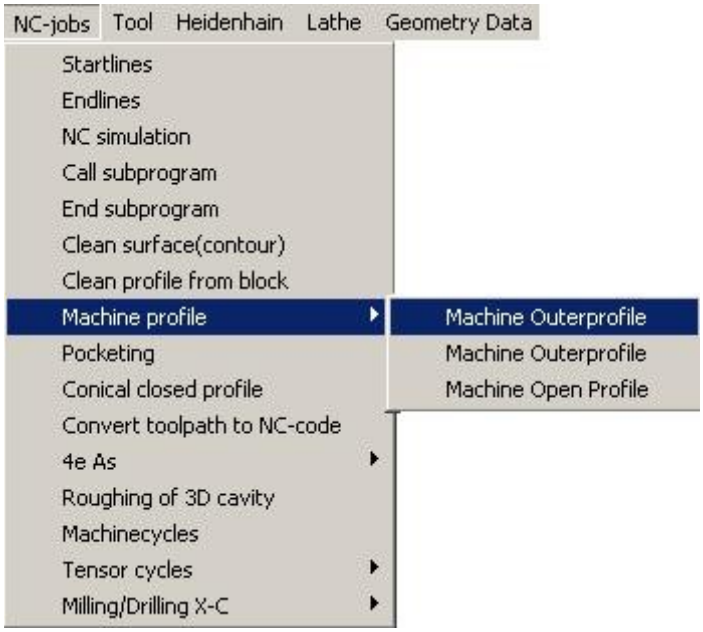
NC-programming for milling

In the preceding chapter have we learned how we to define geometry in the drawing window. In this chapter we will show you based on an example how to generate an NC-program for milling. You will notice that through dialog the NC-program is being built up for a specific NC-job.

For users, not working with a Fanuc-controller but for example are using a Heidenhain controller, some dialogboxes will not look familiar. But work through this chapter using the Fanuc postprocessor and then repeat this for the controller you prefer. You will notice that the dialogboxes will differ per controller on four basic points:
1.startlines of a progam
2. Endlines
3. Loading a tool
4. Cycles (p.e drilling cycle).

The other questions you will get, do not depend on the controller you are using, as a job does not depend on a controller. Right from menu *Help* you will see several menus:

In menu *NC-jobs* there is big variety of NC-jobs available. This varies from drilling to pocketing and 4-axis programming. (pic.1)

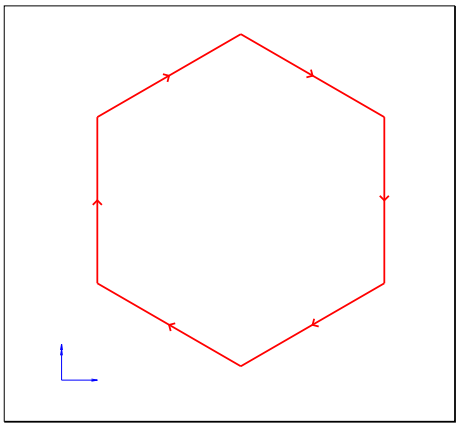


pic.1

In this example will now move step-by-step in generating an NC-program to machine a profile on the outside (*Machine Outerprofile*).

Machine an Outerprofile

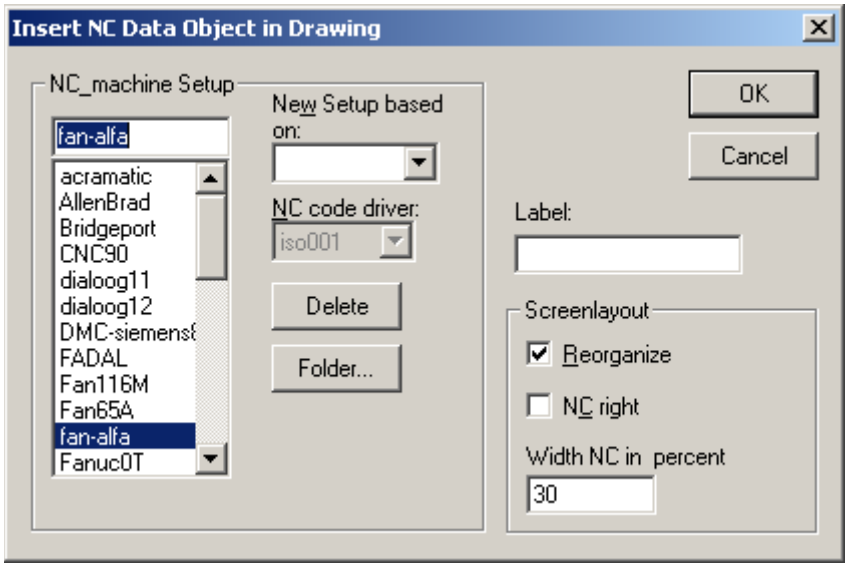
Open drawing *tennc01.ccd*



pic.2

We will generate a program to machine this hexagon.

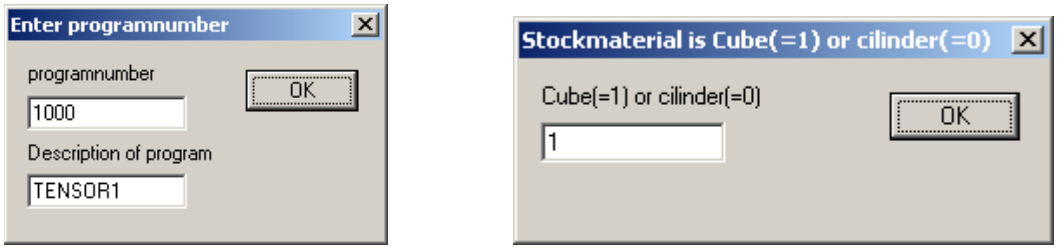
Selection of controller
First we will have to determine for which controller we want to generate the program. In this exercise we will choose Fan-alfa. This is the *postprocessor* for all common FANUC-controllers. To insert an NC-window for *Fan-alfa* we move to menu: *Special->Insert NC* and select *Fan-alfa* in the list of controllers. A second new window(*NC-window*) will appear in Tensor (pic.3).



pic.3

In this window the NC-program will be written. Actually this window is a text-editor where the user can type or change text if so desired.

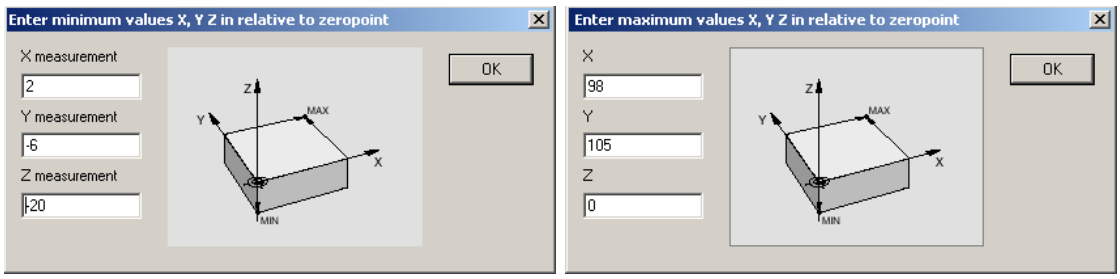
Startlines
As any programs has its startlines we will define these first by moving to: *NC-jobs->startlines* But before we do this, be sure that only the hexagon is selected. This is what you will see (pic.4):



pic.4

Enter the same values as shown in the pictures. Tensor will ask the user to determine the dimensions of the stockmaterial: cube or cylinder? In this case we will select the Cube-shape(=1).

Now we need to define the position of the lower left- and upper right point of the cube in accordance with the drawing origin (0,0,0) (pic.5). This will eventually also be the origin of the NC-program.
In this case we have selected the profile. Tensor will then automatically present values that surround the entire profile plus 10 percent. This will save you some time calculating. We can simply click on *OK* two times.



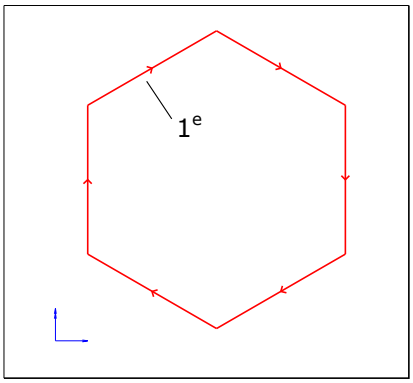
pic.5

If nothing had been selected Tensor will present default values of 100x100x20.

```
%
O1(TEST)
(FROM/50,50,100)
(STOCK/BLOCK,100,100,20,0,0,20)
```

In the NC-window you will see the startlines. Line 3 and 4 are between brackets. For FANUC-controllers text between brackets will be skipped. But the lines are necessary for the Tensor NC-simulator to know what the startpoint of the tool and size of the stockmaterial will be.

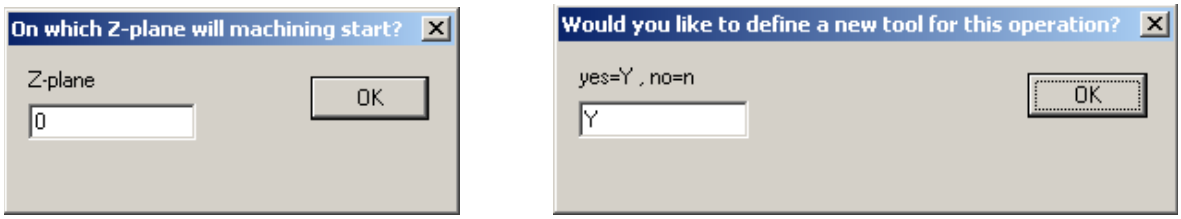
Job selection



pic.6

Now the startlines are defined we will select from the list of NC-jobs. Deselect all elements in the Drawing window. Now select the hexagon as is shown in pic.6. We will choose direction climb-cut and the upper left line will be the first in selection. This means we are already now defining where the program will enter the profile and direction of cutting. Now move to menu *NC-jobs-> Machine profile->Outerprofile*. A dialog will start between user and Tensor which will result into a complete NC-program to machine the hexagon-profile.

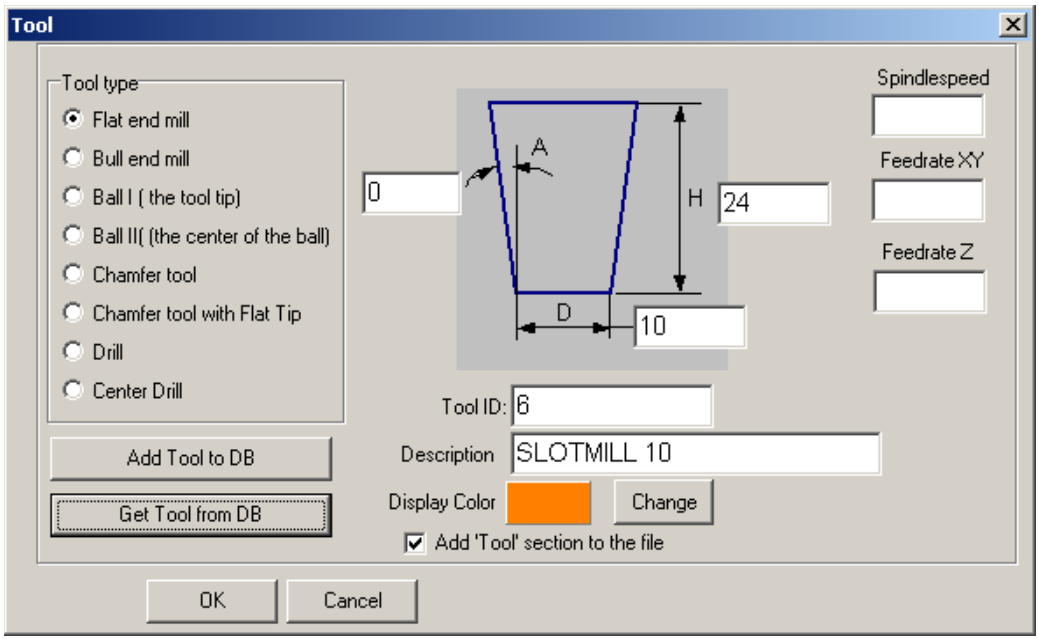
We will run through this dialog. Remember to use the same values as shown in the pictures.



pic.7

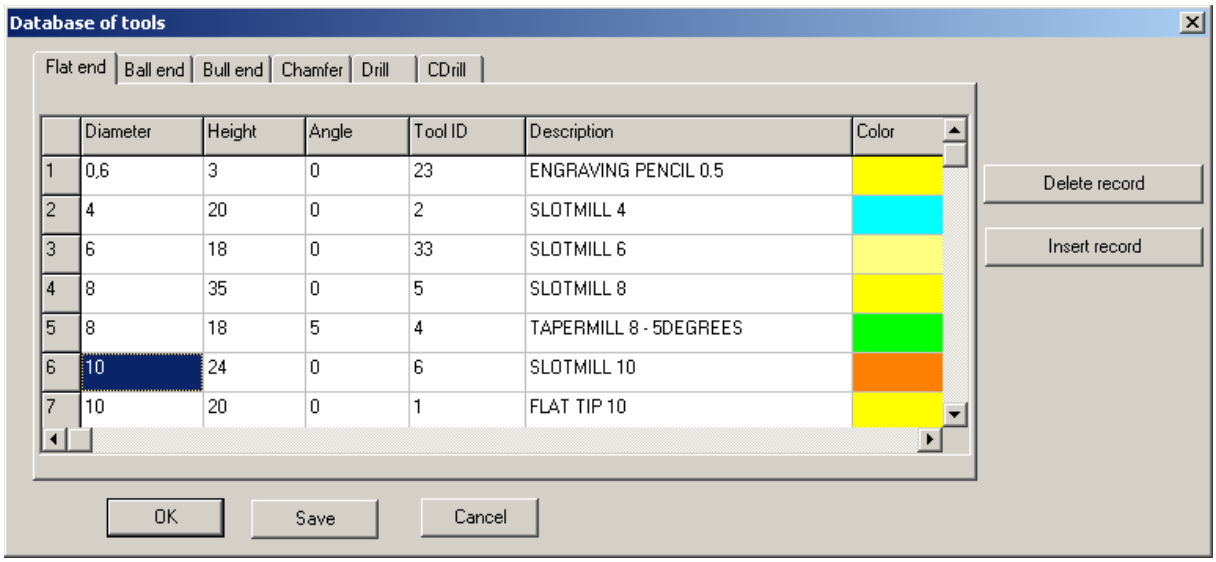
The topside of our cube will be our Z=0 plane. As we haven't yet selected a tool for this job we will answer the question with yes (**Y**).

Select from a toollibrary



pic.8

When selecting a tool this dialogbox will appear(pic.8). You can see the user can select from a list of **8** different type of tools. Just to see what types of tools are available, click on each radio button and see what dimensions define each tool. In this exercise we will select a *Flat End Mill*. Values for the diameter height and angle can now be entered. But there is also the option to select from a list of predefined tools. For this, click on button *Get tool from DB*



pic.9

This is what you will see (pic.9). By clicking on *Insert Tool* the user can define new tools and add them to the list by clicking the *Save* button. (don't forget to Save !). You can also delete tools from the list by clicking *Delete Record*

Attention: Don't forget to click on the Save-button when changes are being made !

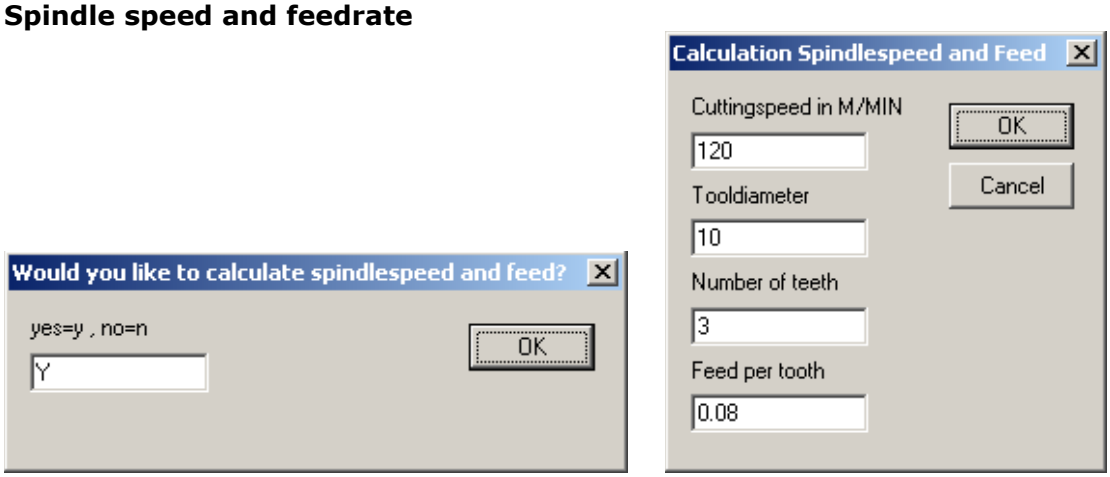
Parameters of tools

The value *Height* stands for the cuttingheight of the tool. During simulation there will be a check if the depth is not too large. Tensor will return a warning if this is the case. (Just as there will be a collision check at Rapidfeed). *Tool* ID is the toolnumber which should be in accordance with the toolnumber defined on your CNC-controller, to prevent errors or collision on your machine. The *Description* of the tool will also appear in your NC-program to make it easier to check your program on the CNC-controller. *Attention*: some controllers only accept capital letters. For each tool you can define a separate *Color* for removed material during simulation. This will enhance the overview during simulation.

Select the *SLOT MILL 10* from the list and click *OK* . Then again click on *OK* to confirm selection. Finally click a third time on *OK*.

Tip: Drag the window when you are in the listing of tools(pic.8). You will then see the picture in the previous window(pic.9) explaining the parameters.

Spindle speed and feedrate

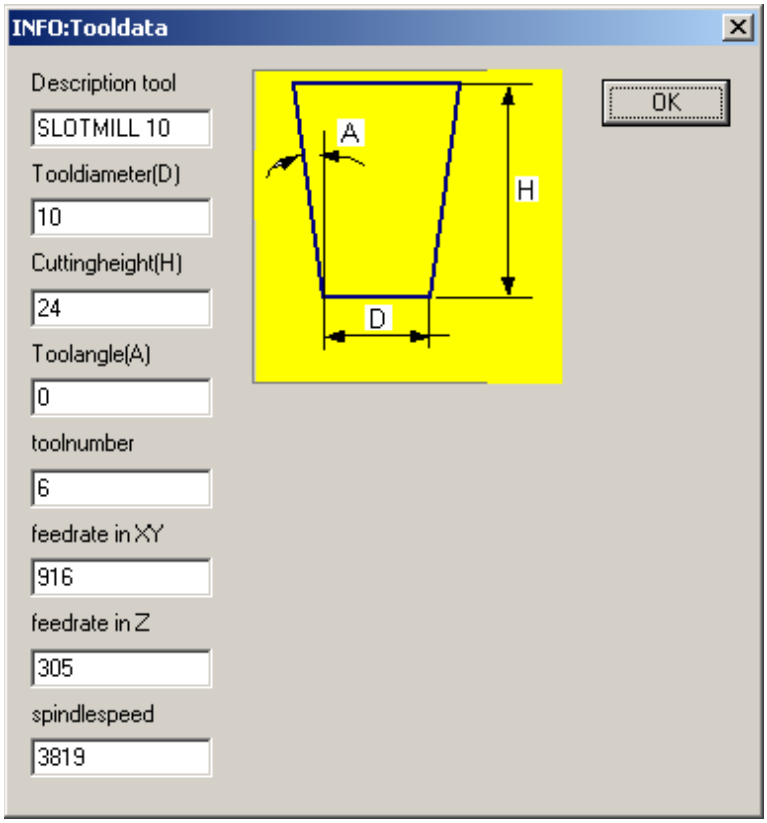


pic.10

By using the standard formules, *spindle speed* and *feedrate* will be calculated by Tensor. The calculated values can be changed by the user in the dialogbox after calculation if so desired. (pic.10)

Tooldata

As all tooldata are now defined, Tensor will present them to the user one more time:

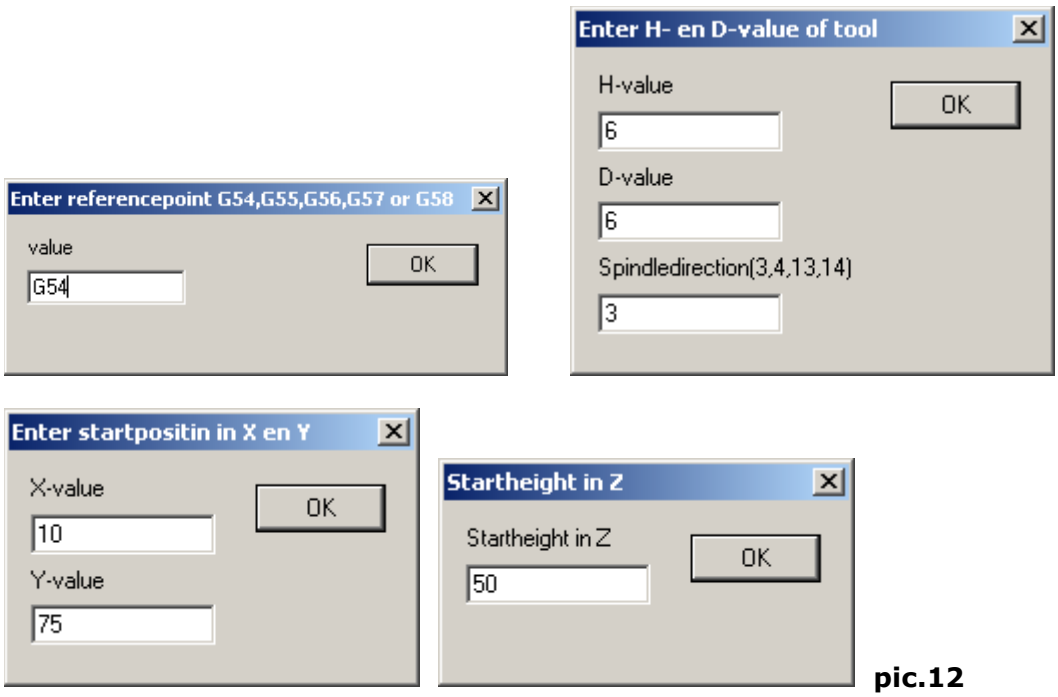


pic.11

In this dialogbox once again you can alter the cuttingconditions (pic.11)

NC-code to load tool

Tensor will now generate the necessary NC-code to load the tool. Each controller has its own specified NC-code for this. Thus each postprocessor will have different questions. For FANUC-alfa the following dialogboxes appear:



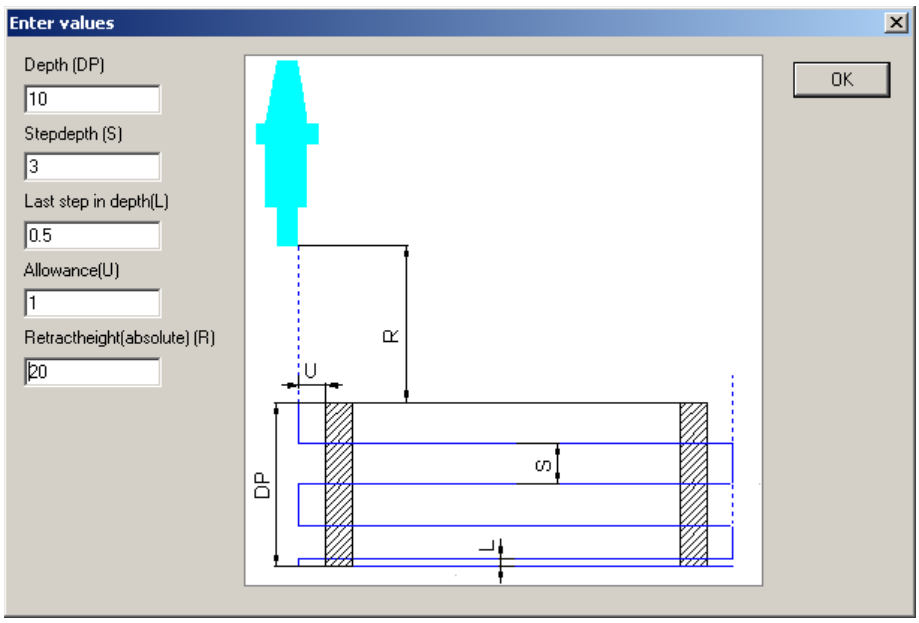
pic.12

With this result:

G00 G28 G91 Z0
G49 Z0
M01
(TOOL/MILL,10,0,24,0)
(COLOR,255,128,0)
N2 (SLOTMILL 10)
G00 G17 G40 G49 G80 G90
T6 M6
G54 G00 X10 Y10
G43 Z50 H6 S3819 M03

Again you will see lines between brackets. These are the values of the tool which the Tensor NC Simulator needs to simulate. Every time you load a tool the same dialogboxes appear. For instance you can also define and load a tool in menu *Tool->Load Tool*.

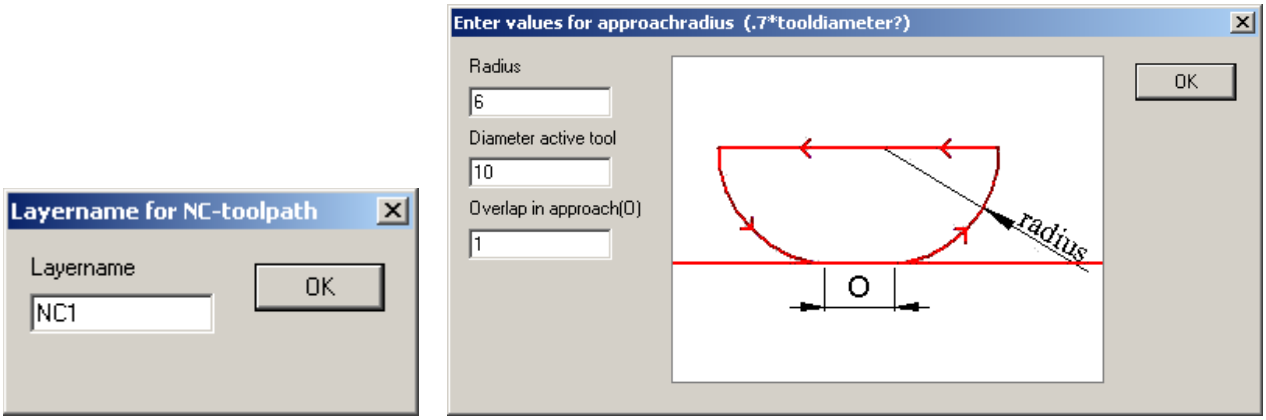
Job parameters



pic.13

The user can now enter the values how the part should be machined. Number of steps will be adjusted to a higher value as 10/3=3,33. Later on you will be asked if you want to finish the profile.

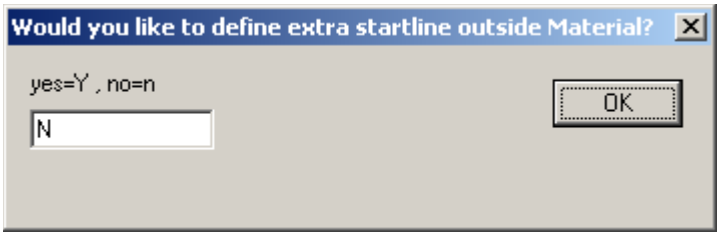
You can enter a layername(description) for the toolpath (geometry) which will be generated.(pic.14) In this case we enter *NC1.*



pic.14

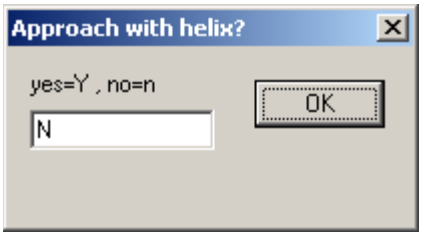
An approach will be defined at the center of the first selected element in the chain. (pic.14) The value Tensor presents for the radius will be 60% of the diameter value, as a value smaller than 50% will probably generate an error on the controller for toolcompensation. To improve the surface in the profile at the position of the approach, you may enter an overlap value.

An extra line can be attached to the approach. This might come in useful if you don't want the tool to plunge into the material but that it will approach from outside the block. In this case we will enter No (*N)* (pic.15)



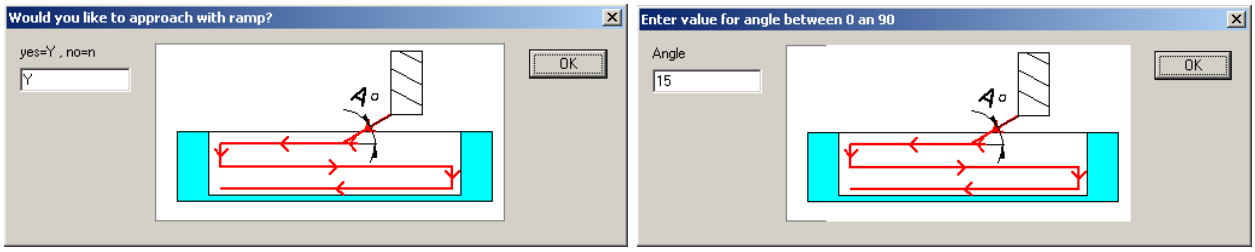
pic.15

There are several ways to lower in Z. The most common is simply to plunge straight into the material. Tensor offers you two more options. They will be presented to the user. The first one is to lower in Z with a helix. The diameter of the helix and angle of plunging in Z is related to the diameter of the tool. In this case we will enter No(**N**). (pic.16)



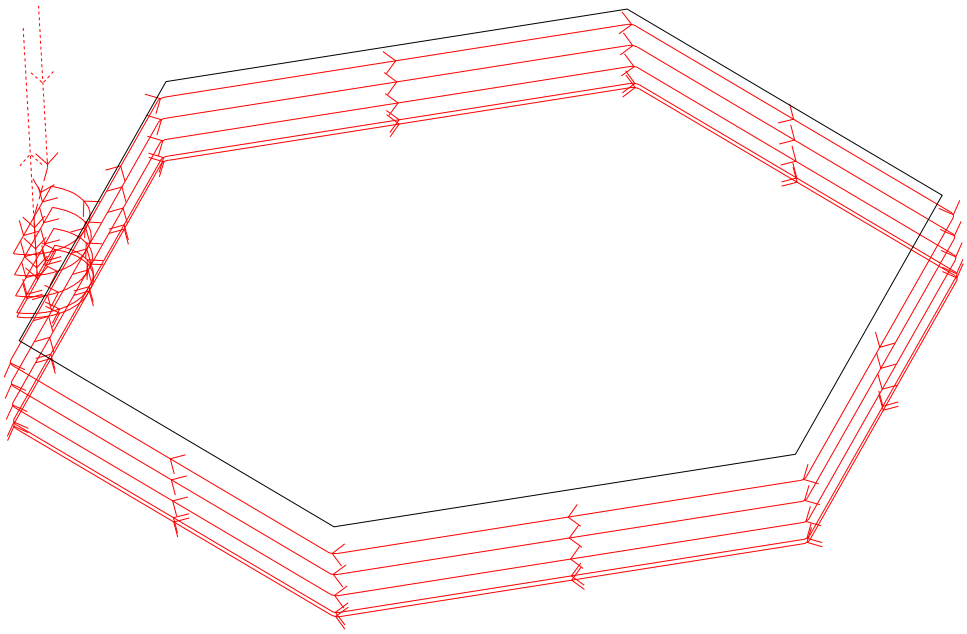
pic.16

The second option is to plunge with a ramp. We will confirm with Yes(**Y**) and enter a value of 15 degrees for the ramp. (pic.17)



pic.17

NC-code for roughing_



pic.18

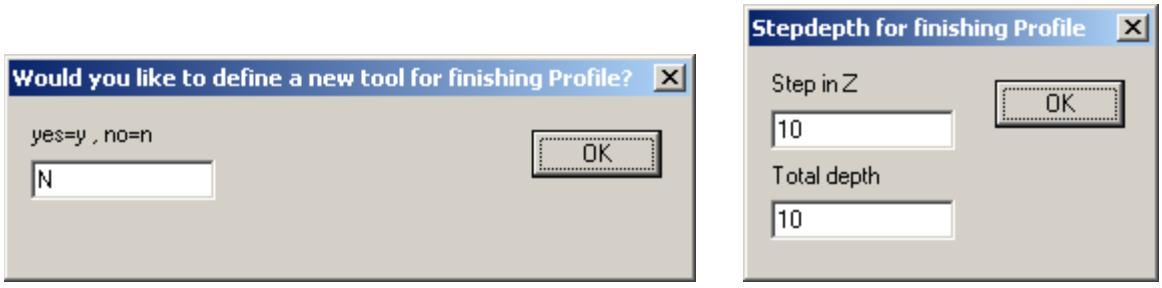
NC-code is now being generated in the NC-window with the calculated values. You will also see Tensor generates comment at the beginning an end of a job: (*END OF MACHINING OUTERPROFILE*) and (*START OF MACHINING OUTERPROFILE*). This will help you in having a good overview of your program.

Click through your program using arrow-keys

By using arrow-keys on your keyboard you can run through your NC-code in the NC-Window. At the same time you will see a red arrow in your drawing-window moving over the geometry which is in accordance with each NC-line. So if you want to make any manual changes in your program (p.e. feedrate) you will know in which geometry of you part you are making changes.

Profile finishing

As we entered an allowance of 1 mm, we want to finish the profile as well. We therefore will answer with yes(**Y**). First question is if you would like to load a new tool for finishing.(pic.19) In this case we will continue with the same tool and therefore enter No(**N**).



pic.19

Automatically an approach is made. The user can define the step in Z for finishing the profile. Default the value will be the total depth which is most common in practice. We will leave the

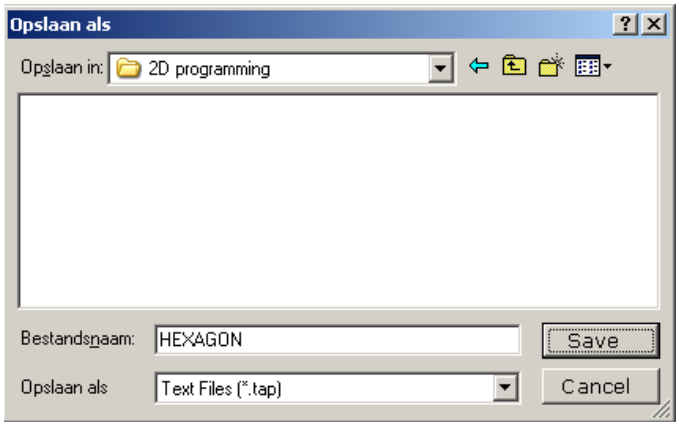
value as it is (10 mm). Again NC-code is generated for finishing the profile, with the accompanied comment.

Endlines
The NC-program is almost ready. To complete the program we will add *endlines*. For this we move to menu *NC-jobs->Endlines*. For FANUC-alfa the following lines will be added:

G00 G28 G91 Z0
G49 Z0
G28 Y0
M09
M30
%

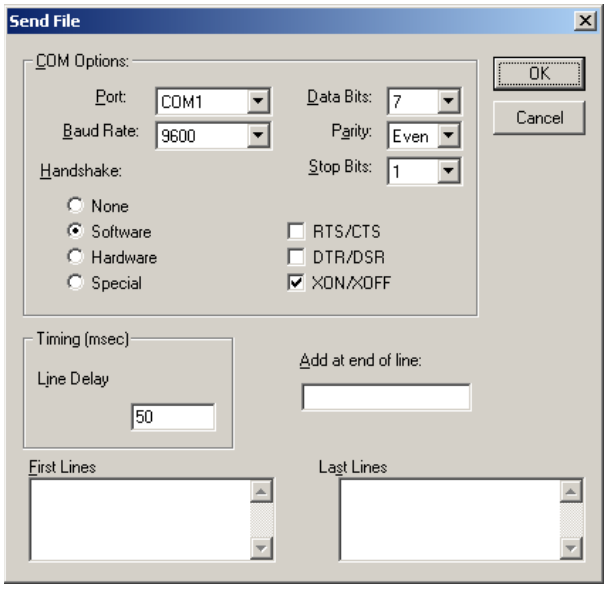
***Exercise*: Try to make your own NC-program for an outerprofile. You can select a different CNC-controller. You will then see the code for loading a tool and start- and endlines differ from Fanuc.**

Save NC-program or send to machine with RS232
You may make a copy of your program by moving to *File->Save Copy as*. Save the file as a text file. You can add a different extension the *.tap* (pic.20)



pic.20

There is also the option to send the program directly to your machine by using the RS232-option. (you will of course need a RS232-cable). Move to *File->Send* and you will see a dialogbox where you can define the parameters. Check the parameters on your controller, they should be he same (pic.21). By *File->Receive* you may send a program from your controller back to your PC and save it on your harddisk.



pic.21

Simulation

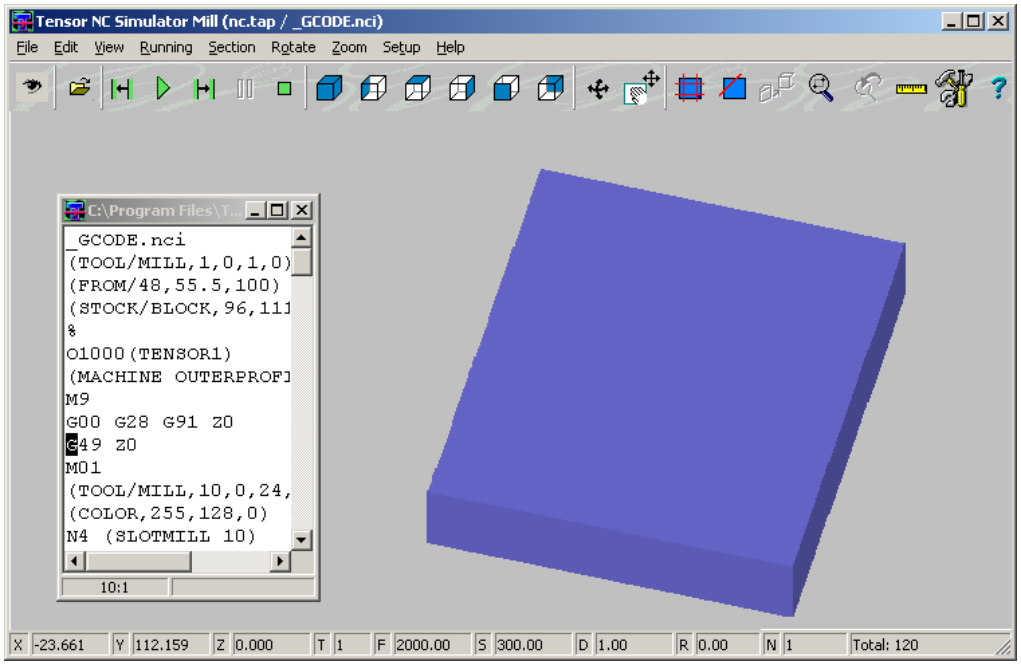
The Tensor NC mill Simulator

The program is now complete. To visualize and check if no errors are made, we can simulate in Tensor NC Simulator. On the far right of you drawing-window there are eye-buttons. Move the mouse to the left eye-button. You will see a balloon with text SIMUL MILL:

By clicking on the left eye-button Tensor will make a copy on the harddsik of the content in the NC-window. We the can import this in the Tensor NC Simulator.

If you did not start up the Tensor NC Simulator, you need to do this. If you followed instructions during installation you will have a shortcut on your desktop. If not read the these instructions at the beginning of this manual (*Installation of Tensor*).
The best thing to do is always start the simulator when you start Tensor. You then only need to click on the bottom of your screen to switch between the two applications.

We now move to Tensor NC simulator. The first button on the left side of the toolbar is an eye-button. By clicking on this button Tensor NC Simulator will load the NC-program you just saved by clicking on the eye-button in Tensor. (The eye-buttons are made for the users comfort, to avoid the user first making a copy in Tensor by moving to menu *File->Save copy as..* and afterwards move to menu *File->Open* ..). If you just did a simulation Tensor NC Simulator will ask you to save a copy. Answer with *No*, to avoid overwriting the copy you just made in Tensor. If you still want to have a copy again click the left eye-button in Tensor.



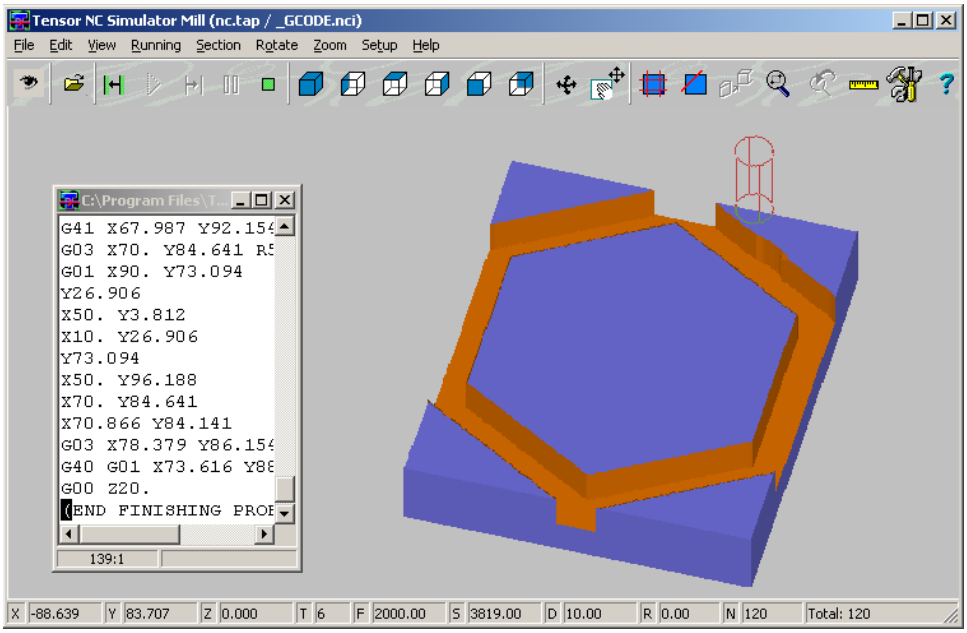
pic.22

Immediately you will see a block representing the stockmaterial (pic.22). These are the dimensions we defined in the startlines. If there is no definition of stock in the NC-code, Tensor will notice and will ask you to enter values in accordance with the NC-program.

Buttons

 **pic.23**

With these buttons(pic.23) we can choose how we want to run the simulation. The third button allows you to simulate the program step-by-step. The second button will give you a complete simulation until the end of the program. Clicking the fourth button will give you a time out. The fifth button will abort the simulation. You can then only start the simulation from the beginning. The first button(rarely used) will take you one step backwards each time you click. The removed material will not return but you will see a line or arc belonging to the NC-path. In this case click on the second button for an automatic run of simulation. The result will then be:



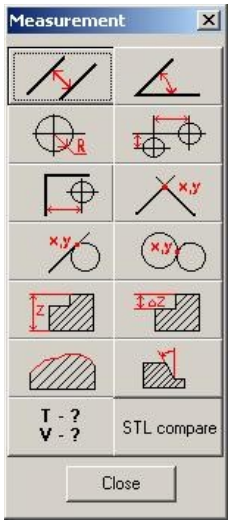
pic.24

Try to run the simulation step-by-step using the third button. For this first click on the fifth button

Machiningtime

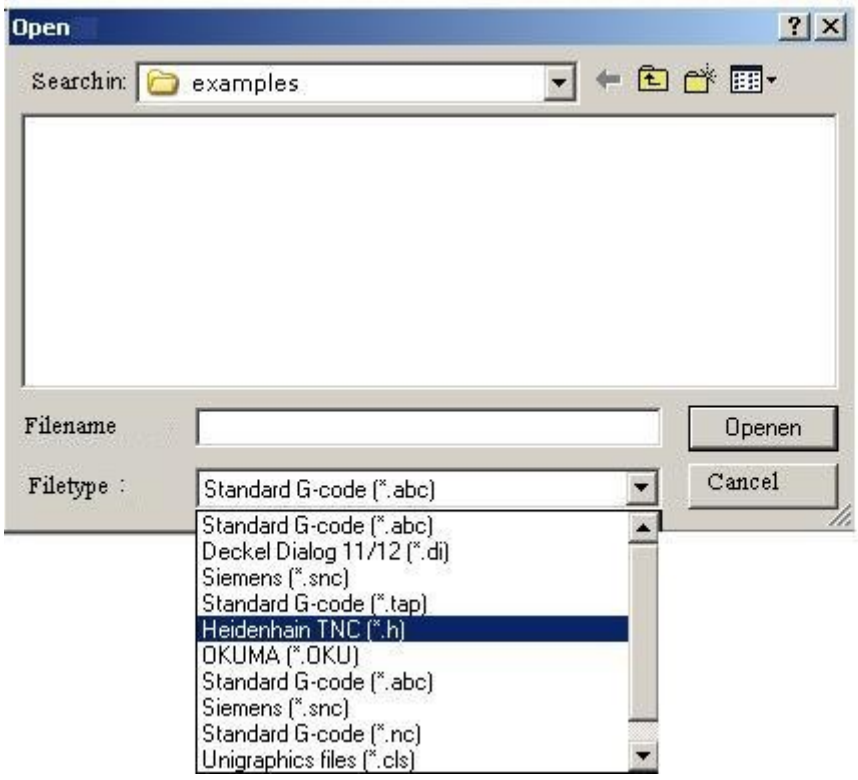
The button with the measuretape allows you to check dimensions on the block after simulation. For example the distance between 2 parallel lines.

But more interesting is the machiningtime. Click on the *T-? V-?* button to see what is being calculated. You may consider this quit accurate as time for toolchange is also included. pic.25):



pic.25

External made programs
Programs not being made in Tensor can also be simulated in Tensor NC Simulator



pic.26

Attention: Be sure the program has the proper extension!!
If you p.e. want to simulate a Heidenhain program be sure to select the Filetype (extension) in this case *Heidenhain TNC(*.h)*:So if necessary change the extension of the NC-program.

Probably tools present in the external program will not be defined for Tensor NC Simulator. But automatically at every tool command you will be able to define the dimensions and color of simulation. You can also move the cursor to a specific line and insert a tooldefinition by clicking the rightmousebutton.

Conclusions
This was an example how to make a program for an outerprofile. What can we highlight here?

Dialog
First, there will be a dialog between the user and Tensor. Tensor will ask the questions and you answer by using your knowledge of machining, tools feedrates etc. This means Tensor will do the unpleasant work (calculating) and you will always be in control.

Startlines
In the startlines dimensions of the stock are defined which are later used in the Tensor NC Simulator.

Load tool
When loading a tool the user can select form a tool library. The library can be changed and you can insert tools you use in your shop. Every tool can have its own color of simulation to improve the view while simulating. Code between brackets represent the tool dimensions and color. In the other NC-jobs in the *NC-jobs* menu loading a tool will be done in the exact same way as is shown in this example. But it can differ for different controllers. P.e. in Heidenhain you need to enter values for DL- and DR-, which you don't have to do in Fanuc. Furthermore Tensor can calculate feedrates and spindle speed. If you do not select a new tool the last used tool will be the active tool.

Cuttingconditions
Through dialogboxes with pictures the user will know what the parameters represent. You may decide to do a finishing using a different tool. After entering these values NC-code is automatically being generated in the NC-window. Where necessary you will see comment in your program.

Simulation
After entering endlines the program can be simulated by clicking the left eye-button. Tensor will save the content of the NC-window which you can import into the Tensor NC Simulator by clicking the eye-button. Machiningtime is presented.

Attention: At any given time you can do a simulation of generated NC-code, the program does not have to be completely ready. Let's say you want to a drilling job after profiling. You can first simulate the profiling and then continue with a new job.

Other NC-jobs

We will briefly describe the other options in the *NC-jobs* menu and the other menus.

Startlines
Startlines are being generated for each available postprocessor

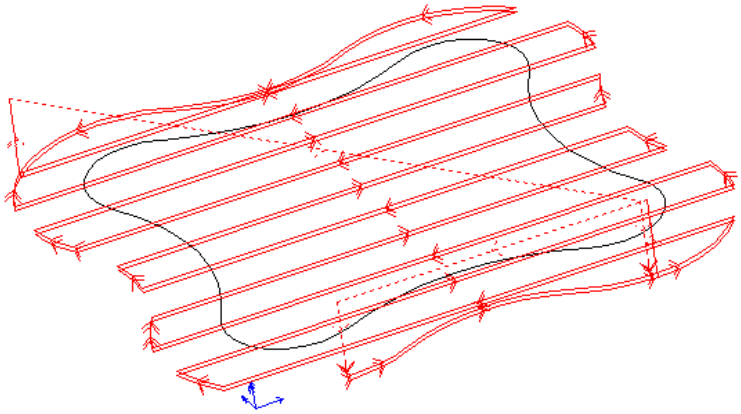
Endlines
Endlines are being generated for each available postprocessor

NC simulation
This is the same function as the left eye-button.

Call subprogram
NC-code is being generated to call or define a subprogram. This is only activated for a few postprocessors (for example Acramatic).

End subprogram
NC-code to define end subprogram. This is only activated for a few postprocessors (for example Acramatic).

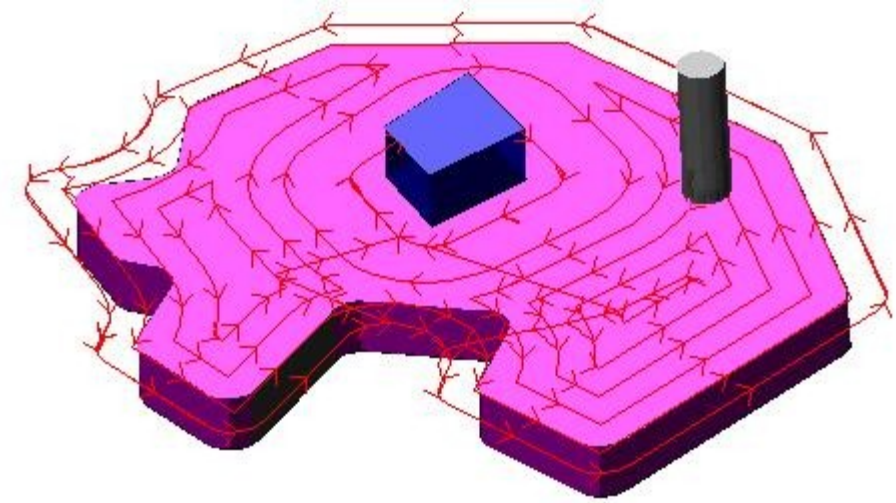
Facing surface



pic.27

By selecting a closed chain a clean surface-job is being generated. Tensor for example will ask the user to enter on which Z-level the job starts. This can be Z=5 with a depth of 5 mm which will result into surface on Z=0. Watch *facing.avi*

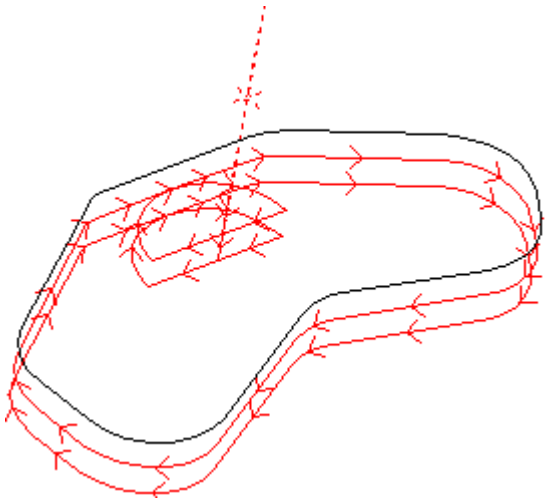
Clean profile from block



pic.28

You will frequently use this option. It allows you to machine a defined part from defined stock material. The stock material is defined by a closed chain you need to draw. Be sure the profile lies within the chain of stock material.
ATTENTION!
The profile of stock material must have a specified *layername*. This name should always(!) be **#** , so Tensor will be able to recognise this as stock material. Be sure that beside the elements of this profile no other elements have this *layername* **#** !!
The profile can be finished as well as the bottom with, if so desired, a different tool. When selecting the profile the user already determines the direction and order of finishing. Watch *cleanprofile.avi*

Machine inner/ outerprofile

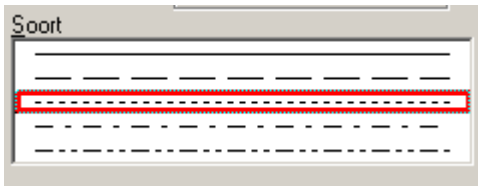


pic.29

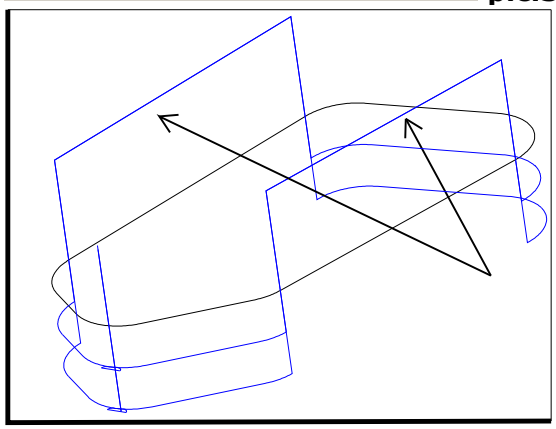
Inner and *outerprofile* are besides the approach direction exactly the same. It is possible to generate a finishing job with, if desired, a different tool. When selecting the chain the user defines direction and on which element the approach will be defined. Watch *innerprofile.avi*

Clamp or microjoint

Tensor allows you to define positions(lines) in the profile to lift the tool if there are clamps holding the part. By changing these lines into dashed lines, Tensor will recognize these positions. Be sure to choose the correct linetype (type 2). Look at pic.30 .

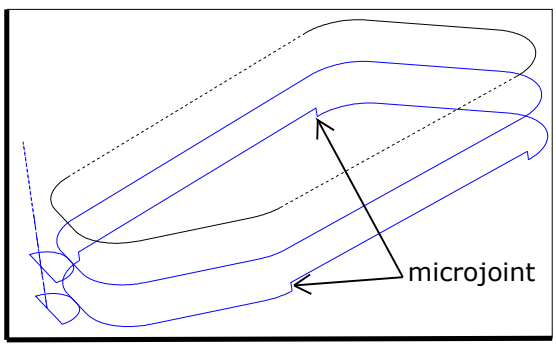


pic.30



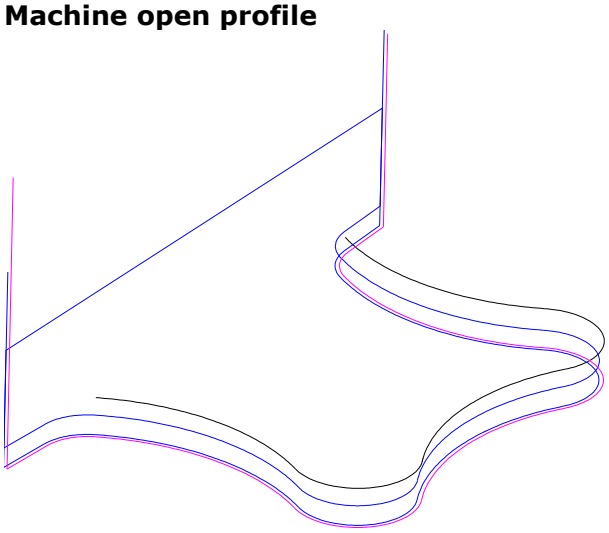
pic.31

Besides lifting the tool over a clamp Tensor offers you the option to leave a thin part of material. This by lifting the last cut in Z on the specified dashed lines. This might come in handy if there are no clamps to prevent the part being moved. For example you could leave 0.5 mm of material and later after machining use a hammer to remove the part from stock material. Therefore we will call them *microjoints*. (pic.32)



pic.32

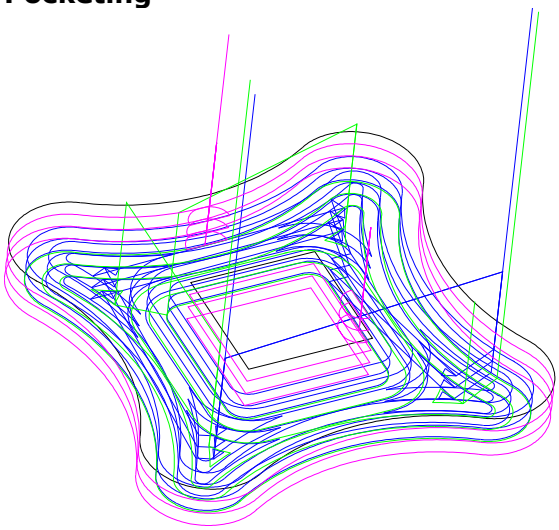
Machine open profile

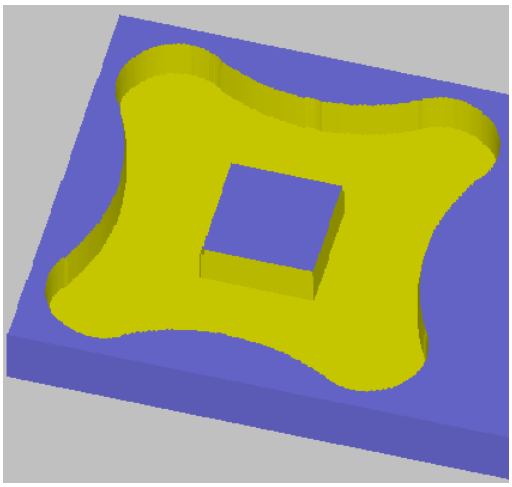


pic.33

An open profile is treated a little bit different compared to a closed profile. There is an option to machine using toolcompensation while this is standard in a closed profile. Furthermore after each step the tool is being lifted to return to startposition and plunge. Watch *openprofile.avi*

Pocketing





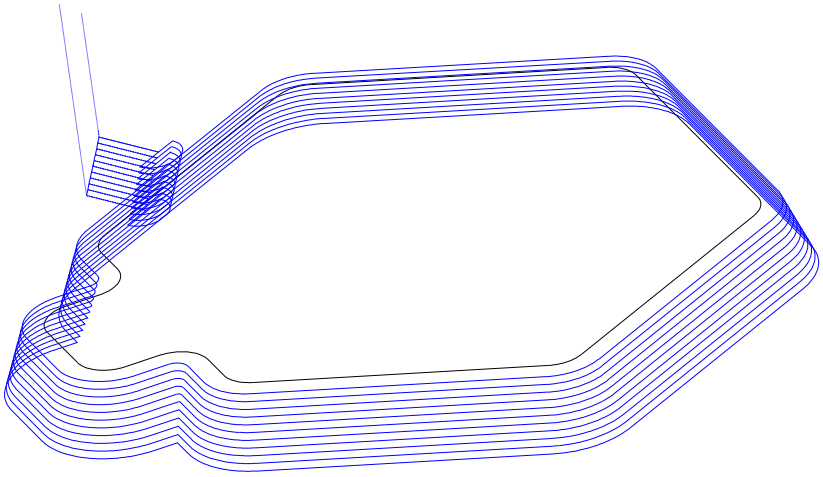
pic.34

Pocketing is an extended feature in Tensor. A number of profiles can automatically be pocketed. Each profile may contain islands, as long as they are completely situated within a outer profile. Each profile, island and bottom can be finished if so desired. It is possible to generate a drillingcycle at each startpoint of a toolpath, if so desired.

ATTENTION!
Be sure to take the following two remarks in account:
1. If you want to pocket with islands be sure that all island-profiles have the layername : **$**
Be sure that beside the elements of these profiles no other elements(!) have the layername **$**
2. The direction of the island-profiles should be opposite to the direction of the outerprofiles:

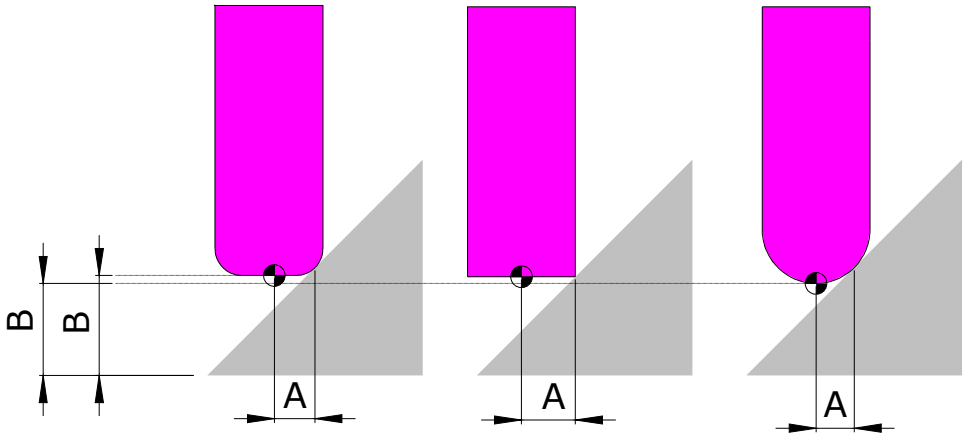
When selecting the chains, the user defines direction and on which element approaches will be defined. This is always on the middle of the first element. Watch *pocketing.avi*

Conical closed profile



pic.35

This option allows you to machine and finish a conical surface. You can define several types of tools, like flatend mill and a bullend mill. After all, for a bullend mill the reference point will be on a different Z-level than a flatend mill when intersecting with conical surface. See pic.36



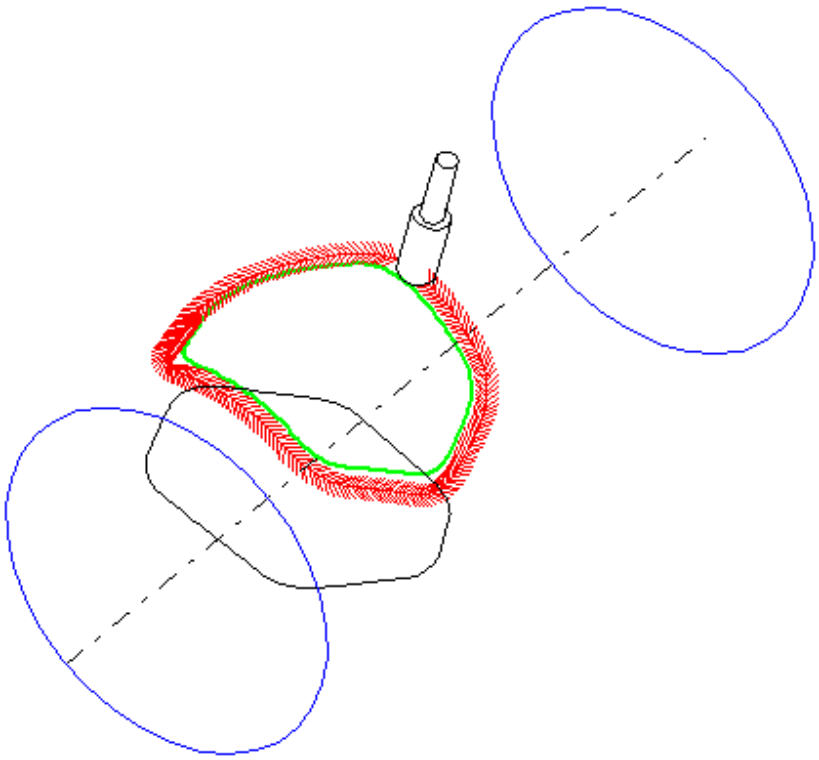
pic.36

In file *conic.avi* you may take a closer look at this option

Exercise: Try do make a toolpath opening drawing *conical profile.ccd*

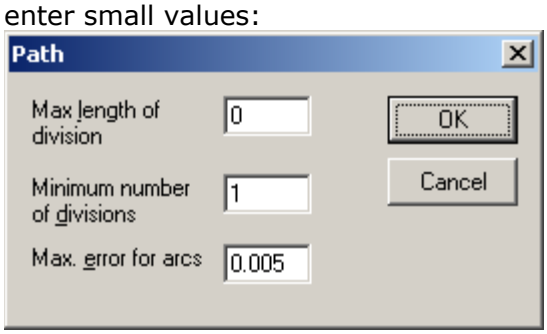
Convert toolpath to NC-code
If you have already defined a toolpath without using any options in the NC-jobs you can convert this into an NC-program by using this option. Tensor will ask you to define a tool and if you would like to use toolcompensation, and will then convert the toolpath directly into NC-code. You can also use this option to convert a toolpath(geometry) generated by one of the options in the *NC-job.* Watch *convertpath.avi*

Convert 2D profile to 4-Axes on cylinder



pic.37

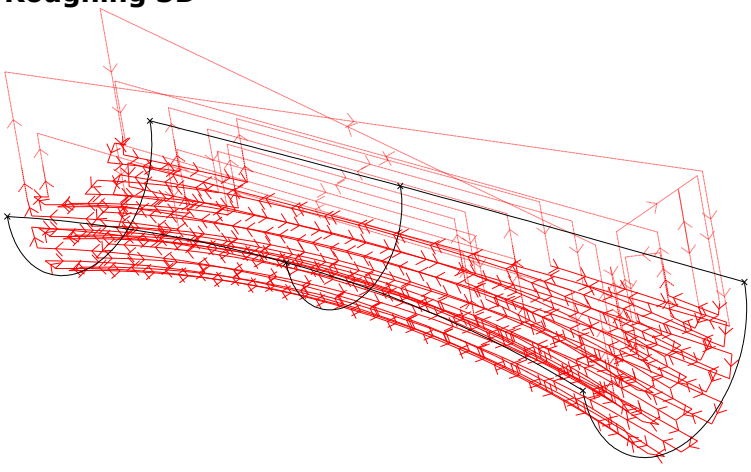
This option allows you to wrap a 2D profile around a cylinder. Not only the diameter of cylinder needs to be defined but also the tooldiameter. If the exact profile needs to be wrapped, the toolpath needs to be corrected in a fourth axis. Tensor therefore will generate a 4-axes program. To get an accurate result the profile needs to be divided into small lines. For this move to menu *Change->Break->Interpolate*. To get an accurate result don't hesitate to enter small values:




```
G01 X89.483 Y2.623 A-12.177
G01 X90.145 Y2.318 A-11.108
G01 X90.718 Y2.002 A-10.003
G01 X91.2 Y1.675 A-8.866
G01 X91.588 Y1.341 A-7.703
G01 X91.881 Y0.999 A-6.521
G01 X92.076 Y0.653 A-5.324
G01 X92.174 Y0.304 A-4.12
```

Watch *profile4axes.avi.*

Roughing 3D



pic.38

For more information about this feature read chapter *3D milling in Tensor.*

Machinecycles
In this feature you can use all cycles available in a controller. Most common used cycles are in ISO-controllers G81,G83 etc. For Heidenhain this may vary from CYCL 1, CYCL2 to CYCL 210 etc. For this feature you need to select one or more points which represent the location on which the cycle is being executed. Watch *cycle.avi*.

Submenu Tensor cycli

In this submenu you may find several features you will probably often use. For example rectangular pocketing slotted hole or to engrave text on an arc.

Profile /cycles X-C
Here you can generate a multi-axes program for a multi-axis lathe-machine. This can be a profile. The program will not contain X and Y, but X and C-values. Also for cycles you will see XC coordinates. The C-value represents the angle of rotation for the Z-axis.

Menu Tool

This menu contains three items:

Load Tool
With this option you can load a new tool at any required moment outside an NC-job. You will notice the same dialogboxes will appear as when you load a tool during an NC-job.

Show current tool
This allows you to check which tool is active on that particular moment.

Calculate spindlespeed and feedrate
This option allows you to calculate a spindle speed and feed. Tensor will use the new calculated values.

Menu Heidenhain
Most options available in the *NC-jobs* menu are to be found here as well. But in this menu Tensor will generate NC-code by using the LBL-function used in Heidenhain-controllers. This will shorten the NC-output and will give the user a better overview on the NC-program. There are some more options to manually generate specific Heidenhain-codes.

Menu Lathe
For this we refer to chapter *NC-programming for lathe*.

Menu Geometry

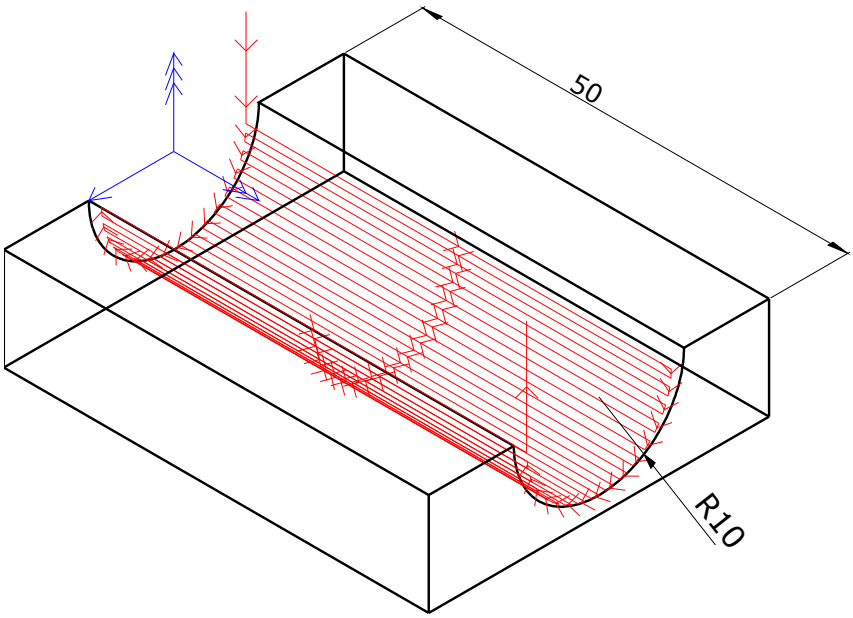
Geometry Data
By selecting one or 2 elements Tensor will show data for these 2 elements. For example the distance between parallel lines or an angle between lines, distance between 2 arcs etc. The quickkey is *D*.

Check profile on small arcs
This feature will check if there are very small arcs present in a profile. If the length of these little arcs are smaller than 0.001 mm they are removed from the profile. The CNC-controller will see the start- and endpoint as an equal point. The chance is 50% the controller will generate a 360 degrees arc on you part. So that's why the *dangerous arcs* are being removed.

3D Milling in Tensor

Tensor is able to generate an NC-program for single- and doublecurved surfaces. These are being defined by cross- and longitudal sections. By working through several exercises in this chapter you will learn about features generating a 3D-program.
These features you may find in menu *3D*.

Path and Skin

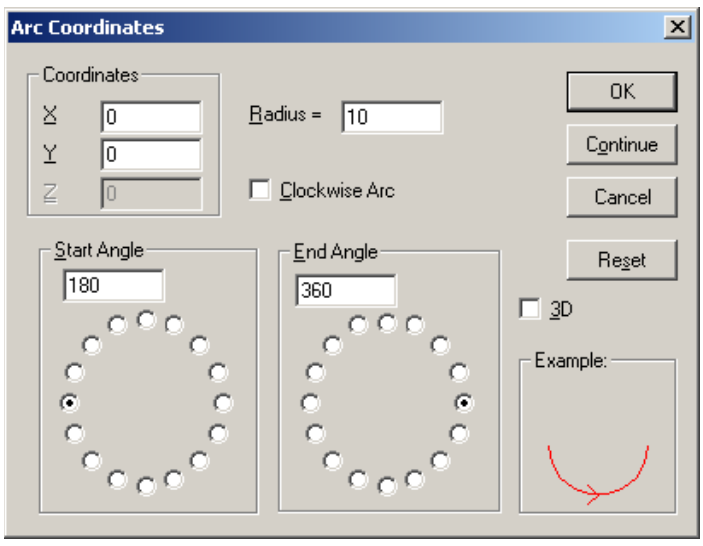


pic.1

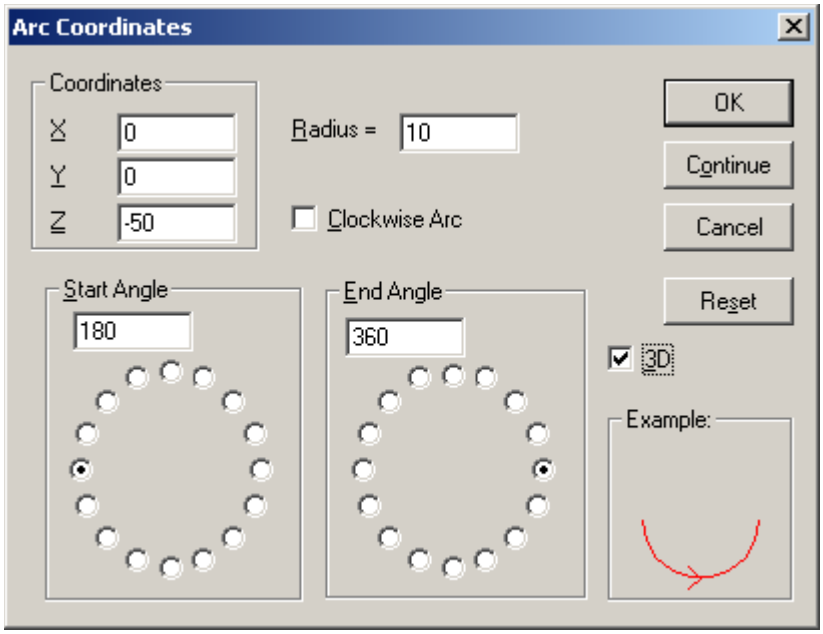
Exercise: Draw and generate an NC-toolpath for cavity in pic.1

Define 3D geometry
By following the instructions you will construct the cavity as in pic.1:

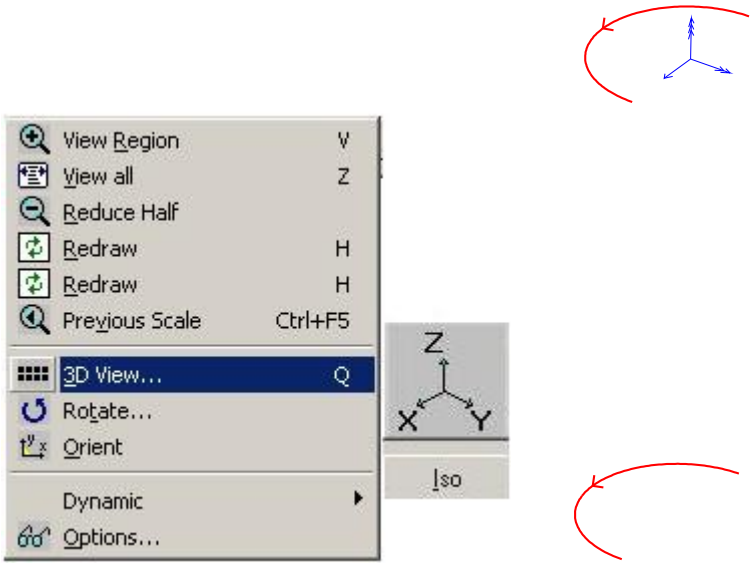
1. *Draw->Arc- >Coordinates* and enter :



2. Repeat this but now enter -50 for the Z-coordinate. To be able to enter a Z-value you have to activate button 3D on in the dialogbox:



3. Move to menu *View->3D View* and select *ISO-view* (quickkey Q):

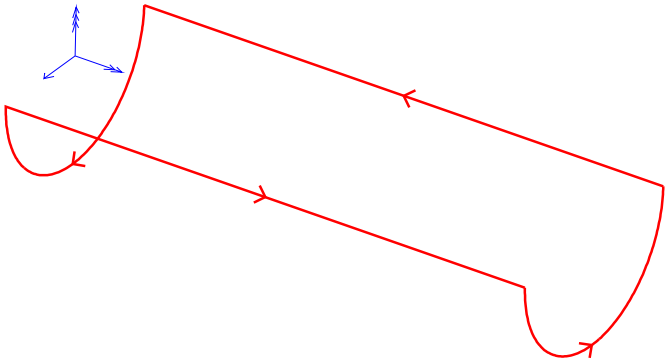


pic.2

4. We will now rotate the two arcs around the X-axis to get them in right position. If the two arcs are selected we move to *Edit->Cut*. With *Edit->Paste* the arcs are being pasted back into the drawing by entering 90 at *Rotation X* with this result:

pic.3

5. Select the arcs in opposite directions, activate the *Closed Chain*-button and move to *Draw->Line->Connect:*

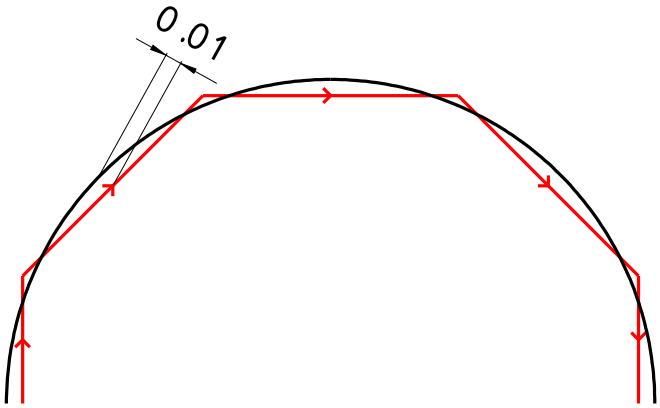


pic.4

As mentioned you can imaginary define a surface between sections (skin). Then you will be able to generate a toolpath for this surface. In this example the lines are longitudal-sections and the arcs the cross-sections (vice-versa is also possible)

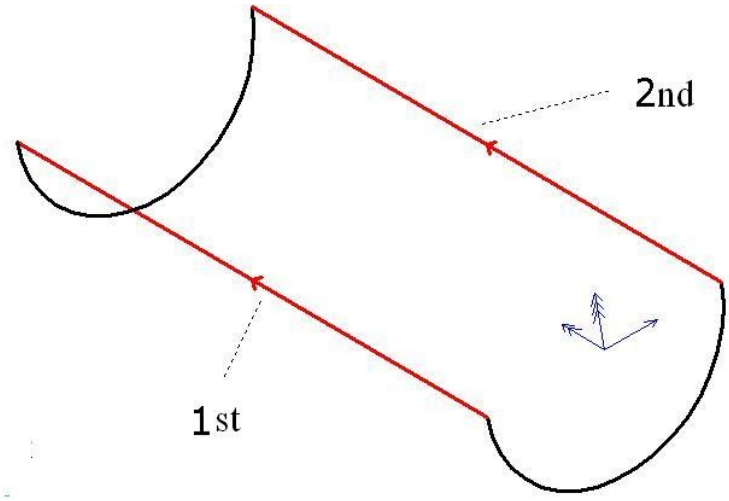
Generate 3D toolpath

In menu *3D* you will find feature *Set Path* and *Skin*. *Set Path* defines the accuracy with which Tensor will approach the arcs. This because the toolpath will only contain (small) lines representing the arcs from the sections. If the longitudal sections also contain arcs (not in this example) they will be approached by lines. (pic.5). The deviation of the arc/lines is determined by three criteria:
a) Max. length of division,
b) minimum number of divisions and
c) max error for arcs.



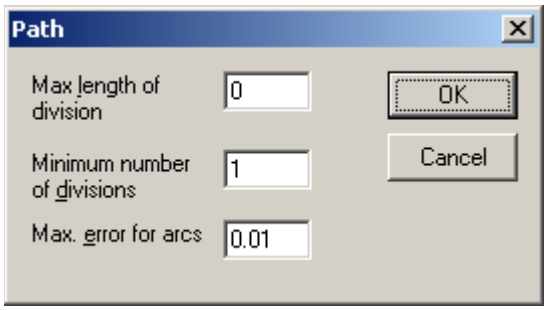
pic.5

6. Select the two lines in direction and order as shown in pic.6.



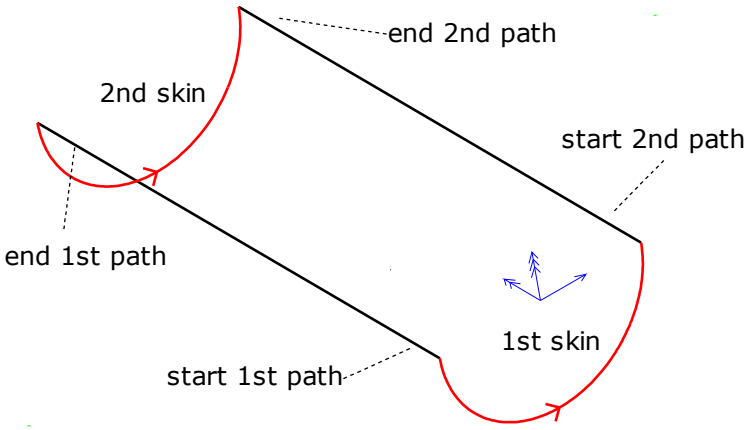
pic.6

7. Then move to menu *3D->Set Path* and enter values shown in pic.7 and click *OK*. In this example Paths only contain lines. This means the last criterium does not apply in this case and therefore option b. is deciding



pic.7

8. *Deselect* the lines. We will now select the cross-sections (*skin*)
Attention: Be sure to select in the right *order* and *direction*. (see pic.8). The 1st *skin* starts where the first *path* starts and ends where the last *path* ends (in this case the second). The last *skin* (in this case the second) starts at the end of the first *path* and ends at the endpoint of the last *path* (in this case the second).



pic.8

9.
Now move to menu *3D->Skin*.
In the dialogbox you can enter several parameters to determine the final toolpath:

Tool
You can define for what tool you want the toolpath to be generated.
In this case we select a bullend mill diameter 4. Leave the E-value 0. This means you enter a slotmill if the E-value equals the diameter value.

Accuracy
Here you will find option "*Max. distance between lines*". The smaller the value the smaller the *scallop-height* on the end-result will be. We enter a value of 0.1 mm. Tensor will show approximately how many lines the toolpath will contain.

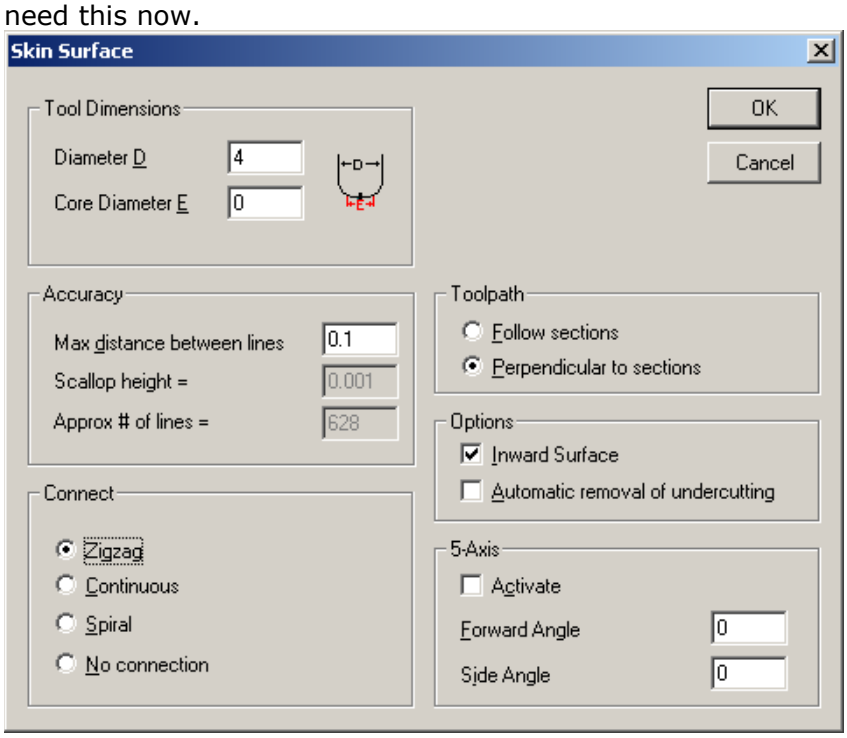
Connect
You can select a strategy. *Zig-zag* means the tool will then climb cut and then upper cut the surface. Select the *Zig-zag* option.

Toolpath
In this case the toolpath will be generated in direction of the two arcs as they are the *skin* sections. We prefer direction of the lines (*Paths*) and therefore select *Perpendicular to sections*.

Options
As we are machining a *cavity* we will activate *Inward surface*.

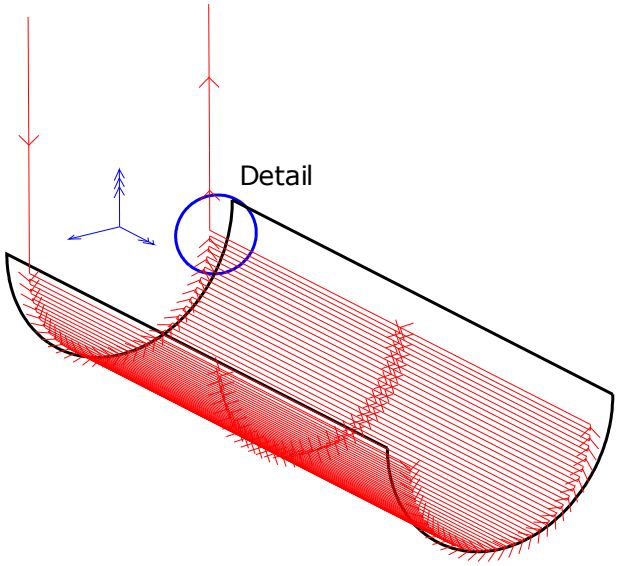
5-Axis

By activating this option Tensor can generate 5-Axis simultaneous movements. We don't need this now.

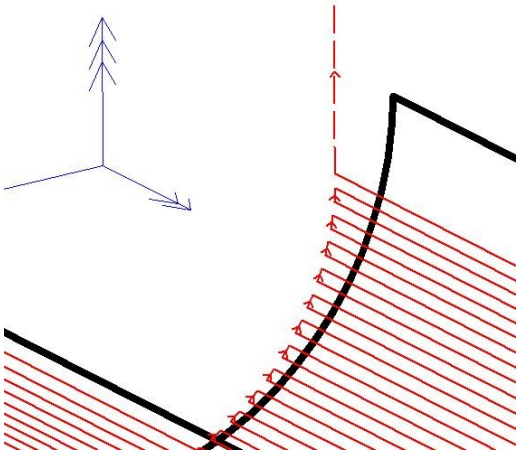


pic.9

Enter values as shown in pic.9 and click *OK.* The result is the toolpath in pic.10. A detail of the toolpath is visible in pic.11:



pic.10



pic.11

Here Tensor generates one long toolpath containing 628 lines.

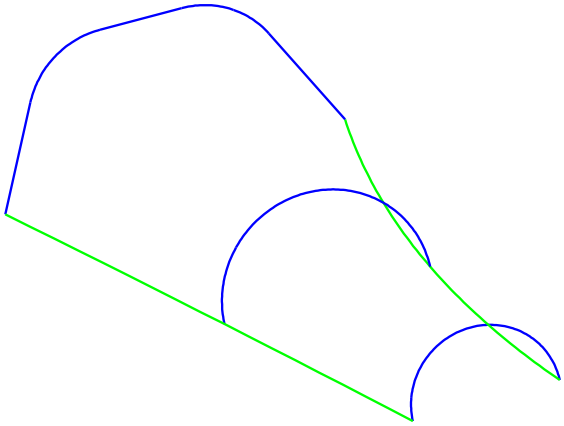
Exercise: *Undo* the Skin-action and try to enter different values to see what kind of more strategies Tensor can offer you.

Convert to NC-code

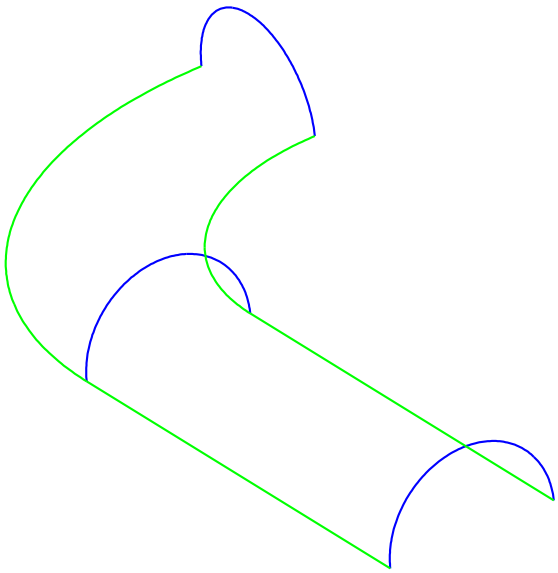
To convert the toolpath into NC-code, use feature *Convert toolpath to NC-code* in menu *NC-jobs*.

You can watch this example in video *3D-a.avi*. Drawing *3D-a.ccd* contains the original sections geometry.

Some more examples



pic.12

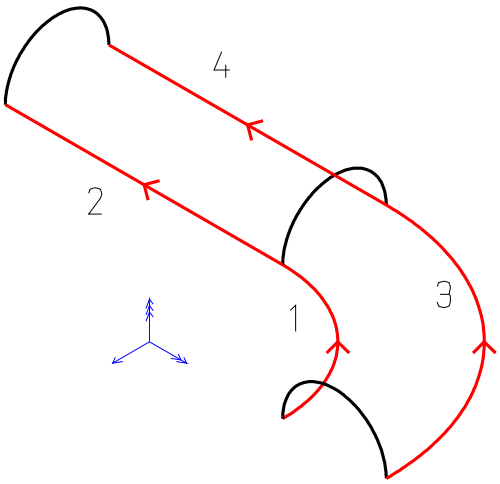


pic.13

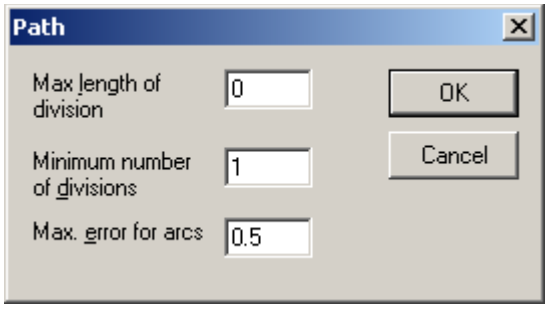
Pic.12 and pic.13 are two more examples of 3D parts. For pic.12 you can open drawing *3D-b.ccd* and watch video *3D-b.avi*. For pic.13 this is *3D-c.ccd* and video *3D-c.avi*. You can see that the number of sections is infinite. However, the paths must contain an equal number of elements. This doesn't apply for the skin sections. And considering direction and order, remember the remarks made in **8.**
Exercise: Try to make the toolpaths demonstrated in the videos, or define your own 3D-part.

3D Roughing

In Tensor you can define a roughing-job. As example we will take the part in pic.14 also to be found in drawing *3D-c.ccd*. First we will define a toolpath using *Set Path* and *Skin*. Only this time the toolpath will not be very accurate as we are merely roughing. This toolpath we will use as input for *Roughing 3D*. Open drawing *3D-c.ccd* and select the four elements as you can see in pic14. These elements will be our 2 paths with the values in pic.15 .

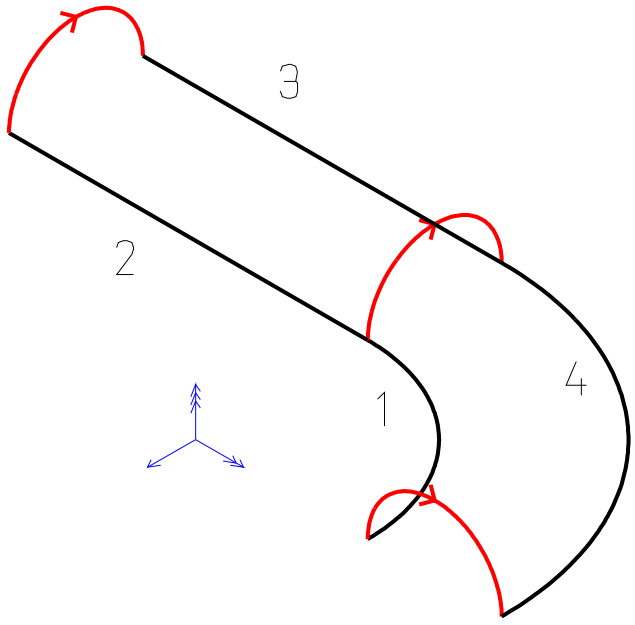


pic.14

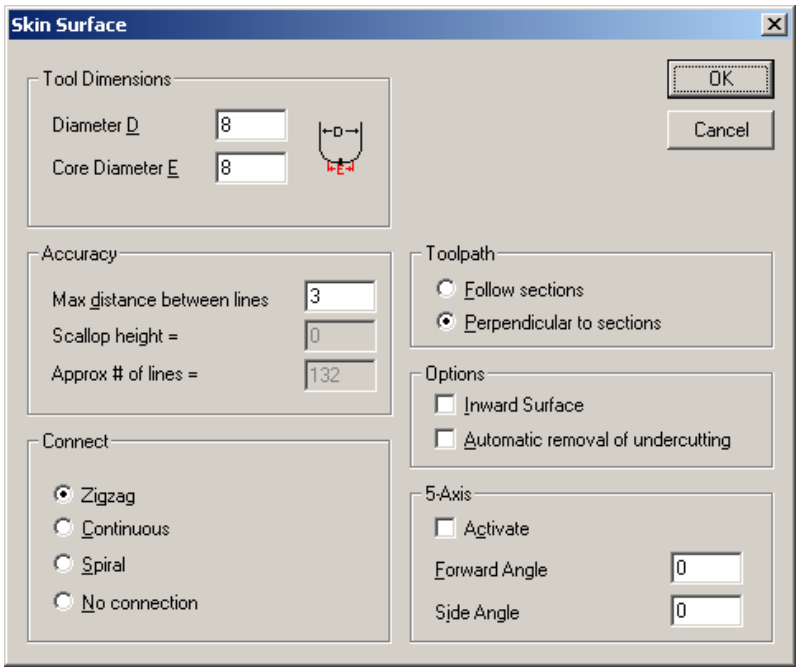


pic.15

We will now select the skin sections as in pic.16 and enter values as in pic.17:

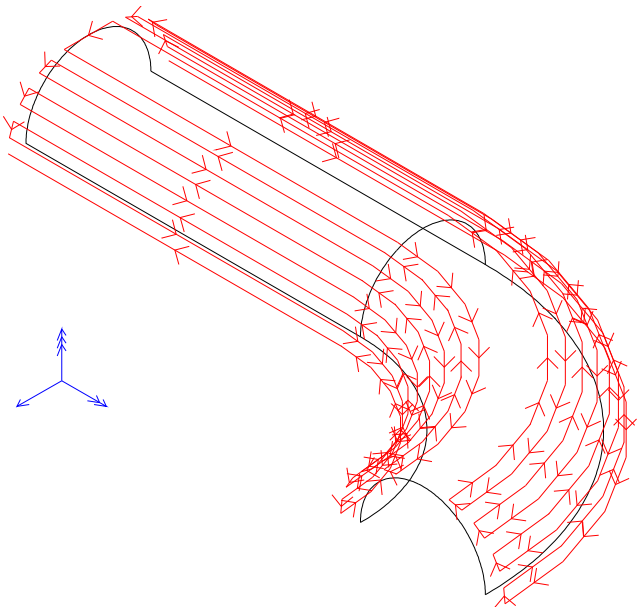


pic.16



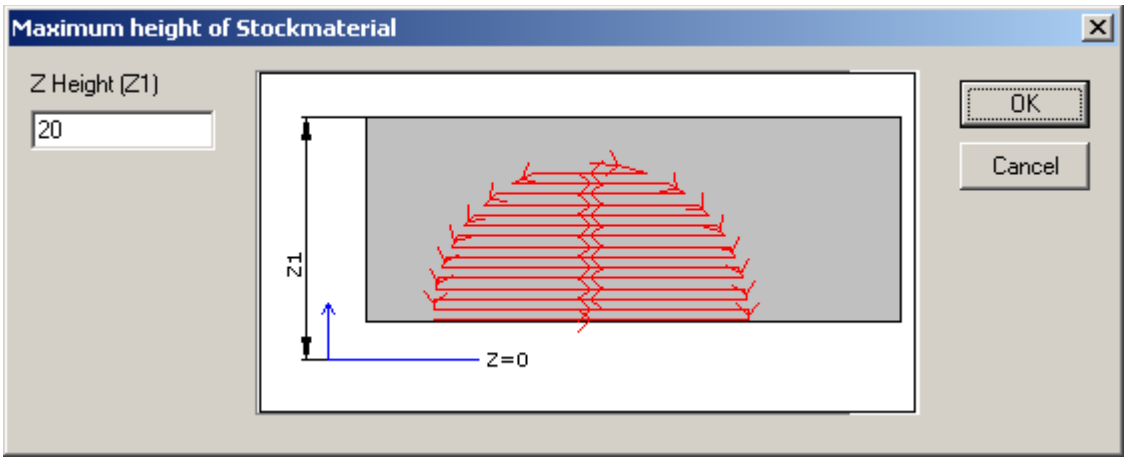
pic.17

We will use a slotmill 8 to rough this part. The result of this *Skin-operation* is the toolpath in pic.18:

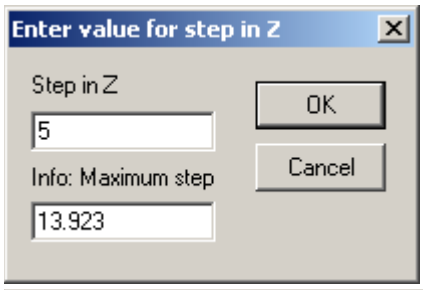


pic.18

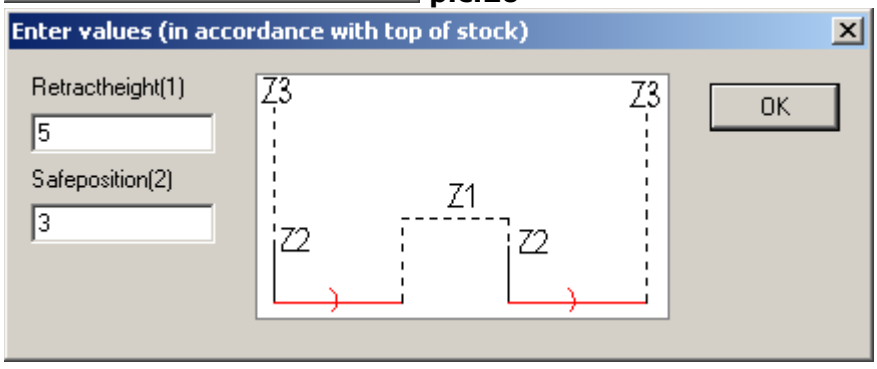
This path is one chain. After selecting this chain we move to *NC-jobs->Roughing 3D* roughing and will define the complete roughing toolpath. There will be several parameters we need to define concerning stock material (pic.19) and depth of cut (pic.20). Enter Z-height 20 mm and step 5 mm .Also we need to enter values to plunge and retract form stock material (pic.21):



pic.19

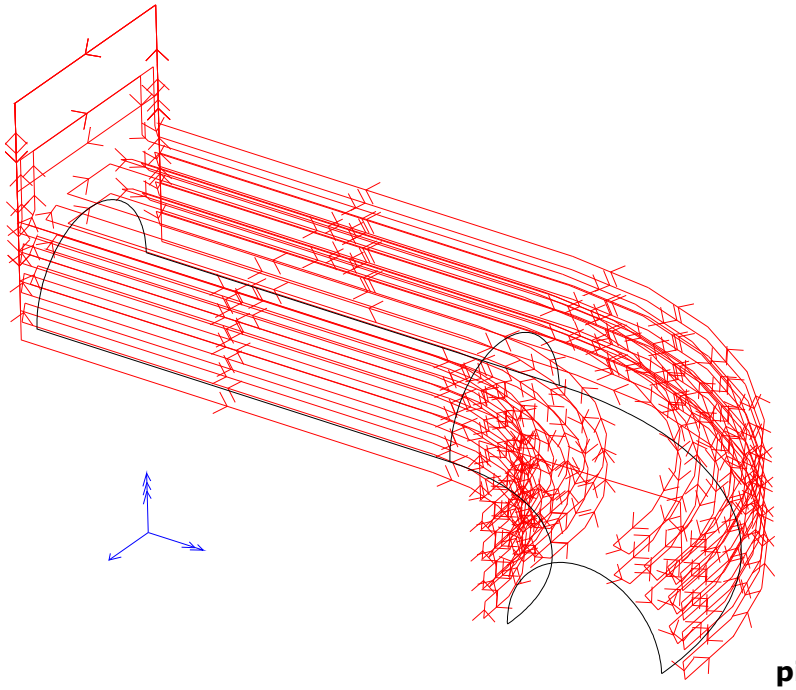


pic.20



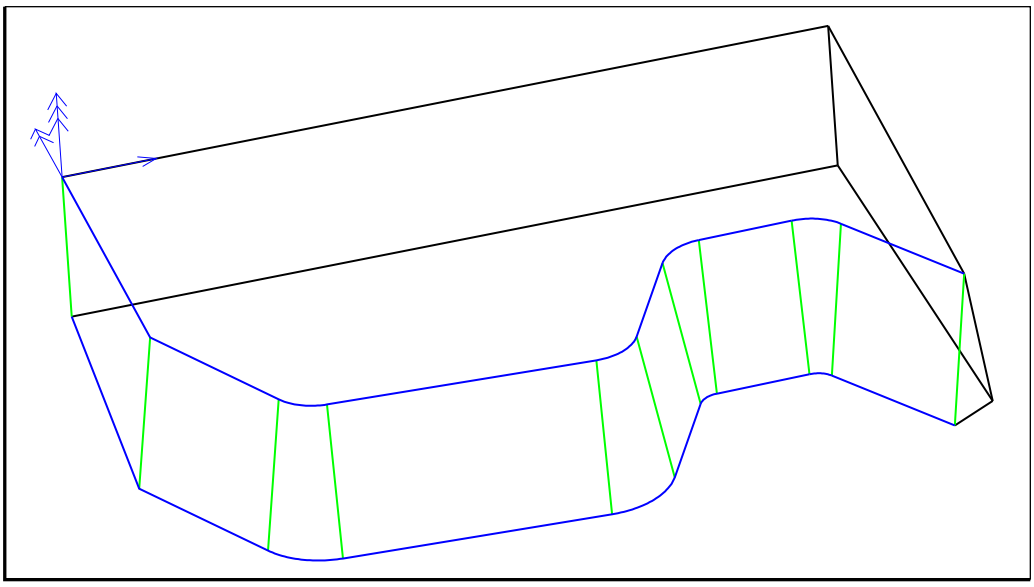
pic.21

The output of this NC-job will be the toolpath in pic.22. Using Convert toolpath to NC-code in menu NC-jobs you may convert this into NC-code. This is also demonstrated in *3Droughing2.avi*.



pic.22

Open a 3D –wireframe

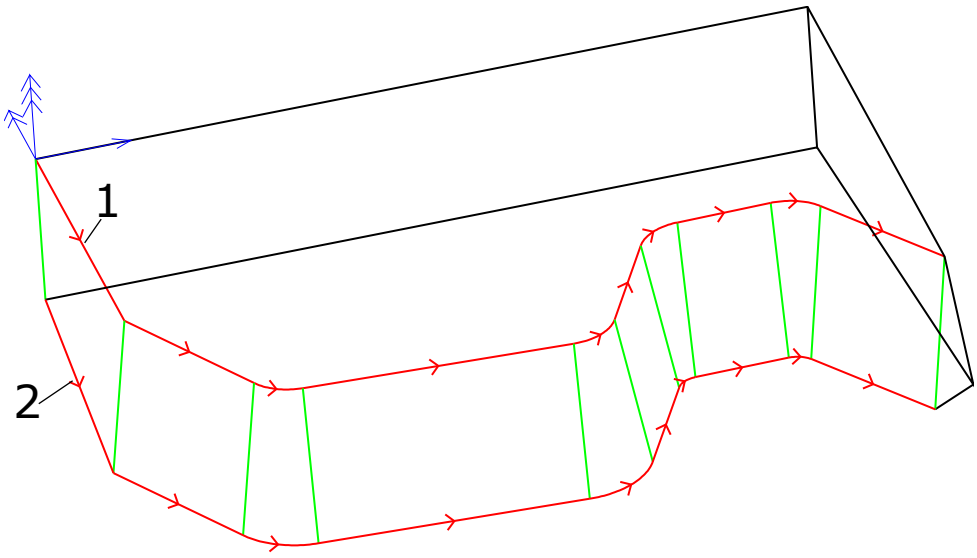


pic.23

Today, more and more you receive digital drawing of parts you need to make, like Dxf and Iges-files. These 2 formats you can import into Tensor. A 3D model you will usually get in Iges-format. This will give you an advantage that Tensor directly converts the part 1 on1 into a 3D-wireframe in the drawing-window, from which you may define *paths* and *skins*. (pic.23)

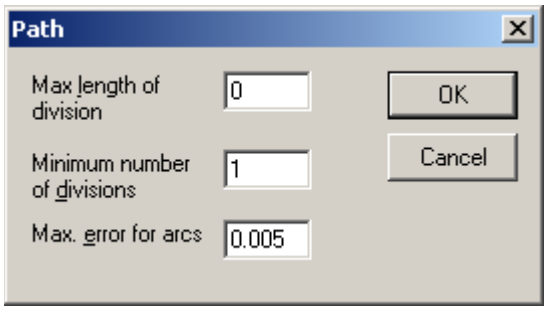
Exercise: open file *Iges.igs* in Tensor

Activate the *Default* 3D-view in menu *View->3D View* (quickkey *Q*). We will use the Path and Skin features to get a quick result. Select the two chains as shown in pic.24. (first select the upper chain) so the toolpath will start from the top.



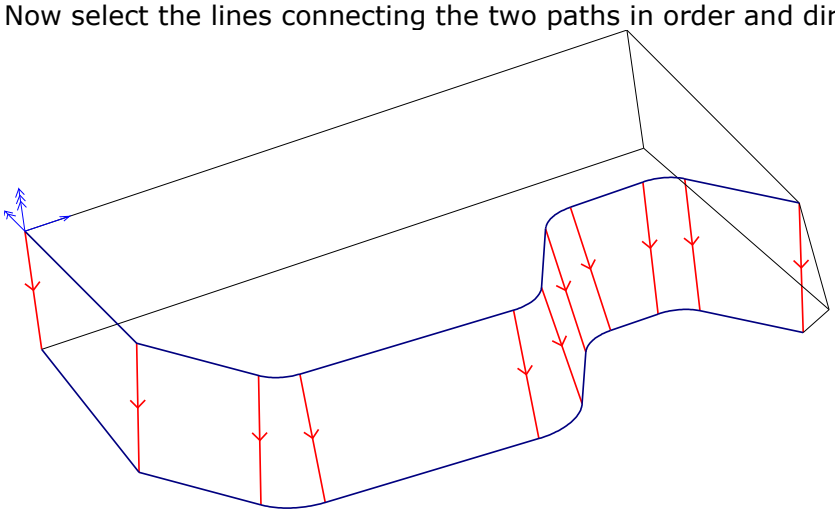
pic.24

Now define the paths in menu *3D->Set Path.* By entering 0 and 1 for the first two parameters we will limit the number of lines in the toolpath as for one line from the path we only need one NC-line. The deciding criterium here will be the accuracy of the fillets. (pic.25)



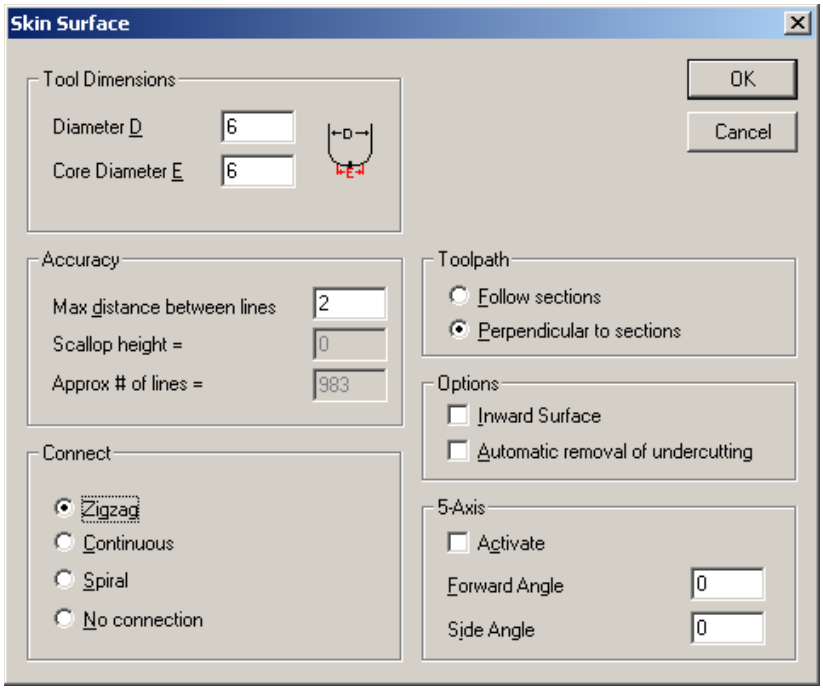
pic.25

Now select the lines connecting the two paths in order and direction as in pic.26 .



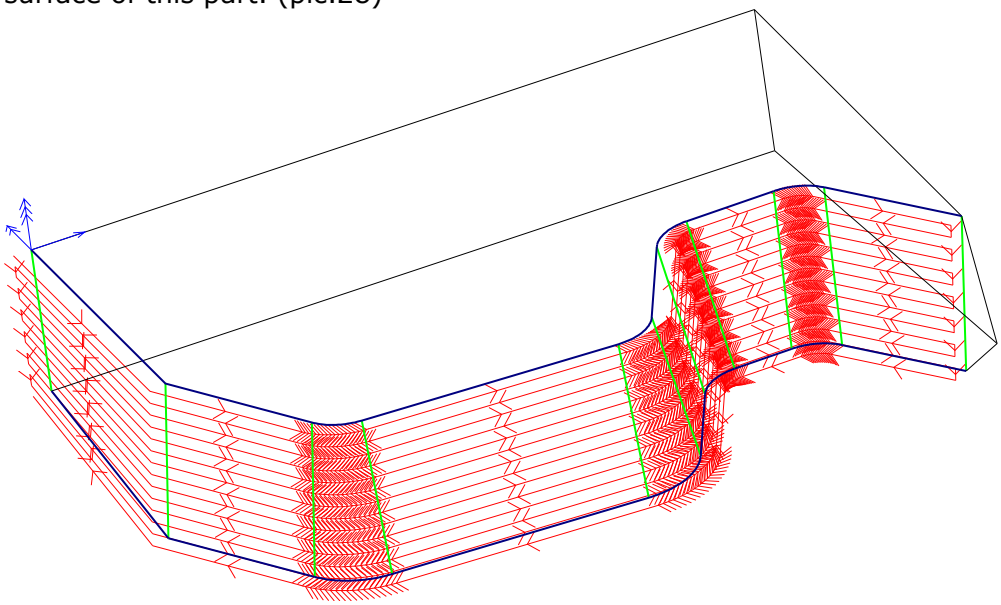
pic.26

Now move to menu *3D->Skin* and enter the values form pic.27:



pic.27

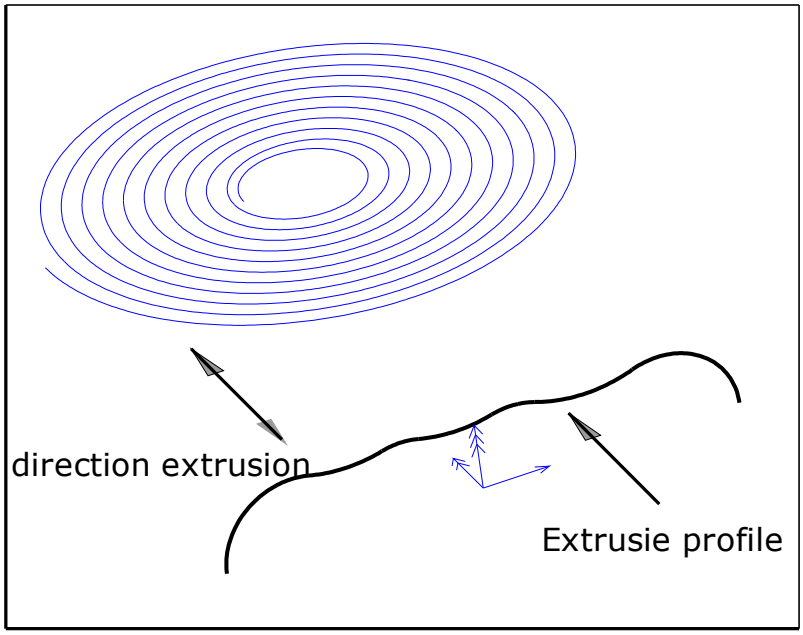
The tool will lower 2 mm per layer and the result will be a zig-zag toolpath along the surface of this part. (pic.28)



pic.28

You can also watch video *Iges.avi*.

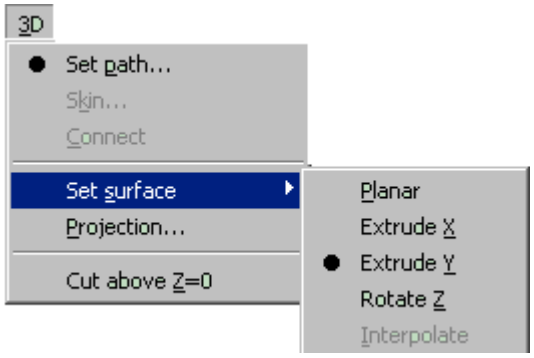
Extrude



pic.29

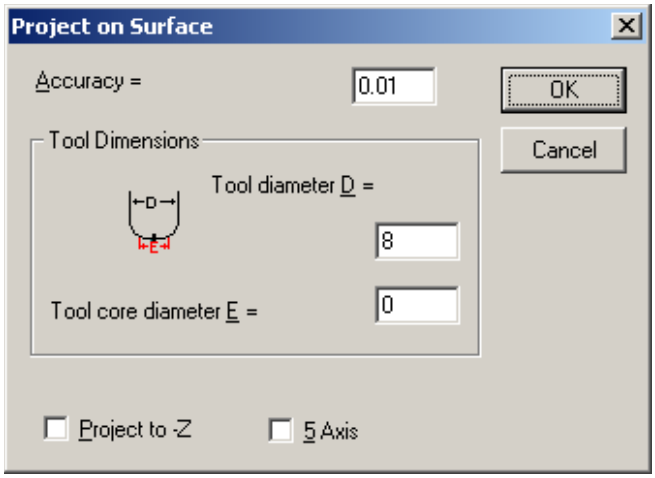
In this example we will project the spiral on a single curved surface. By imaginary extruding the profile in Y-direction we will define the surface, on which the spiral will be projected.

Exercise: Open drawing *extrude-y.ccd*
Select the profile an move to menu *3D->Set Surface->Extrude Y*. (pic.30)



pic.30

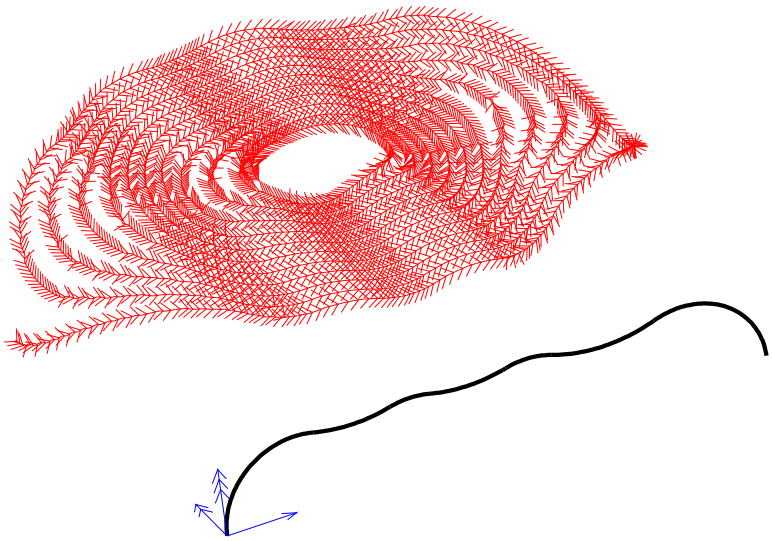
Tensor will now save the imaginary surface in its memory by extruding the profile in Y-direction. The profile will automatically be deselected.
Now we select the spiral using the left-mousebutton and the *SHIFT*-key and move to feature *Projection* in menu *3D*:



pic.31

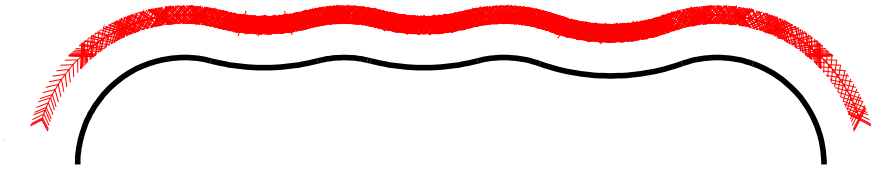
The dialogbox from pic.31 will appear. Several parameters can be defined. First the accuracy of projecting on the surface. We set this to 0.01 mm. The generated toolpath depends on what tool we will use. A ballmill will intersect the surface on a different point than a slotmill will do. Tensor will calculate this for you. This means if you enter a value 0, the result will be a toolpath that exactly lies on the extrude surface as no correction is required with tooldiamer 0. We will define a ballmill of 8 mm.

Option *Project tor -Z* we will not activate in this case. This means we will get a toolpath where Tensor presumes the tool starts from above the surface. If we activate this option it's presumed the tool will approach from below the defined surface. The result you can see in pic.32.



pic.32

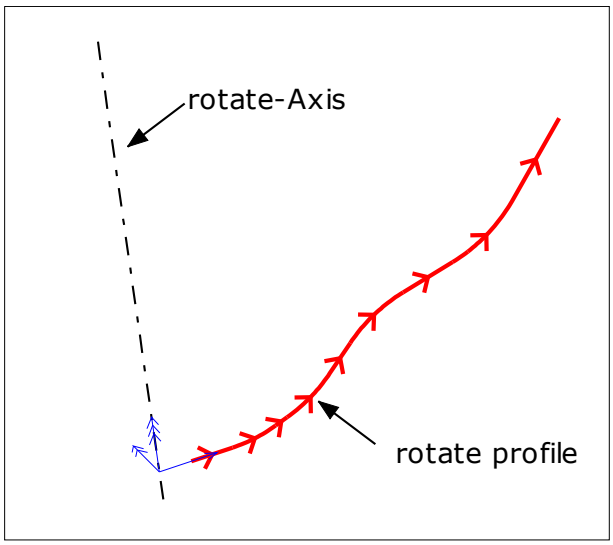
The path contains small lines. To imagine how the result will be look at the *Front View* (pic.33).



pic.33

You can also watch video *extrude-y.avi*.

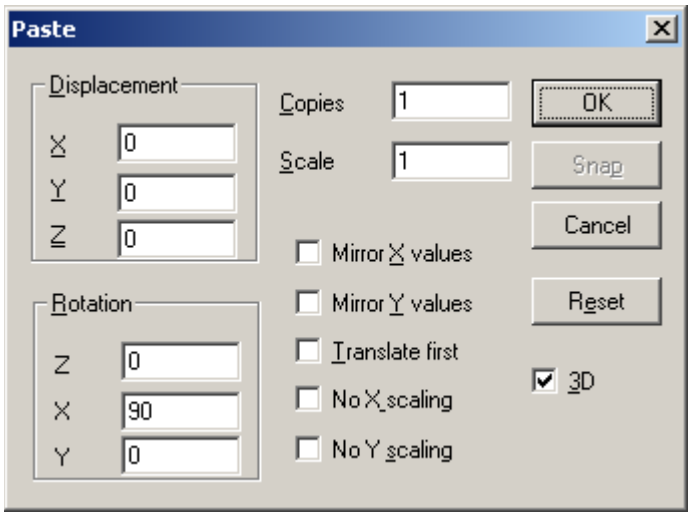
Rotate Z



pic.34

By rotating the profile 360 degrees around the Z-axis (rotate-axis) Tensor will create an imaginary surface. (see pic.34)

Exercise: Open drawing *rotz.ccd*
Select the profile as in pic.34. This profile lies in the XY-plane/ To rotate it around the Z-axis we need to rotate it first 90 degrees over the X-axis so it will lie in the XZ-plane. Move to menu *Edit->Cut* and then *Edit->Paste* this by entering 90 degrees in *Rotate X* (pic.35).

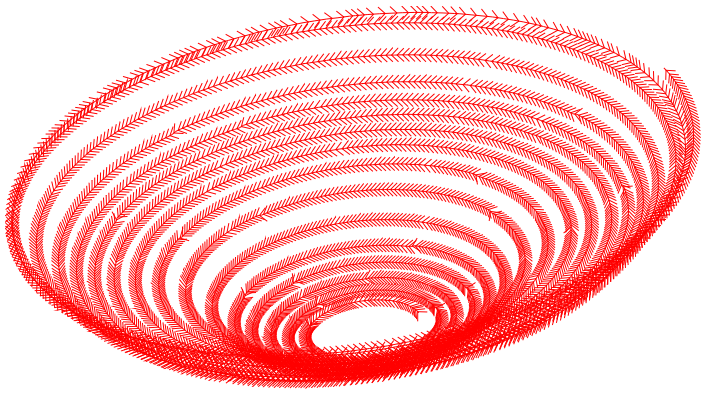


pic.35

The profile now is in the right position to the Z-axis. Keep the profile selected and move to menu *3D->Set Surface->Rotate Z*. Tensor will now define the imaginary surface. Deselect the profile.

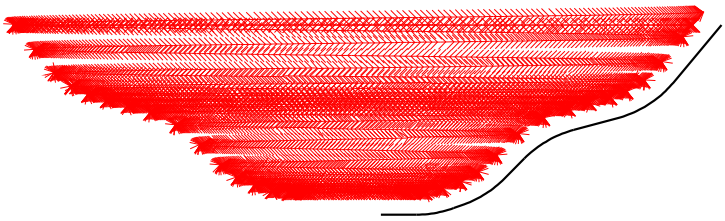
In this drawing there is a spiral, but it is not visible right now because it has been blanked. We can unblank this through menu *Edit->Unblank* and select for Layer *spiral*. If the spiral is not completely visible in the window use *View->View all.* Keep the spiral selected and move to menu *3D->Projection*. We will enter the same values as we did for the Extruding-example (ballmill diameter8 and accuracy 0.01). The result is to be seen pic.36 .

You also take a look at *rot-z.avi*.



pic.36

The front view will give you a better picture to understand what this feature does (pic.37)



pic.37

Interpolate
Here you can project geometry on a double curved surface. To define this surface use the *Path* and *Skin* features. Define a path and when selecting the skin-sections instead of moving to *3D->Skin* you move to *3D->Set Surface->Interpolate*.
Attention: Remember the path need to have an equal number of elements.

Take a look at *interpol.avi* to see how this Works.

P.e you could project a text on a surface while machining a cavity for a plastic-mould. Try to do this using the Projection feature.

Summary
You have learned how to create toolpaths for 3D shapes. You will also notice there are limitations to the capacity in generating 3D-toolpaths. High-end solutions will provide you better and stronger solutions. If for example you would like to fillet two double curved surfaces you will not manage this using Tensor. But what you did see is that 90% of 3D-parts you will run into can be programmed with Tensor.
What are the main points which we will point out in this summary concerning 3D-programming.

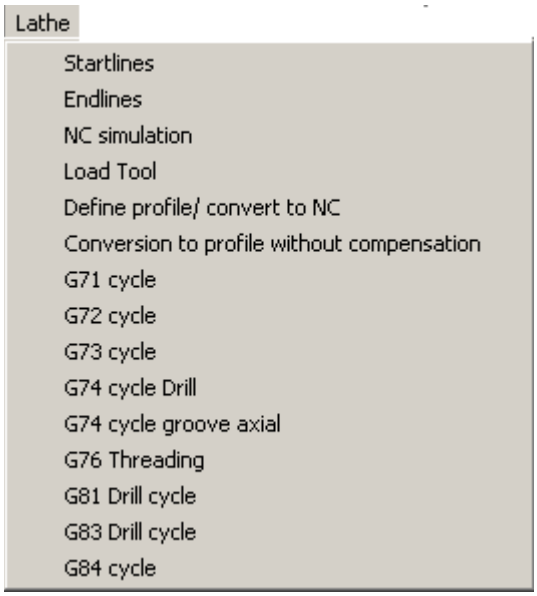
1. Defining 3D geometry. Try as much as possible to draw you geometry in 2D (XY-plane) and afterwards move or rotate this in the right position in 3D using the clipboard (*Cut->Paste*) .
2. Try to define logical paths and skins when defining a 3D part. Remember the paths and skins need to intersect and be divided at the intersection point (*Edit->Break->Intersect*). If not, the skin–feature will turn grey in the menu and will not work.
3. Select *paths* en *skins* in the right direction and order. The startpoint of the 1st skin is also the startpoint of the 1st path. The endpoint of the last skin is also the endpoint of the last path.
4. Try to get a 3D-wireframe from your customer if possible in Iges-format(version 3.5). It might save you a lot of time. Specifically ask your customer to save the 3D model in his CAD-sytem as *wireframe-model*!! This will avoid that there will be a lot of unnecessary geometry in the Iges-file which you then have to remove yourself.
5. The more you practice the better you will get in constructing 3D parts. It requires more imagination to work in 3D than it does in 2D.

NC-programming for lathe

In chapter *Drawing with Tensor* we learned how to define geometry. In this chapter we will work through an example how to generate code for lathe-jobs.

Right from menu Help you will see several menus:

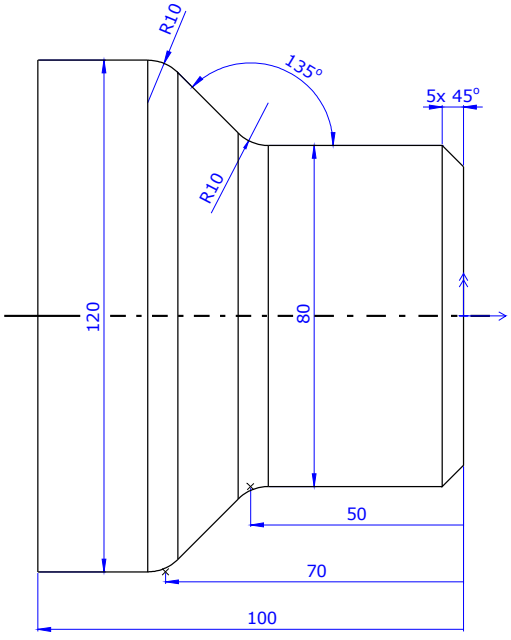
In menu Lathe there is a big variety of lathe-jobs available. This varies from roughing cycles to drillcycles. (zie pic.1)



pic.1

In this example will now move step-by-step in generating an NC-program to machine a profile with a roughing-cycle and a drill cycle.

To generate a lathe program we first need to define the profile we want to machine:

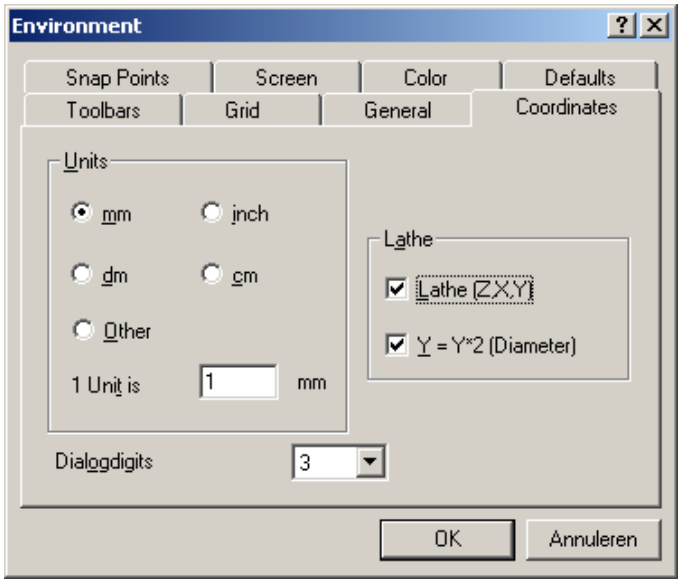


pic.2

Drawing the profile

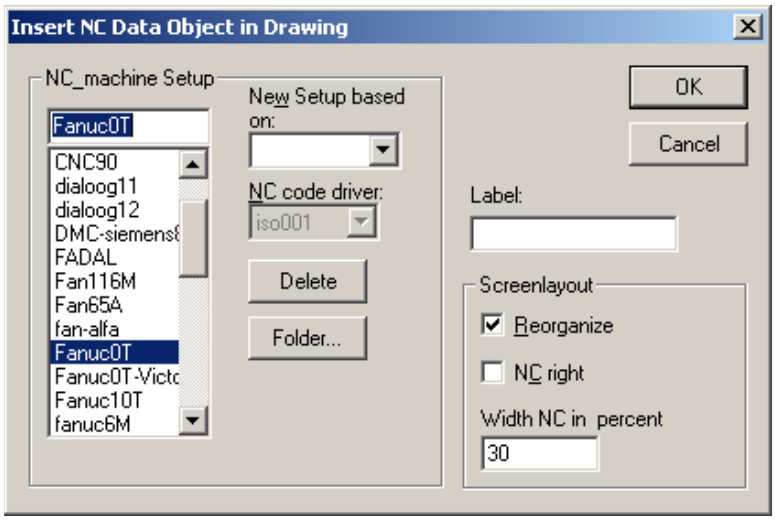
You can do this in the way you learned in chapter *Drawing with Tensor*. However, in menu *Lathe* you will find feature *Define profile/ convert to NC.* Here you can define your lathe profile step-by-step through dialog.
Watch lathe1.avi

In *lathe1.avi* you will see how easy you may define the profile in pic.2
If you define this without the above mentioned feature, remember lathe is usually programmed in a different plane than XY, namely the ZX-plane. Therefore you will have to change this manually. You can do this by moving to menu *Special->Options* tab-page *Coordinates*. Here you can also activate diameter programming instead of radius programming by activating *Y=Y*2*. (pic.3). At the startpoint we will define a line of 10 mm.
Try to make the profile using *Define profile* feature or open drawing *lathe1.ccd*.



pic.3

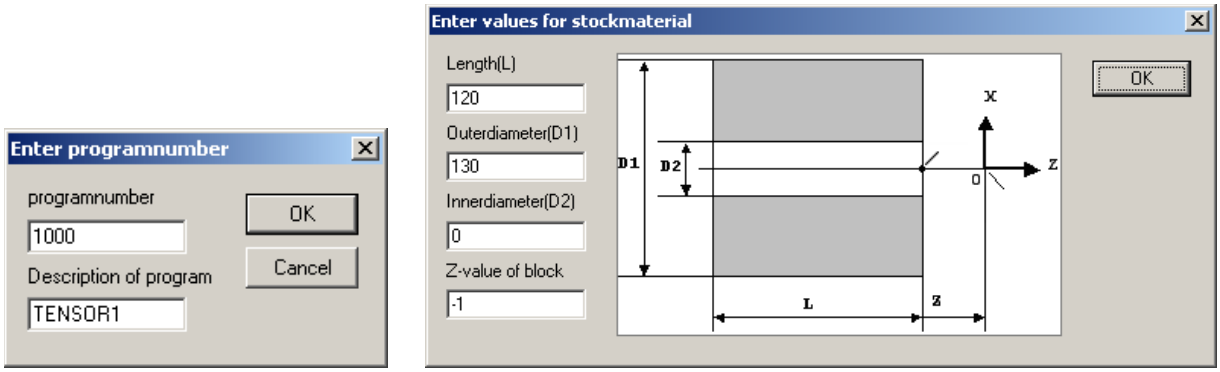
Selecting controller
First we have to decide for which controller we want to make the NC-program. In this example we will select *Fanuc 0T*, the most common used controller, We move to *Special->Insert NC* and select the Fanuc 0T form the list (pic.4)*:*



pic.4

A new window will appear in Tensor: *the NC-window*. In this window the NC-program will be written. Actually this window is a text-editor wherein the user can type or change text if so desired.

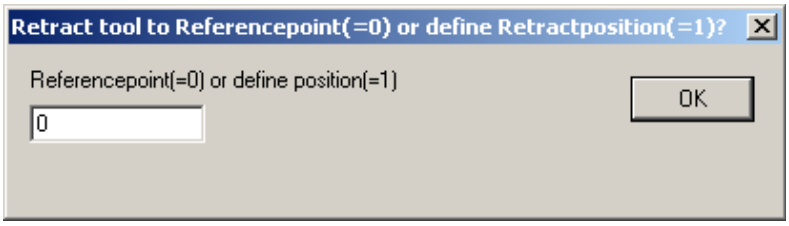
Startlines
As any programs has its startlines we will define these first by moving to: *Lathe ->Startlines*:



pic.5

In this chapter we will enter the same values as are shown in the pictures. Tensor will then ask the user to determine the dimensions of the stock material. If the profile is selected before you activate *Startlines* Tensor will present dimensions surrounding the profile. If not you will have to calculate the values. Therefore it's preferred to select the profile.

In *Startlines* automatically you will be asked to load a tool. That's why Tensor will ask how retract to a safe position. (pic.6):

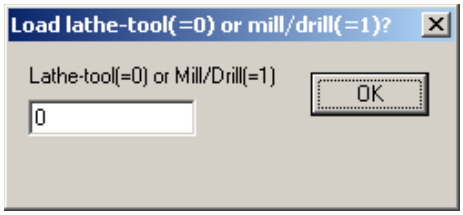


pic.6

%
O1000
(STOCK/110,130,0,-1)
G28 U0
G28 W0

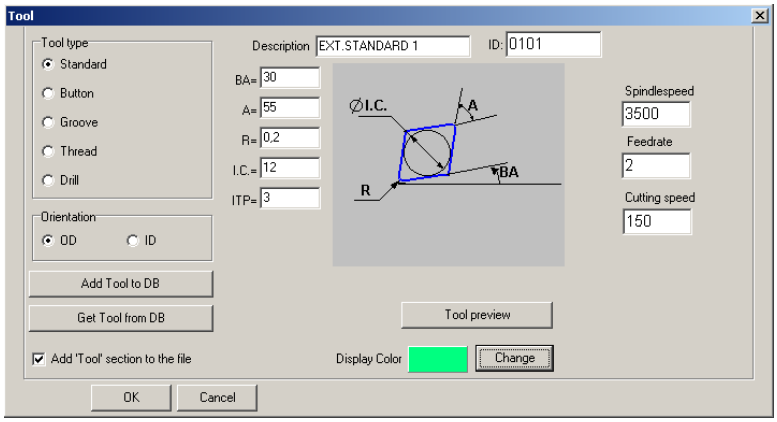
In the NC-window the first NC-lines appear with the definition of the stockmaterial in line 2. This is between brackets as the Fanuc-controller will consider this as comment. However the Tensor NC Simulator will use these to simulate the program.

We will now load a lathe-tool(=0). It is also possible to load tools for driven tools (=1) (pic.7), but more about this later on. We will now concentrate on lathe-jobs.



pic.7

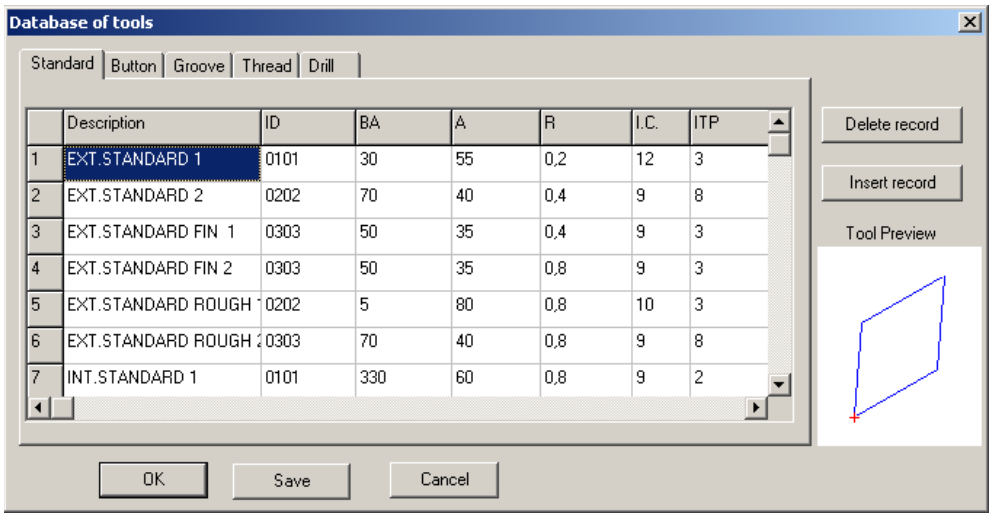
Select from toollibrary



pic.8

A window of a tool library will pop u on your screen (pic.8). There are **5** possible types of tool to be defined/selected. By clicking on a every one of the radio-buttons you will see what type and what parameters define the tools. In this case we select *Standard* tool. Values like tooltipradius etc. can now be entered. However, it is also possible to select from a database. Click on button "*Get tool from DB "*.

The following window appears (pic.9):



pic.9

This is what you will see (pic.9). By clicking on *Insert Tool* the user can define new tools and add them to the list after clicking *Save* button. (Don't forget to Save!). You can also delete tools from the list by clicking *Delete Record*

Attention: Don't forget to click on the Save-button when changes are being made !

Parameters of tools

The *description* of the tool will also appear in your NC-program to make it easier to check your program on the CNC-controller. *Attention*: some controllers only accept capital letters. *Tool* ID is the toolnumber which should be in accordance with the toolnumber defined on your CNC-controller, to prevent errors or collision on your machine. For each tool you can define a separate color for removed material during simulation. This will enhance the overview during simulation.

Tip: Drag the window when you are in the listing of tools(pic.9). You will then see the picture in the previous window(pic.8) explaining the parameters.

Select de EXT. STANDARD 1 with ID 0101 and click on OK. You can also enter values for spindle speed and feedrate.

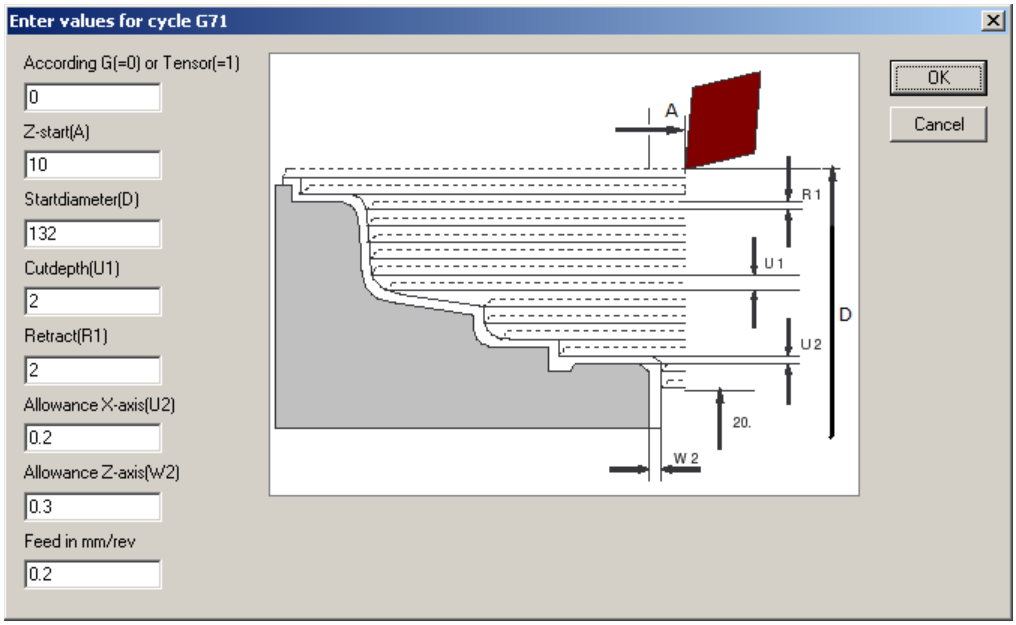
Then click OK twice. The result in the NC-window will be:

(TOOL/STANDARD,30,55,0.2,12,3)
(COLOR,0,255,128)
T0101
G96 S3500
G50 S150 F0.2 M3

The program now contains the necessary code to load a tool on your machine. Dimensions of the tool and color of simulation is described between brackets.

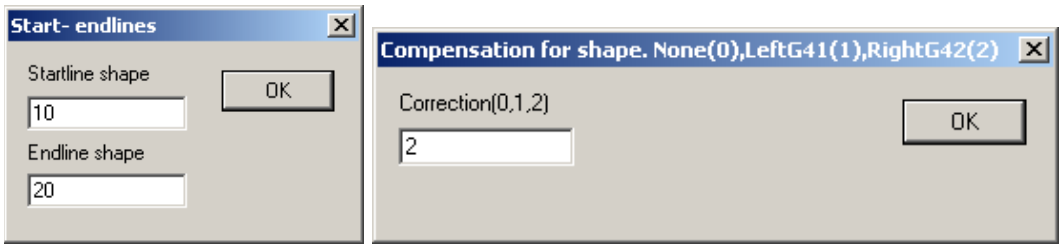
Roughing cycle

We will now select the profile (direction or chain should be in –Z).
On practically every CNC-controller an axial roughing cycle is available. For Fanuc this is cycle G71. In menu *Lathe* this feature is also present *Axial Roughing (G71)* and we will therefore select the feature.



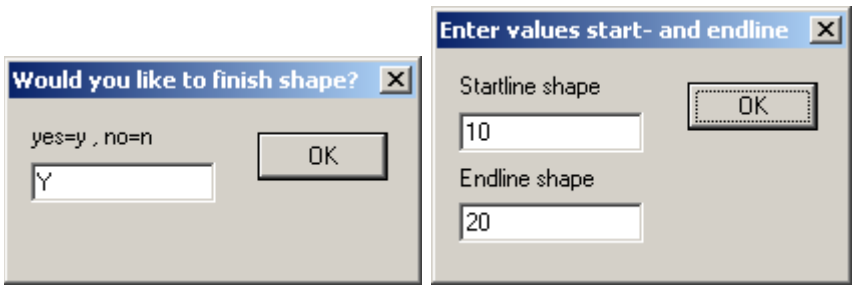
pic.10

In pic.10 you can see there is a picture describing the parameters you are asked to enter for the axial roughingcycle. Most values speak for themselves. Except the first parameter needs some more explanation. For this moment we will enter value 0 (*According G*). Later on this chapter we will highlight this. By clicking *OK* you will be asked to enter the number for the start- and endline of the profile. (pic.11). We enter 10 and 20. For toolcompensation we select right(=2) compensation.



pic.11

The NC-code for the G71-cycle is now written into the NC-window. Automatically Tensor proposes to finish the profile with G70. Usually this is preferred (pic.12)



pic.12

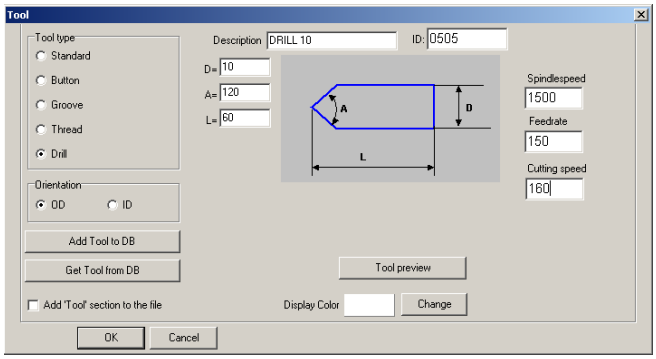
As it concerns the same profile we enter 10 and 20. The total result is shown below:

G71 U2. R2.
G71 P10 Q20 U0.2 W0.3 F0.2
N10 G0 G00 X0.
G42 G01 Z0.
G01 X70.
G01 X80. Z-5.
G01 Z-45.858

G02 X85.858 Z-52.929 R10.
G01 X114.142 Z-67.071
G03 X120. Z-74.142 R10.
N20 G40 G01 Z-100.
G70 P10 Q20

Drilling

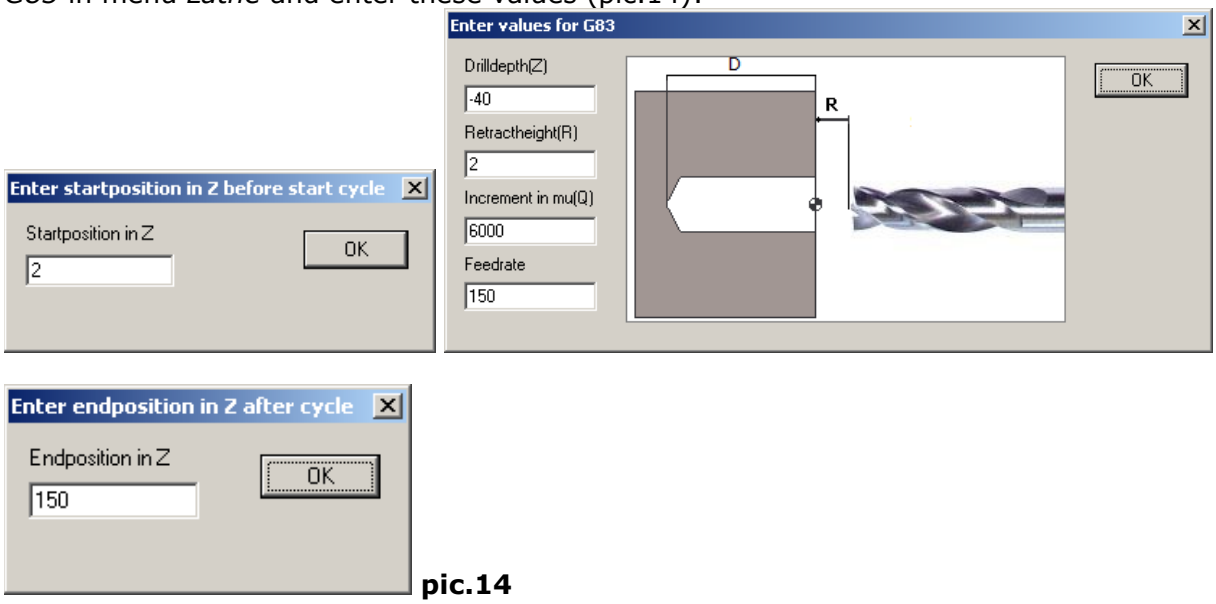
To drill a hole of 10 mm we will use the available drillcycle on the controller. As the depth of drilling will is 40 we will choose *Deepdrill cycle G83*. First we need a toolchange to load a drill diameter 10. Move to menu *Lathe->Load tool*. The procedure is the same as we already have seen in the *Startlines.* Only this time we will select from *tooltype Drill*. Click on "*Get tool from DB "* to select from the list (pic.13):



pic.13

(TOOL/DRILL,10,120,60)
(COLOR,255,255,0)
T0505
G97 S1500
G50 S160 F150. M3

The NC-code to load the drill is generated in the NC-window. Now activate *Deepdrill cycle G83* in menu *Lathe* and enter these values (pic.14):



pic.14

G0 X0 M8
Z2.
G83 Z-40. R2. Q6000 F150.
G00 G80 X200. Z150. T0500M09

Endlines

To finish the program we will make the endlines in *Lathe->Endlines*.
G0Z50.
G49 Z0
M05
G00G91G28X0Y0Z0
M30
%

In video *lathe2.avi* you can watch the actions described in this example.
***Exercise*: Try to make a NC-program for this profile entering different values.**

Simulation

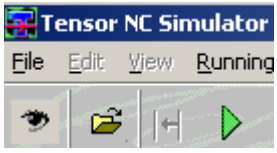
The Tensor NC lathesimulator.
The program is now complete. To visualize and check if no errors are made we can simulate our program in Tensor NC Simulator. On the far upperright of your drawing-window there are eye-buttons. Move the mouse to the right eye-button. You will see a balloon with text SIMUL LATHE

pic.15

By clicking on the right eye-button Tensor will make a copy on the harddisk of the content in the NC-window. We the can import this in the Tensor NC Simulator.

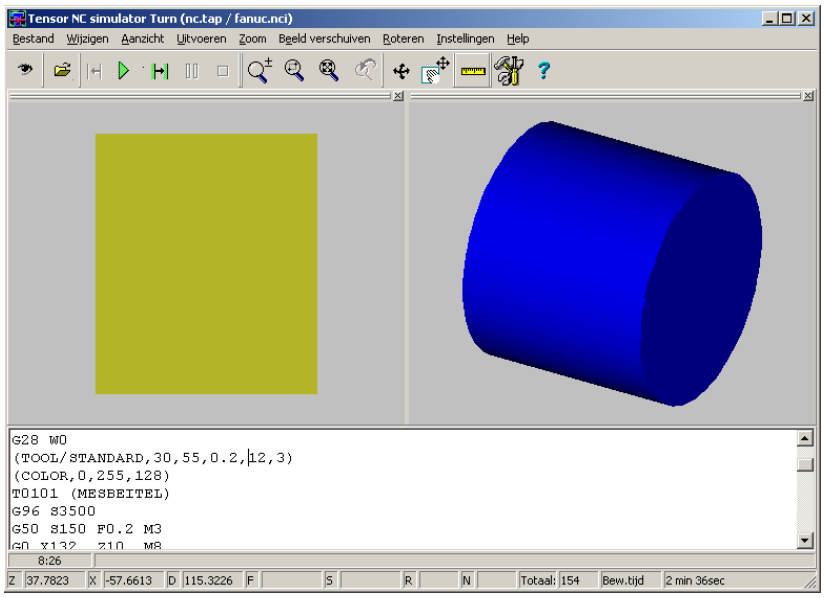
If you did not startup the *Tensor NC Lathe Simulator*, you need to do this. If you followed instruction during installation you will have a shortcut on your desktop. If not read the these instructions at the beginning of this manual (*Installation of Tensor*). The best thing to do is to start the simulator when you start Tensor. You simply need to click on the bottom of your screen to switch between the two applications.

We now move to the Tensor NC simulator. The first button on the left side of the toolbar is an eye-button. By clicking on this button *Tensor NC Simulator* will load the NC-program you just saved by clicking on the eye-button in Tensor. The eye-buttons are made for the users comfort, to avoid the user first making a copy in Tensor by moving to menu *File->Save copy as..* and afterwards move to menu *File->Open* .. in the simulator.



pic.16

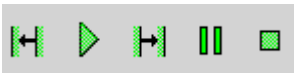
Attention: If you just made a simulation Tensor NC Simulator will ask you to save a copy. Answer with No, to avoid overwriting the copy you just made in Tensor. If you still want to have a copy again click the right eye-button in Tensor.



pic.17

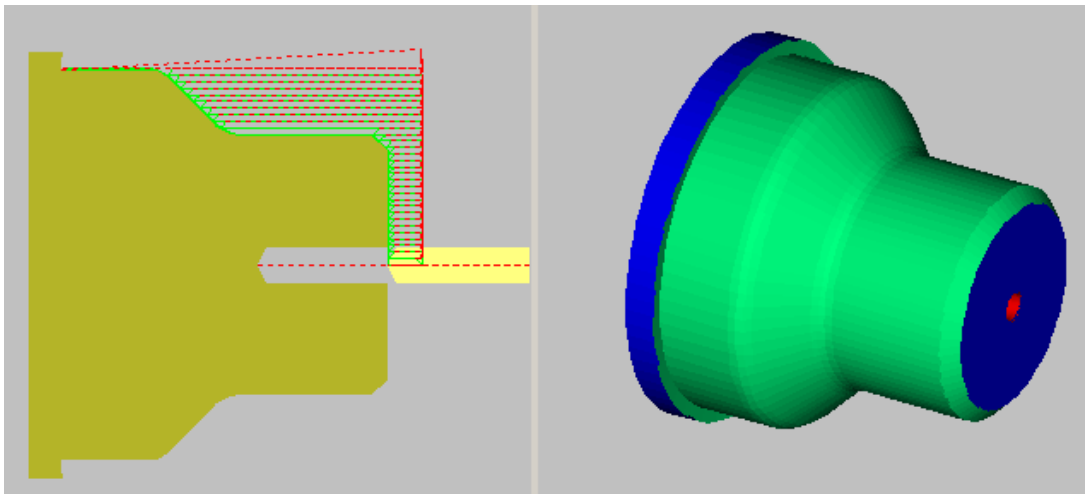
When the file is opened Tensor NC Simulator will recognize the lines describing the stockmaterial and will present it. Also the geometry of tools is known so we can start simulation. There are several ways to run a simulation: step-by-step or automatically.

Buttons

 **pic.18**

With these buttons(pic.18) we can choose how we want to run the simulation. The third button allows you to simulate the program step-by-step. The second button will give you a complete simulation until the end of the program. Clicking the fourth button will give you a time out. The fifth button will abort the simulation. You can then only start the simulation from the beginning. The first button(rarely used) will take you one step backwards each time you click. The removed material will not return but you will see a line or arc belonging to the NC-path. In this case click on the second button for an automatic run of simulation. The result will then be:

Try to run an automatic simulation by clicking the 2nd button. First the G71 cycle will be simulated where after the hole will be drilled (G83). (pic.19)

 **pic.19**

Machiningtime

The button with the measuretape allows you to check dimensions on the block after simulation. For example the distance between 2 parallel lines or dimensions of diameters.

But more interesting is the machiningtime. Click on the *T-? V-?* button. The result (pic.20):

pic.20

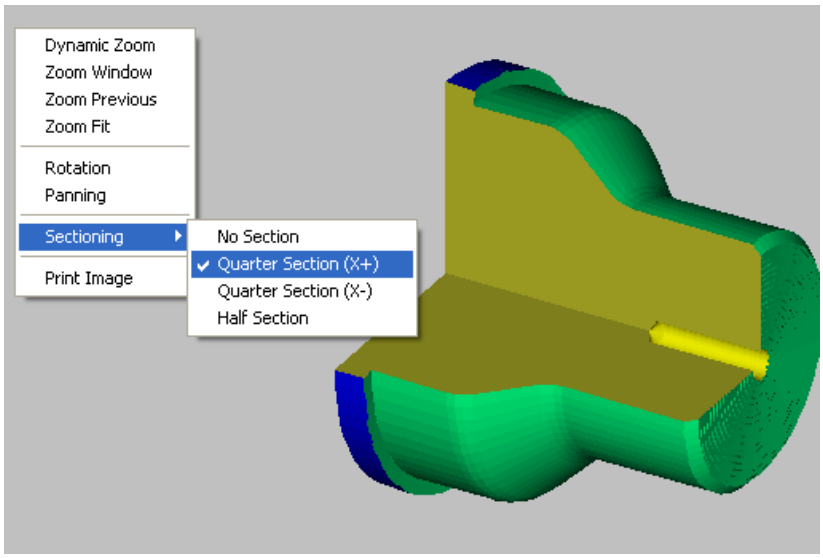


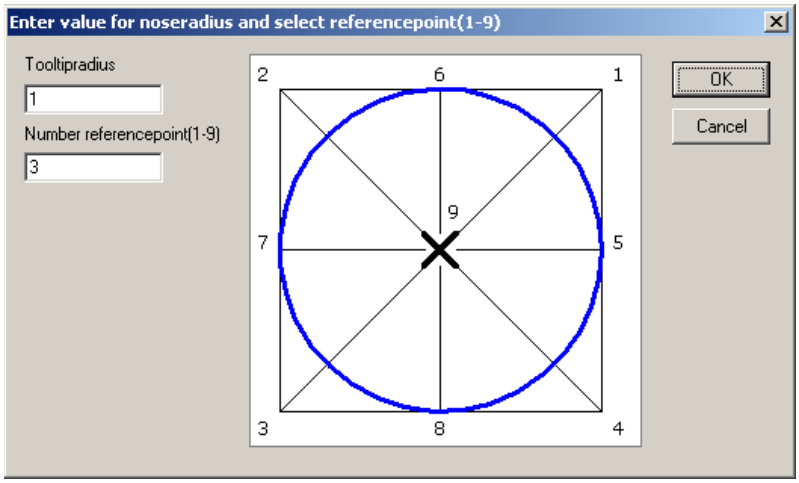
fig21

By clicking the rightmousebutton in the 3D-window you can select a crossection view of your part. (pic.21)

Watch *lathe3.avi* to see what is described above.

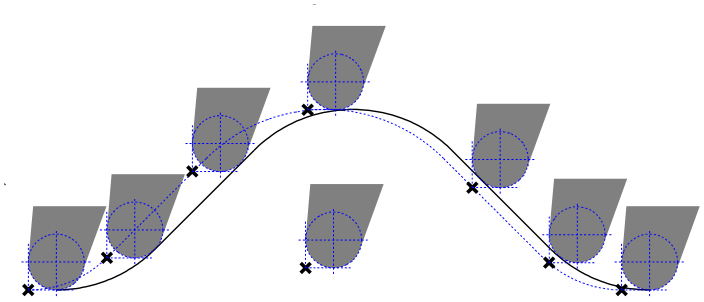
Compensated toolpath

Sometimes you bump into the problem you want to machine a part without using toolcompensation calculated by the controller (G41,G42). The toolpath you then need to define, is different when using G41 or G42. In menu *Lathe* you can use feature *Conversion to profile without compensation* to solve this problem. It will save you a lot of time calculating the path. After selecting the profile two parameters need to be defined. These are the *tooltipradius* and the location of the *referencepoint* (there are 9 possible locations). See pic.22



pic.22

Tensor will then calculate the path the referencepoint needs to follow to give you a correct result on your machine. See pic.23



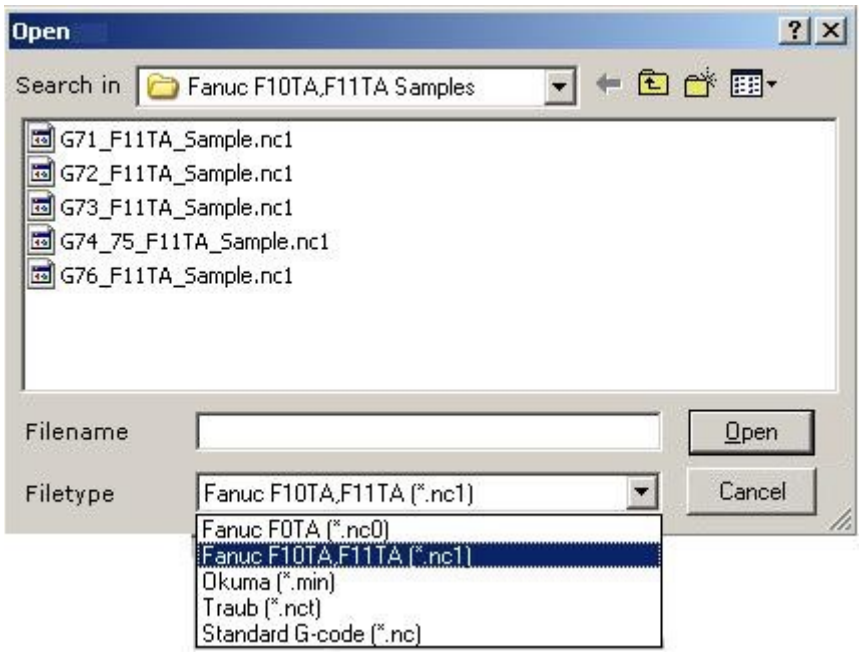
pic.23

You can do this both for an inner- as outerprofile.
To convert this compensated path into NC-code move to menu *Lathe-> Define profile/ convert to NC*.
Watch video *corrected.avi*.
Attention: Take in account the tool is always located on the right side of the profile

Other cycles
In menu *Lathe* you will find a number of lathe-jobs to be used like *radial roughing*, *canned cycle*, *threading* and *drillcycles*. In feature *Define profile/ convert to NC* you can convert a profile directly into NC-code (G01,G02 en G03).

Tensorcycle
For the first parameter in the G71-dialogbox (pic.10) we entered a value of *0*. If we however had entered a value of *1* the *G71* and *G70* would have been replaced with *Tensor70* and *Tensor71*. If you then open this program in the Tensor simulator you will notice the program is substantial greater. This because Tensor70 and Tensor71 will be totally written out in G00, G01, G02 and G03 in X- Z-coordinates. This means you have a *NC- controller independent* NC-program. Therefore it can be used for different controllers. Especially for controllers that don't have intelligent cycles such as G71, G72, G73, G81 etc.

External made programs
Programs not being made in Tensor can also be simulated in Tensor NC Simulator
Attention: Be sure the program has the proper extension!!
If you p.e. want to simulate a Fanuc10T program be sure to select the Filetype (extension) in this case *Fanuc10TA(*.nc1)*. So if necessary, change the extension of the NC-program. (pic.26)



pic.26

Probably tools present in the program will not be defined for Tensor NC Simulator. But automatically at every toolcommand you will be able to define the dimensions and color of simulation. You can also move the cursor to a specific line and insert a tooldefinition by clicking the rightmousebutton.

Conclusions
This was an example how to program an axial roughing cycle and to drill a hole. What can we highlight here?

Dialog
First, there will be a dialog between the user and Tensor. Tensor will ask the questions and you answer by using your knowledge of lathe. This means Tensor will do the unpleasant work (calculating) and you will always be in control.

Startlines
In the startlines dimensions of the stock is defined which is later used in the Tensor NC Simulator.

Load tool
When loading a tool the user can select form a toollibrary. The library can be changed and you can insert tools you use in your shop. There are 5 different types of lathe tools. Every tool can have its own color of simulation to improve the view while simulating. Code between brackets represent the tool dimensions and color. If you want to add a lathe-job to your program using a new tool move to *Lathe->Load tool* first, as this is not being done when defining an new job. If not, the last tool will be used.

Cuttingconditions
Through dialogboxes with pictures the user will now what the parameters represent. You may decide to do a finishing using a different tool. After entering these values NC-code is automatically being generated in the NC-window. Where necessary you will see comment in your program.

Simulation
After entering endlines the program can be simulated by clicking the left right-button. Tensor will save the content of the NC-window which you can import into the Tensor NC Simulator by clicking the eye-button. Machiningtime is presented.

Attention: At any given time you can do a simulation of generated NC-code, the program does not have to be completely ready. Let's say you want to a drilling job after profiling. You can first simulate the profiling and then continue with a new job.

Tips and tricks

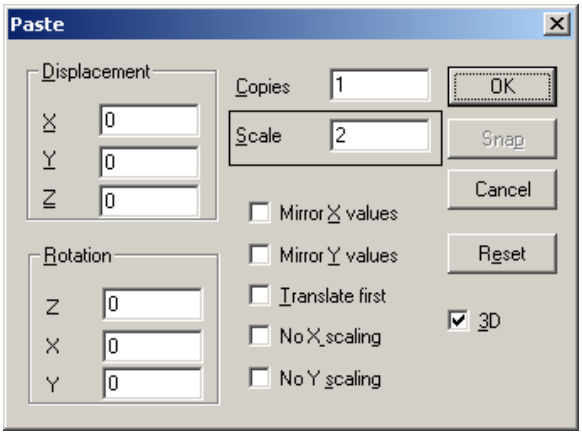
In this chapter we will give you a number of tips and tricks you can use when working in Tensor. It will help you to get a better benefit when programming.

Direct NC-code

If you only need to convert geometry into plain NC-code (G01,G02,G02 or L,CC,RND) Do the following: move to menu *Special-> Insert NC* and select desired controller. Move back to the drawing-window and select the geometry you want to convert. In menu *Special* you can see option *Generate NC*. Click on the item and you will see the NC-code appear in your NC-window. If not, check if the right item in menu *Contour* in the NC-window is activated. One of the first three should activated. You can also click on the camera-button you will see in the toolbar of the NC-window.

Scaling

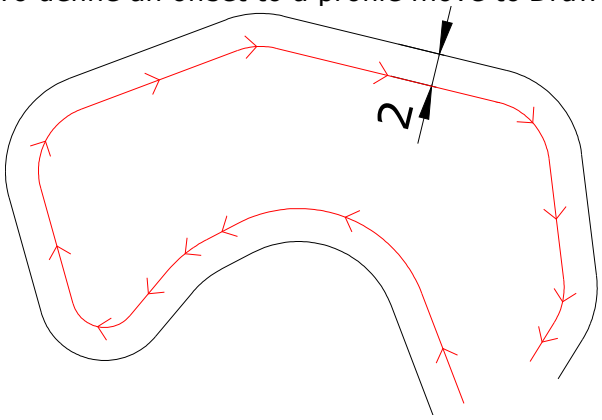
If you want scale geometry this is done very easy by using the clipboard. Select the geometry and copy this to the clipboard *Edit->Cut(or Copy)* Then paste this back into the drawing *Edit->Paste*. First click on the Reset-button so all values are rest. Then enter **2** for the scale parameter if you want to double the size of the geometry.

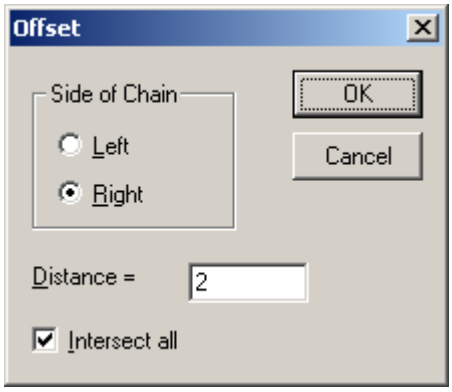


pic.1

Offset a profile

To define an offset to a profile move to *Draw-Other curves->Offset*:





pic.2

Imorting a DXF-file

Probably you frequently will be offered a DXF-file instead of a paper drawing. Tensor can import this without any problem. Often the file contains too much geometry you don't need to machine the part. The best thing the to do is to open a new drawing: menu *File ->New->Drawing (Normal)*. Then move to menu *Window->Tile Vertical* (quickkey *CTRL-T*) so both windows are visible. Now select the geometry you want to use in the DXF-window. Copy this to the clipboard (*Edit-> Copy)* then move to the new window you inserted, and paste the geometry (*Edit->Paste*) in the drawing by clicking the *Reset*-button in the Paste-dialogbox first. You can now close the Dxf-file and continue.

The geometry however will not be on the desired position in X-Y coordinates. How to Watch video *ten06.avi* to look at the best way to do this. This is also described on page19 of this manual.

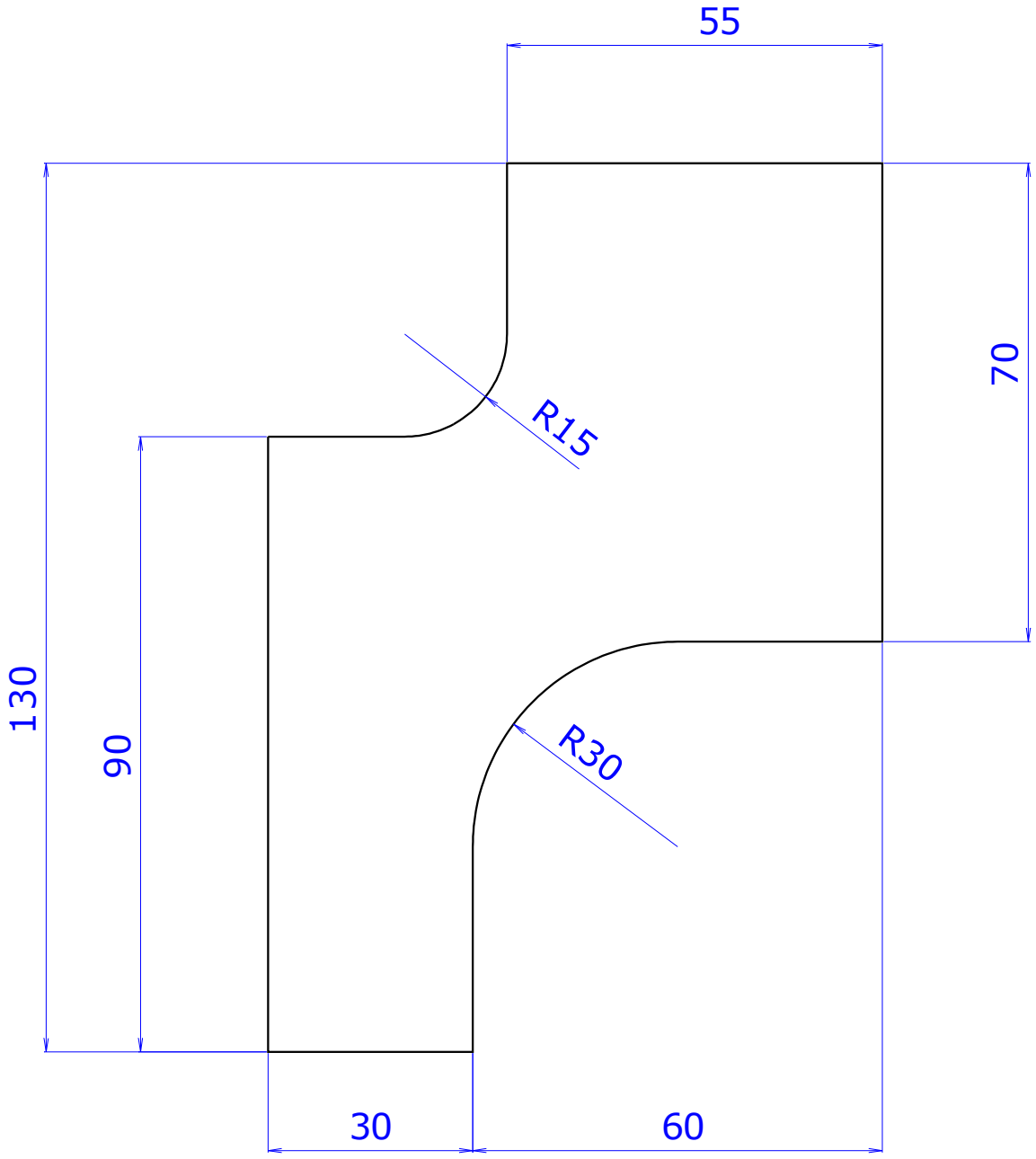
Draw a cube in seconds
Take look at *cube.avi* to see a demonstration of how work *creative* with Tensor

Important when using the clipboard
If you are pasting geometry in the drawing, try to learn yourself *always* first press the Reset-button before you start entering values. You might overlook some parameters that are not zero.

Exercises

In this chapter you will find 15 drawing. You can also find them in the directory where you unzipped *OnyourwaywithTensor zip.exe*. As you are drawing you can play the accompanied video Windows Media-player.

Exercise 1



Used options:

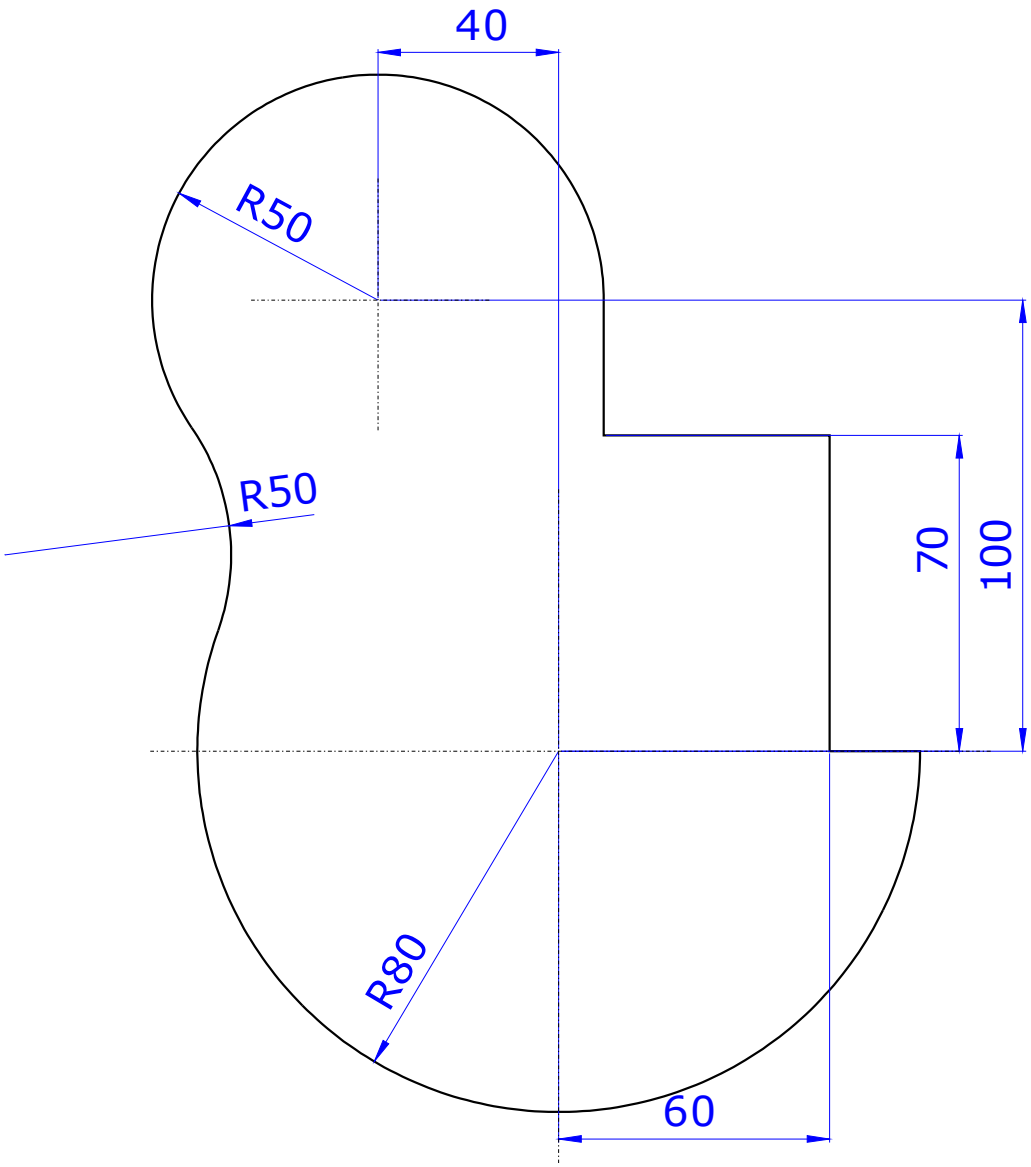
Draw->Line->Aligned (fastkey L)

Draw->Arc->Fillet (fastkey F)

Edit->Trim+extend->Chain (fastkey T)

Special-> Close (closed profile)

Exercise 2



Used options:

 Draw->Arc->Coordinates (fastkey C)

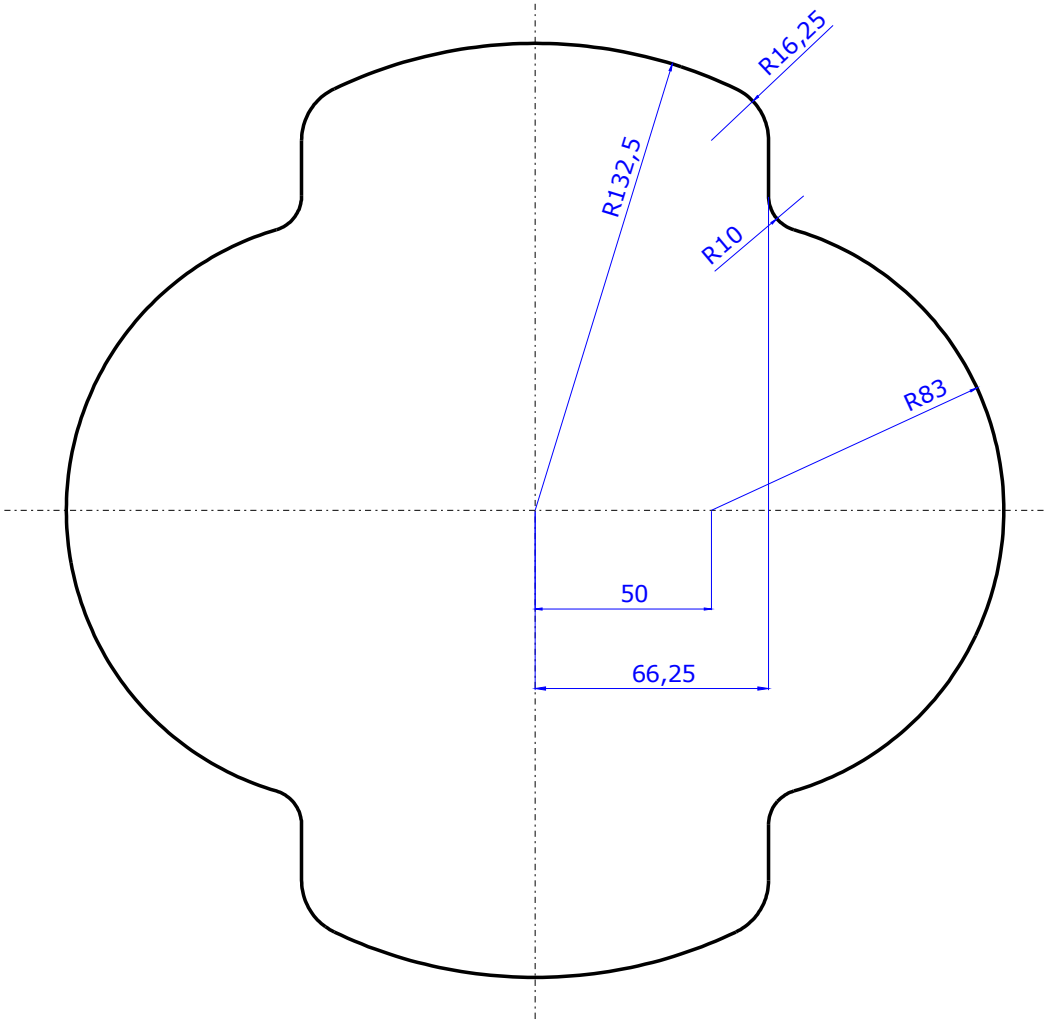
 Draw->Line->Aligned (fastkey L)

 Edit->Trim+extend->Chain (fastkey T)

 Draw->Arc->Fillet (fastkey F)

 Special-> Close (closed profile)

Exercise 3



 Draw->Arc->Coordinates (fastkey C)

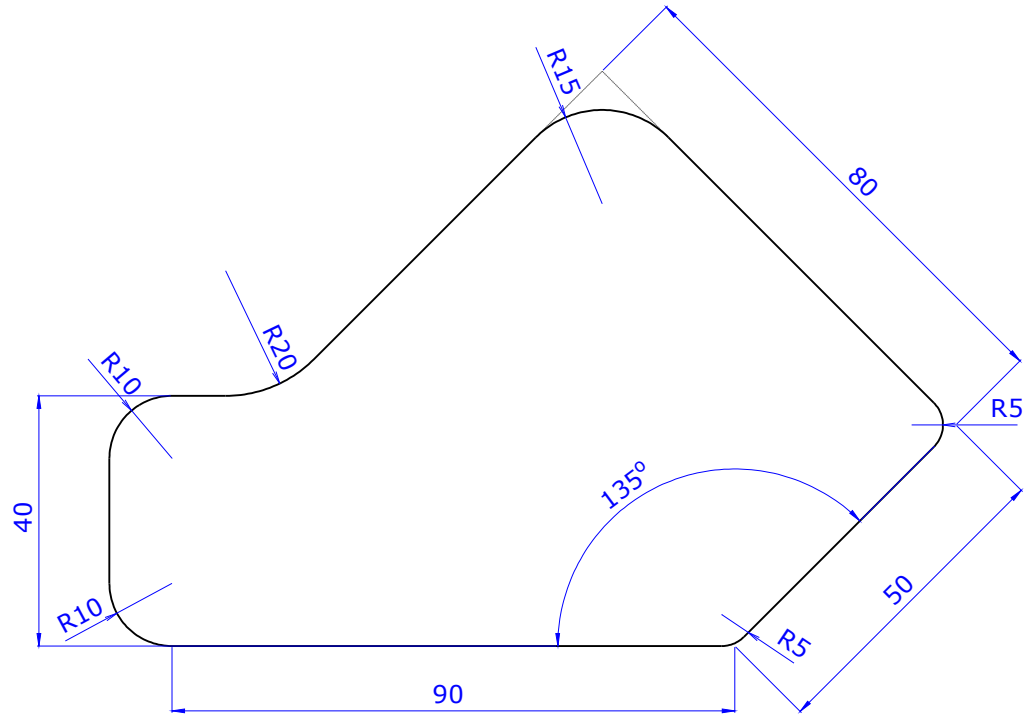
 Draw->Line->Aligned (fastkey L)

 Draw->Arc->Fillet (fastkey F)

 Edit->Copy (fastkey Ctrl-C)

 Edit->Paste (fastkey Ctrl-V)

Exercise 4

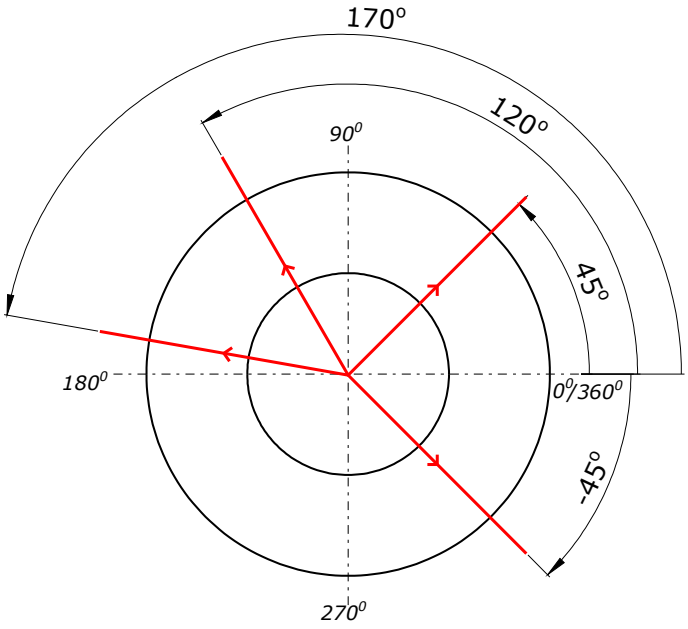


Draw->Line->Aligned (fastkey L)

Draw->Line->Angle

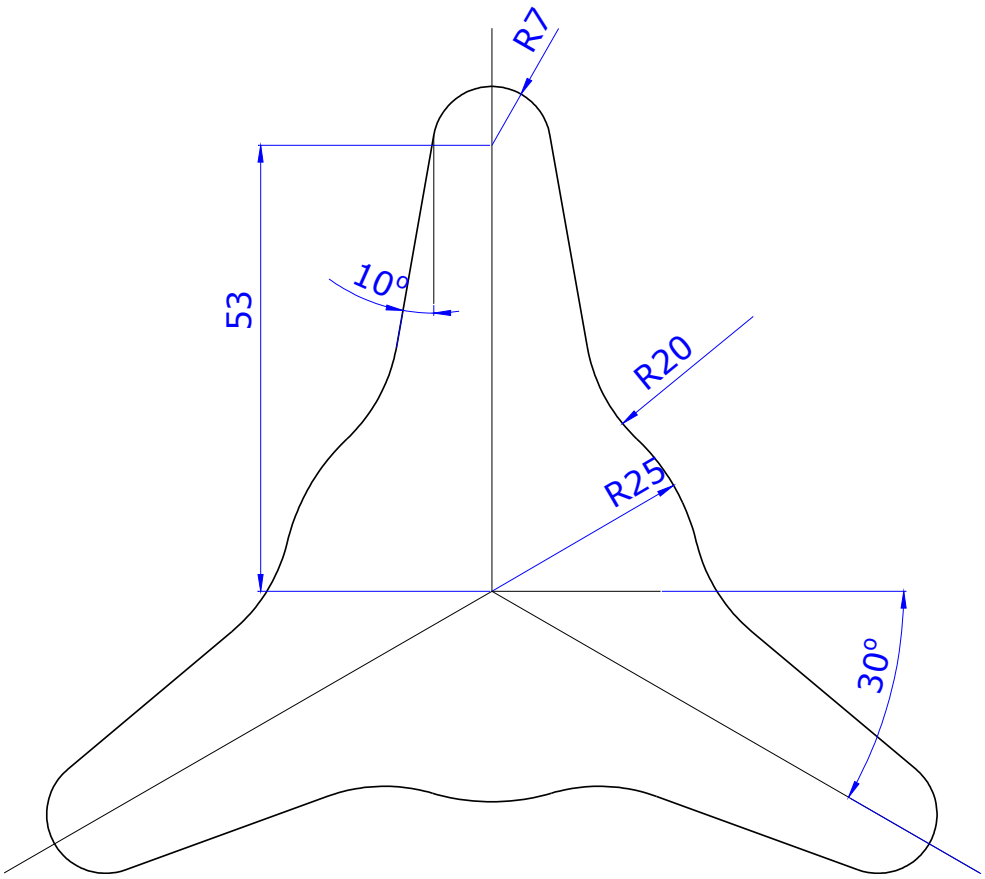
Draw->Arc->Fillet (fastkey F)

Special-> Close (closed profile)



A line pointing to the right is *absolute* 0 degrees . Vertical up is 90°, to the left is 180°, and downwards is either 270° of -90°.

Exercise 5



 Draw->Arc->Coordinates (fastkey C)

 Draw->Line->Angle

 Draw->Arc->Fillet (fastkey F)

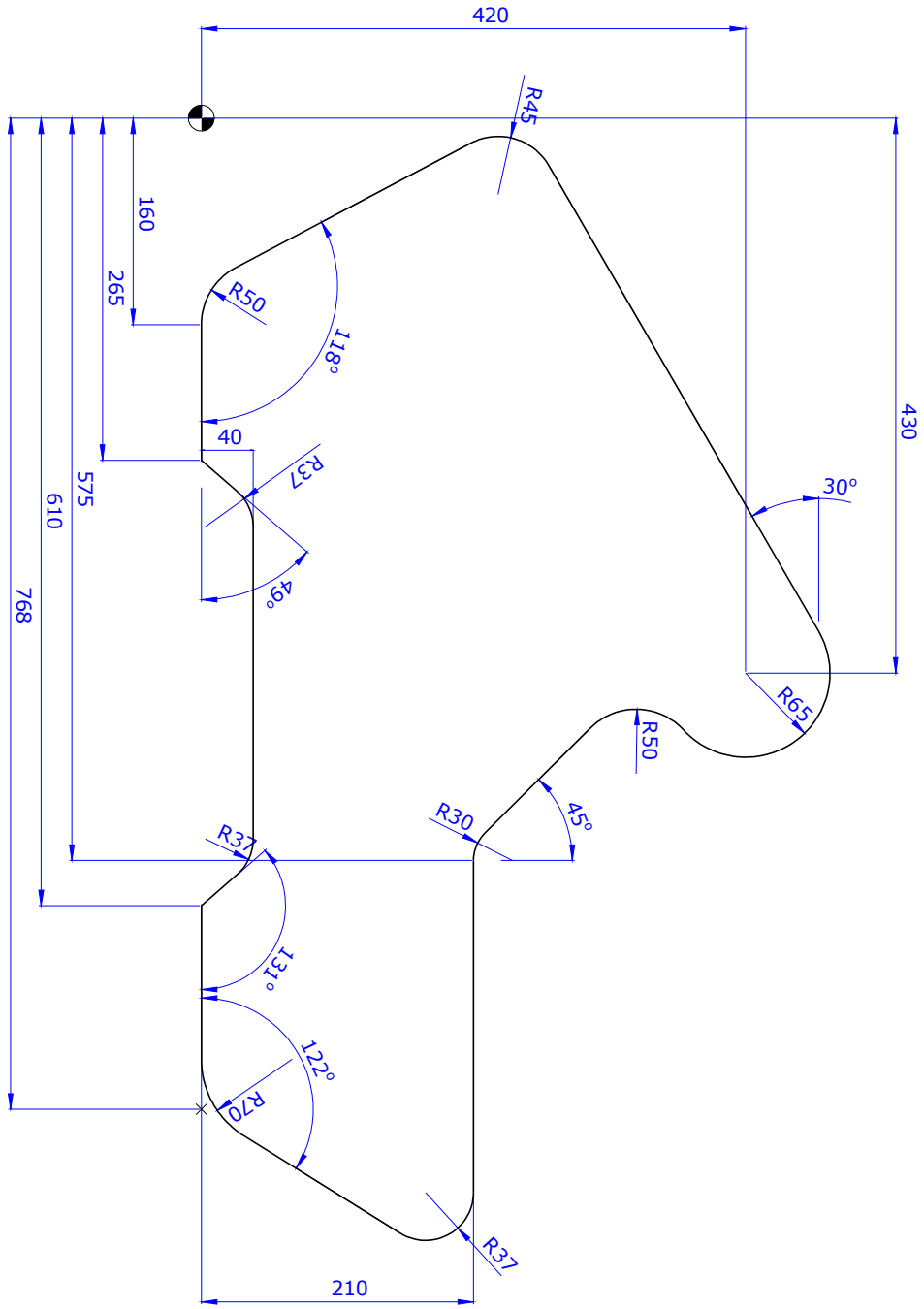
 Edit->Copy (fastkey Ctrl-C)

 Edit->Paste (fastkey Ctrl-V)

 Edit->Trim+extend->Chain (fastkey T)

 Special-> Close (closed profile)

Exercise 6



Draw->Line->Aligned (fastkey L)

Draw->Line->Angle

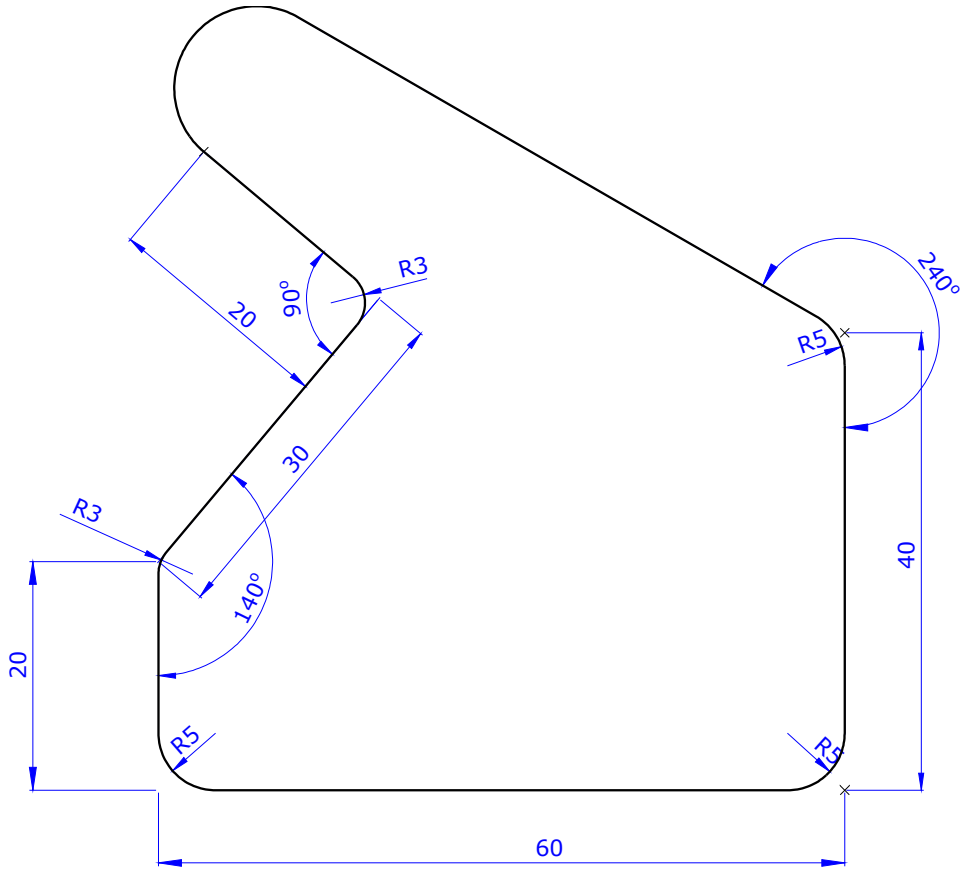
Draw->Arc->Fillet (fastkey F)

Draw->Arc->Coordinates (fastkey C)

Edit->Trim+extend->Chain (fastkey T)

Special-> Close (closed profile)

Exercise 7



Draw->Line->Aligned (fastkey L)

Draw->Arc->Fillet (fastkey F)

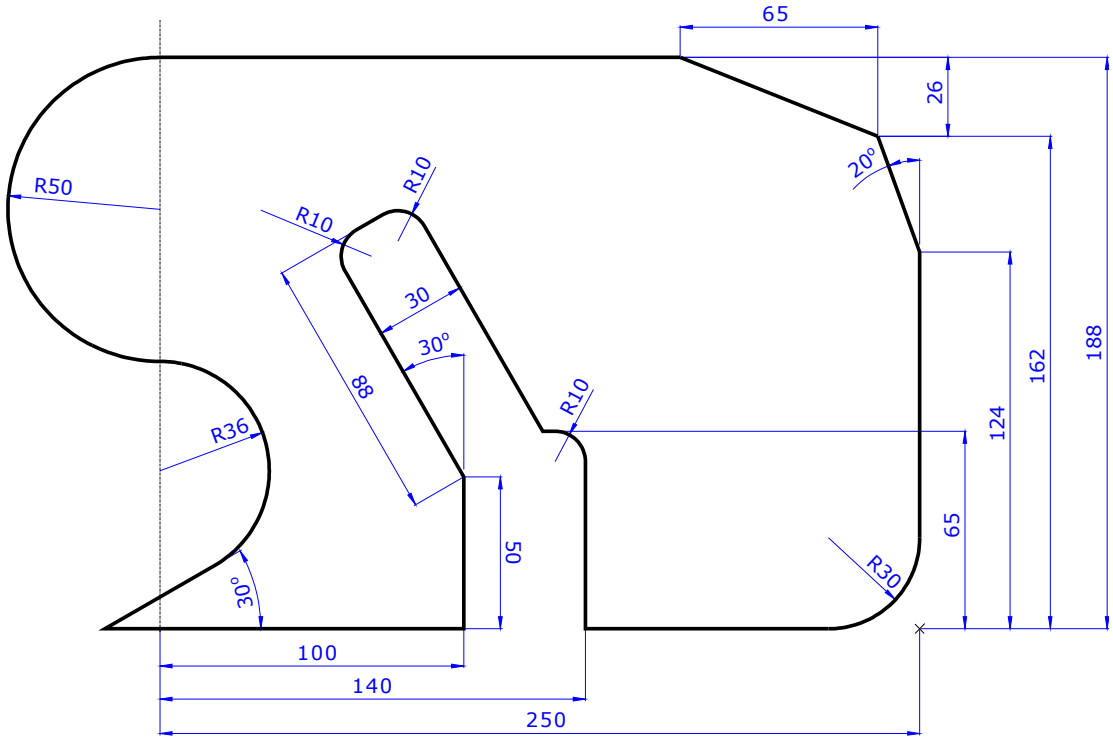
Draw->Line->Angle

Draw->Punt->On entity

Draw->Arc->3 Elements (fastkey 3)

Edit->Trim+extend->Chain (fastkey T)

Exercise 8



Draw->Line->Aligned (fastkey L)

Draw->Arc->Fillet (fastkey F)

Draw->Line->Angle

Axis->Snap to (fastkey P)

Edit->Trim+extend->Tot Chain

Axis->Reset (fastkey R)

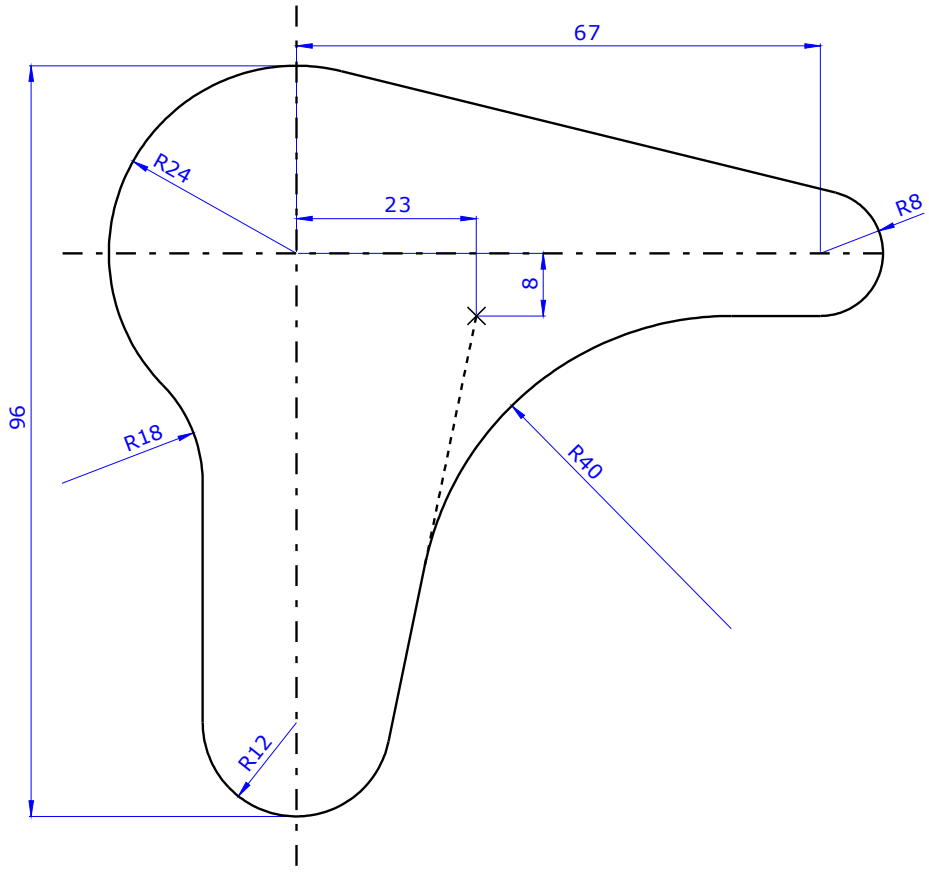
Draw->Line->Join

Edit->Trim+extend->Chain (fastkey T)

Special-> Close (closed profile)

By temporary displacing the axes a simple solution can be found to define the line on the upper right. Afterwards, don't forget to Reset the axes in the original position.

Exercise 9



 Draw->Arc->Coordinates (fastkey C)

 Draw->Line->Aligned (fastkey L)

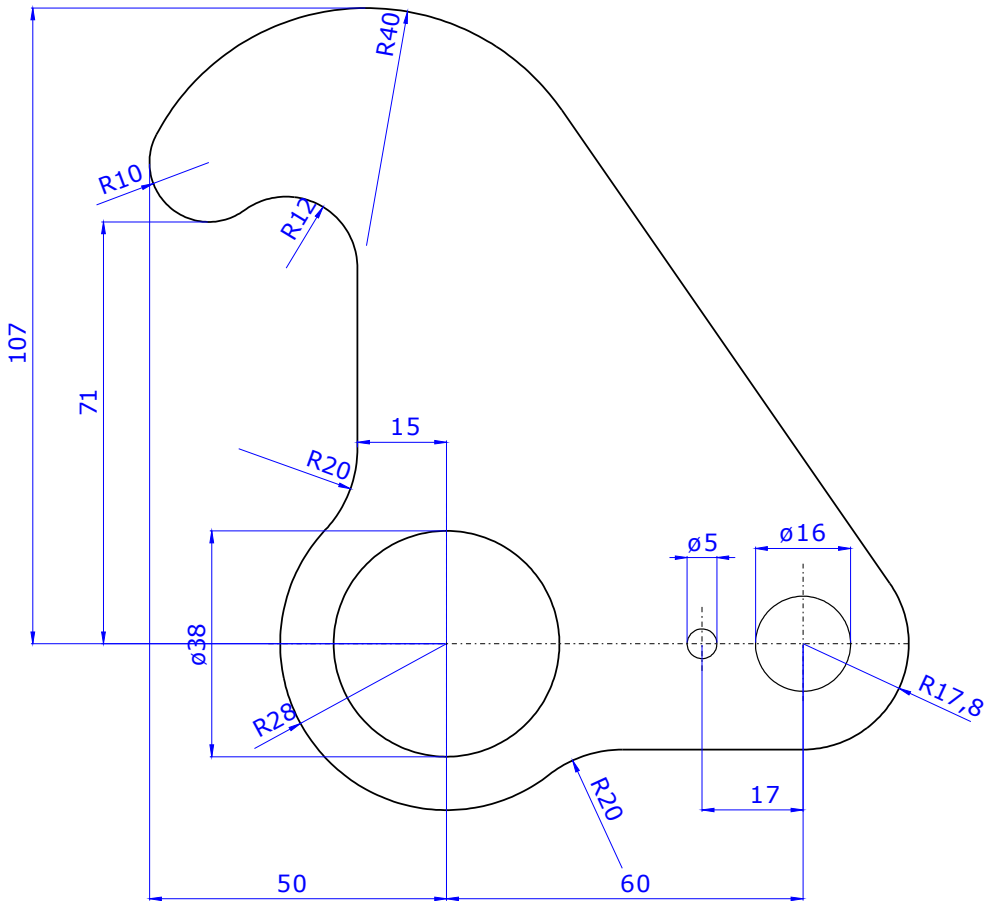
 Draw->Arc->Fillet (fastkey F)

 Draw->Punt->Coordinates

 Draw->Line-> Tangent

 Special-> Close (closed profile)

Exercise 10



 Draw->Arc->Coordinates (fastkey C)

 Draw->Line->Aligned (fastkey L)

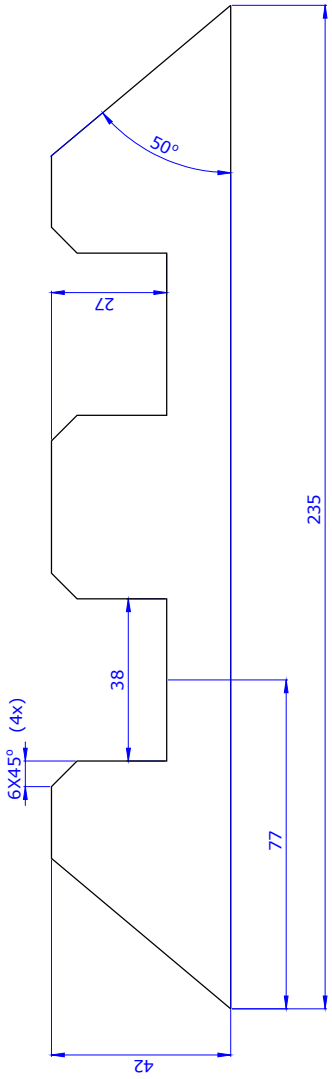
 Draw->Arc->Fillet (fastkey F)

 Edit->Trim+extend->Chain (fastkey T)

 Draw->Line-> Tangent

 Special-> Close (closed profile)

Exercise 11



Draw->Line->Aligned (fastkey L)

Draw->Line->Angle

Draw->Line ->Chamfer

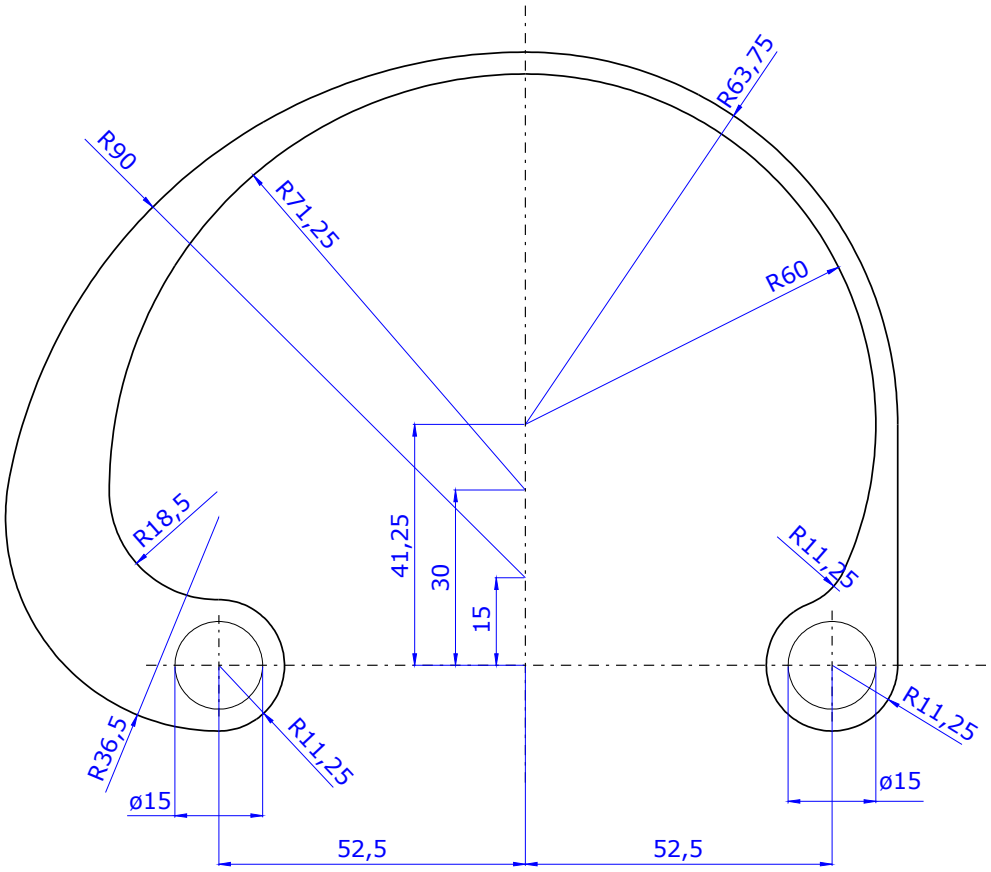
Edit->Trim+extend->Chain (fastkey T)

Edit->Copy (fastkey Ctrl-C)

Edit->Paste (fastkey Ctrl-V)

Edit->Reorganize->Reduce and optimize

Exercise 12



Draw->Arc->Coordinates (fastkey C)

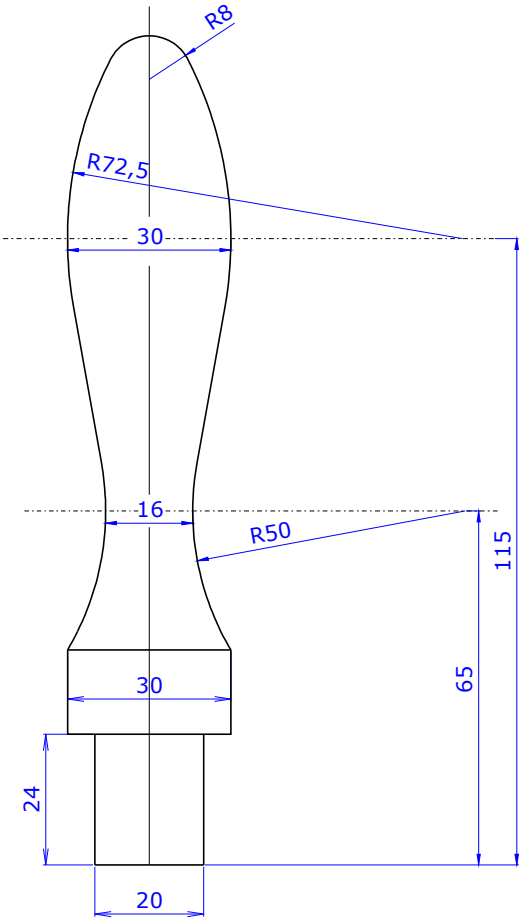
Draw->Arc->Fillet (fastkey F)

Edit->Trim+extend->Chain (fastkey T)

Draw->Line->Aligned (fastkey L)

Special-> Close (closed profile)

Exercise 13



Draw->Line->Aligned (fastkey L)

Draw->Arc->Coordinates (fastkey C)

Draw->Line-> Tangent

Edit->Copy (fastkey Ctrl-C)

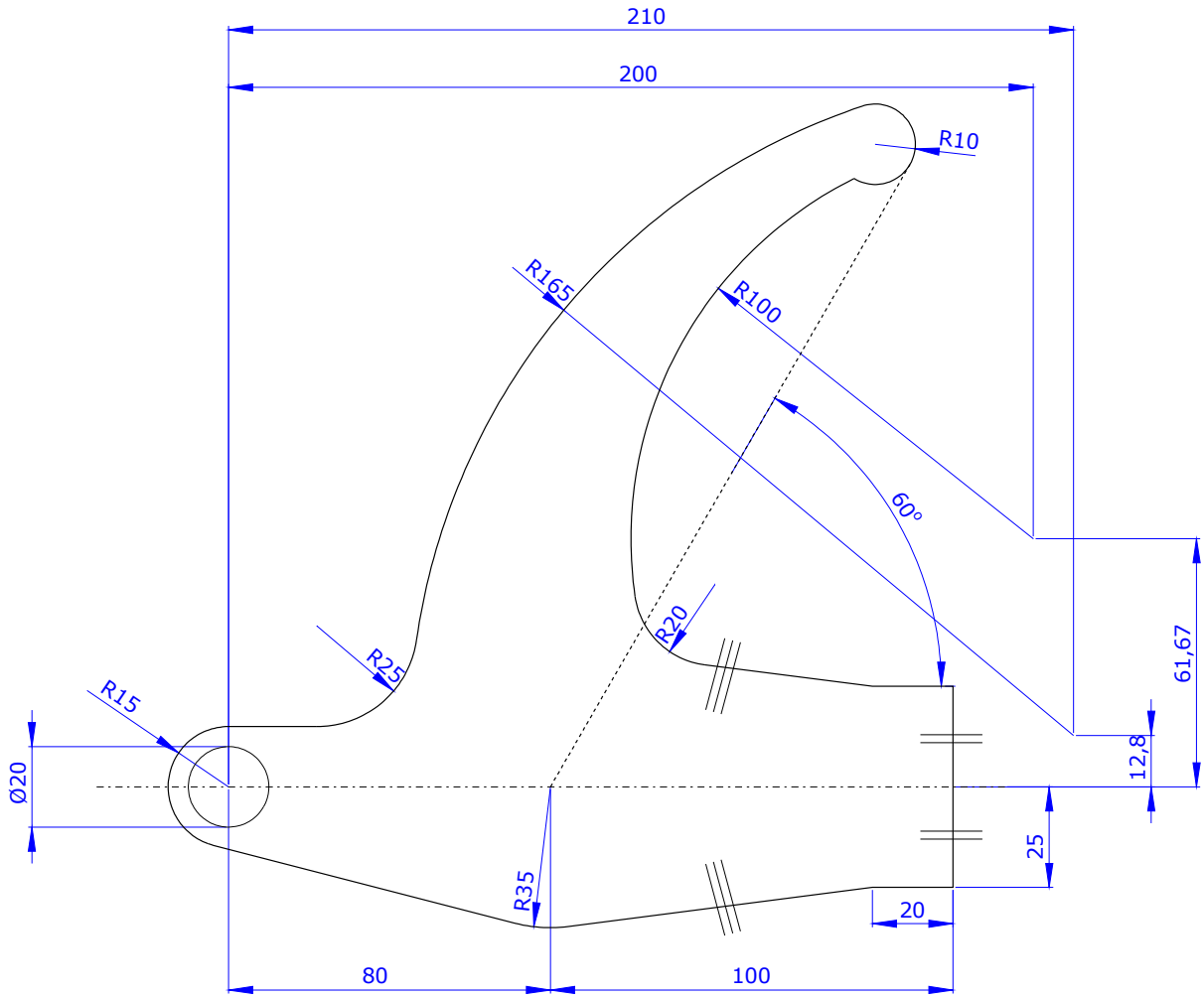
Edit->Paste (fastkey Ctrl-V)

Draw->Arc->Fillet (fastkey F)

Special-> Close (closed profile)

Edit->Reorganize->Reduce and optimize

Exercise 14



Draw->Arc->Coordinates (fastkey C)

Draw->Line-> Tangent

Draw->Line->Aligned (fastkey L)

Edit->Copy (fastkey Ctrl-C)

Edit->Paste (fastkey Ctrl-V)

Draw->Arc->Fillet (fastkey F)

Axis->Snap to (fastkey P)

Draw->Line->Angle

Axis->Reset (fastkey R)

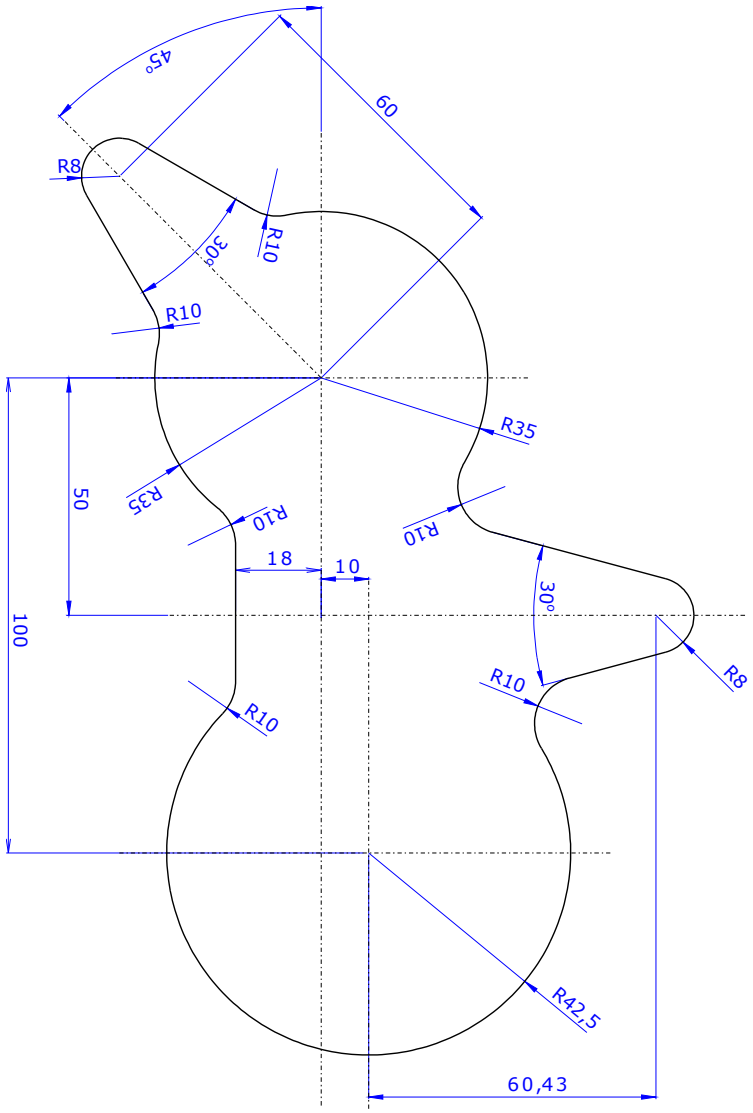
Edit->Trim+extend->Chain (fastkey T)

Edit->Modify Mode

Special-> Close (closed profile)

Edit->Reorganize->Reduce and optimize

Exercise 15



Draw->Arc->Coordinates (fastkey C)

Draw->Line->Aligned (fastkey L)

Draw->Arc->Fillet (fastkey F)

Edit->Trim+extend->Chain (fastkey T)

Axis->Verplaatsen

Axis->Roteren

Draw->Line->Angle

Axis->Snap to (fastkey P)

Special->Close (closed profile)

Axis->Reset (fastkey R)

Edit->Reorganize->Reduce and optimize