

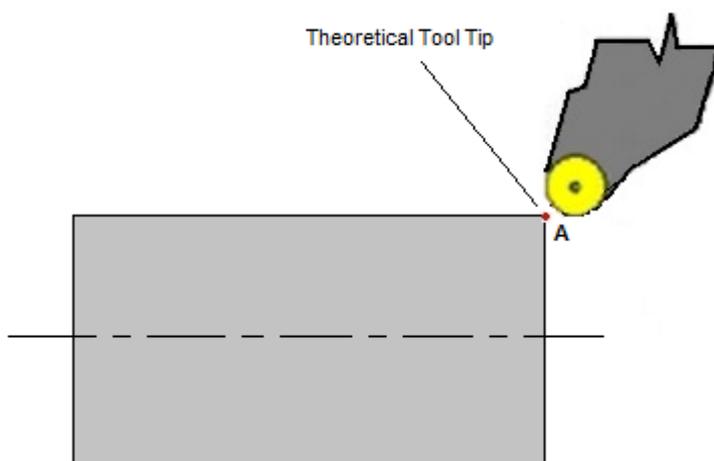
Tool Nose Radius Compensation in CNC Turning

Understanding it, and cutting complex contours without tears



What is Tool Nose Radius Compensation ?

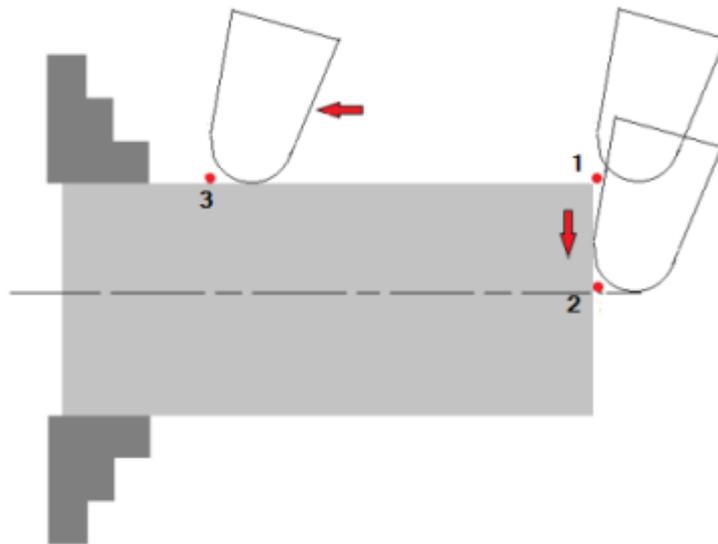
When we set tool offsets for a tool, we typically make a cut along the face, one on the diameter, and set the offsets based on this. We actually set the offsets for the point indicated by the red dot in the picture, the Theoretical Tool Tip (TTT). When we program the tool to move to a certain point, its TTT is the one that actually moves to the commanded point. In the picture below, when we move the tool to point A, the TTT is at point A while the radius is in air, not touching the part.



What happens when we turn various types of contours without TNRC

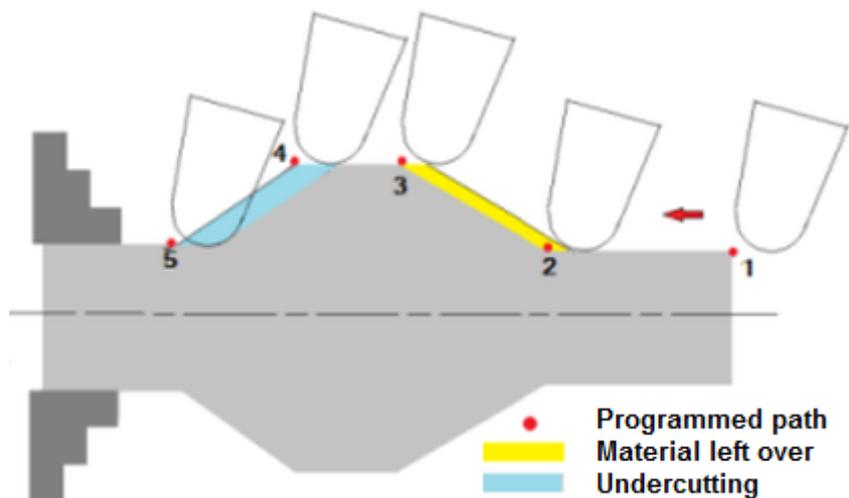
Plain diameter and face

You get the correct dimensions, since the tool radius and the TTT coincide on the face and diameter.



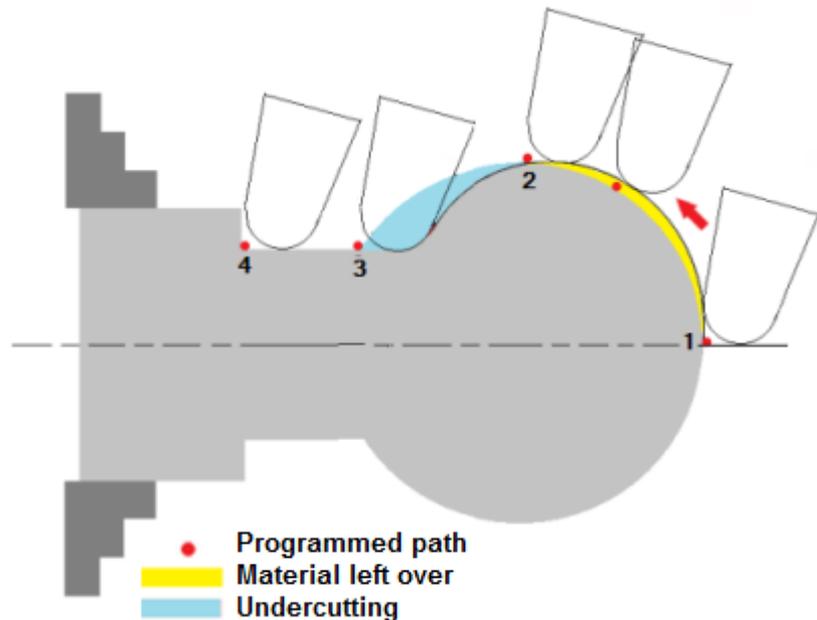
Taper

The TTT moves along the programmed contour, but the nose radius leaves unmachined material in some areas and digs into the material in some areas. On a right side taper you get material left over, and on a left side taper there is undercutting.

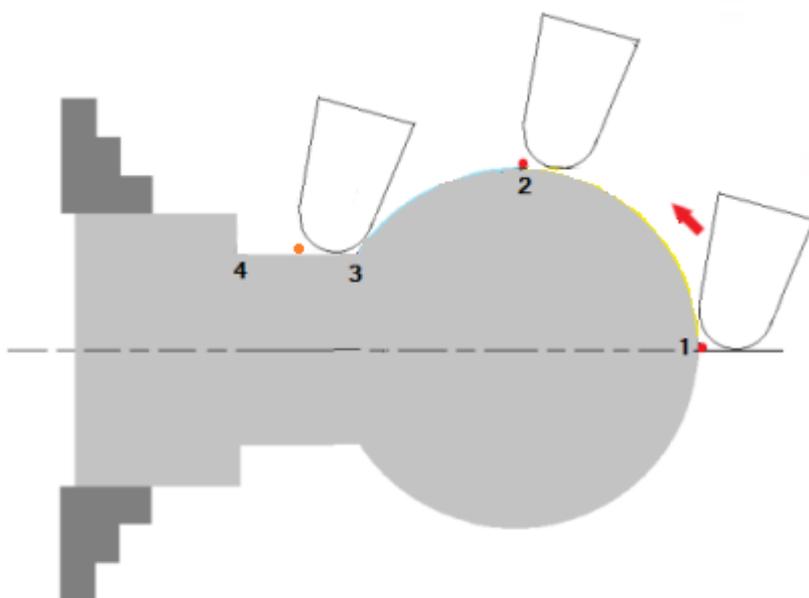


Radius

On a right side radius you get material left over, and on a left side radius there is undercutting. It is very difficult to measure radii, and the typical inspection method is to measure the diameter at point 2. This will give you a correct reading, even though the radius is wrong.



Tool Nose Radius Compensation (TNRC) fixes this problem. Even though we program the TTT to move along the part contour, the TNRC logic in the machine recalculates the tool path and makes the nose radius move along the contour. On tapers or radii the radius is moving along the required part contour, and the TTT point flies in air or digs into the part, like in the picture below. During machining, you'll notice that the tool position coordinates on the machine console do not match the programmed coordinates, because the former is the compensated path while the latter is the programmed (TTT) path.



When must TNRC be used ?

You will never get tapers, chamfers and radii properly without TNRC.

When turning parts with ball shapes, it is quite common to see a batch of parts produced based on this wrong measurement at the machine, and the whole lot get rejected because the radius is not matching. When cutting a 0.5 chamfer with a 0.8 mm radius tool without TNRC you actually get a 0.15 chamfer.

So use TNRC during finish turning of critical radii, tapers or chamfers.

It is in fact best to *blindly use it when doing any finish turning or boring*, and make it a system.

Errors in chamfers and corner radii without TNRC

The tables below show the errors in chamfers and radii when you do not use TNRC. The error on a chamfer is uniform, while the error on a radius varies from 0 at the ends to the maximum shown in the table.

Chamfer

Nose radius	Chf required	Chf obtained
		
1.2	1	0.5
0.8	1	0.7
0.4	1	0.8
1.2	0.5	0
0.8	0.5	0.15
0.4	0.5	0.3

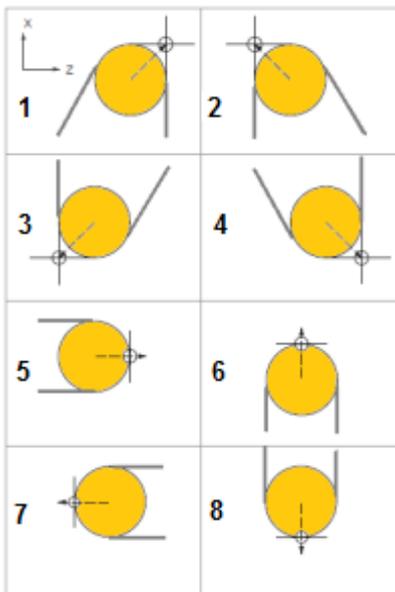
Radius

Nose radius	R required	R obtained
		
1.2	10	9
0.8	10	9.3
0.4	10	9.6
1.2	5	4.15
0.8	5	4.35
0.4	5	4.65

How is TNRC implemented ?

You must do 3 things

1. Add TNRC commands (G41/G42/G40) in the program.
2. Enter the nose radius of the tool on the machine, in the tool offsets page.
3. Enter the tool orientation (see picture below) on the machine, in the tool offsets page.



“My guys seem to be using TNRC, but they don't get contours right”

One of these things may be happening:

1. The programmer has entered the TNRC commands in the program, but the operator has not entered the nose radius and tool orientation at the machine.
2. The nose radius has been entered wrongly at the machine. E.g., using a 0.8 R tool, entering 0.4 at the machine.
3. The tool orientation has not been entered correctly.

Ensure that this check list is followed:

1. **Add TNRC commands** in the program.
2. **Enter the nose radius** of the tool at the machine
2. **Enter the tool orientation** at the machine

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