System Manual

1. Task Description

A crucial element for high quality tool manufacturing is a **correct and precise grinding parameters setting**. Lengthy tuning of these parameters spins out the total time and increases the costs of manufacturing preparation. Bringing a viable solution to this problem can significantly reduce the valuable time of CNC machines and the costs of materials. inDrill automatically designs an optimal abrasive disc cross-cut which enables accurate manufacturing of drilling tools with a user-defined cross-cut and a geometry of the grinding process. The preparations for the drilling tool manufacturing is then entirely handled by a computer which computes the optimal cross-cut and grinding parameters without unnecessary material and grinding machine usage.

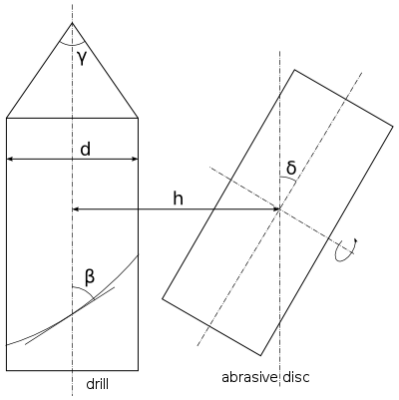
A critical step during the process of manufacturing drilling tools by grinding is the accurate definition of the **abrasive disc's cross-cut**. The task can be defined by seven independent parameters divided into two groups:

Definition of the resulting drilling tool:

1. Drilling tool cross-cut (d)
2. External spiral acclivity angle (β)
3. Angle of the tip (γ)

Grinding technology geometry:

4. Abrasive disc axis angle – vertical (δ)
5. Abrasive disc axis angle – horizontal
6. Angle between abrasive disc and spiral axes
7. Distance between tool and abrasive disc axes (h)



inDrill software solves the problem defined by the above input parameters (1-7) and provides an **output of the optimal design** of:

1. Abrasive disc cross-cut
2. Drilling tool's cutting edge shape

2. Software Description and Program Control

To enter the application please first log into the system and then click the **New computation** button. The computation itself is divided into two logical steps: 1. Parameter Setting and 2. Computation Execution and Analysis of Results. The discussion of these two steps follows.

2.1 Parameter Setting

The upper part of the application's screen contains 2 control panels which allow defining parameters. Panel [**Crosscut editor**] defines the desired tool's crosscut and all other parameters can be specified on the [**Parameters**] panel.

The following information is required to fully define the grinding technology's geometry on the [**Parameters**] panel:

Tool diameter – outer drilling tool's diameter

Distance between tool and abrasive disc axes – distance denoted by *h* which is implicitly defined by the abrasive disc's diameter

Screw acclivity angle – parameter defining the outer screw acclivity angle

Angle of the tip – angle of the tip (the cutting edge is determined by this value)

Disc angle – the rake angle between the abrasive disc and the workpiece

Abrasive disc axis angle – the angle at which the abrasive disc approaches the workpiece (the direction is shown on the crosscut image by a blue axis)

Maximum number of points in the disc crosscut – The computation always determines a precise abrasive disc's crosscut. However, some CNC machines cannot create an abrasive disc which is defined by too many points. Therefore, this parameter allows manually limiting the number of points defining the disc's crosscut. After the computation is completed you can see in the Test of agreement figure how limiting the number of points affects the resulting drilling tool's crosscut.

Panel [**Crosscut editor**] allows controlling some other drilling tool's parameters:

Name of crosscut – defines the name of the crosscut which is shown in the final report and also sets the predefined file name for crosscut's settings export

Repetitions – this number specifies how many same segments form the crosscut. This repeated segment is then defined by the editor below on the panel.

Editing radius – the crosscut definition is performed in a dimensionless environment (without any relation to the tool's diameter on the first panel). This parameter defines the radius in these dimensionless units.

The lower part of [**Crosscut editor**] control panel allows to define the drilling tool's crosscut. The crosscut can be defined either directly in the application or by loading a template from a file (which has been saved previously in the application).

The crosscut is defined by a group of consecutive elements (arcs and lines). The start point of the first element is a point located at coordinates x=editing radius, y=0; every following element starts at the end point of the previous one. Each element defines both the end point and the way to connect the start and end point. There are three options for connecting the points:

- **Line** – Start and end points will be connected by a line. The entry fields x and y define the coordinates of the end point.
- **Arc defined by radius** – Start and end points will be connected by an arc. The entry fields x, y and r define the end point and the radius of an arc which connects the start and end points. Positive values of the radius create a convex arc, while negative radius creates a concave one.
- **Arc defined by center** – Start and end points will be connected by an arc. The arc is defined b its center which has to lie on the axis between the start and end point. The entry fields x, y, x_c and y_c define the end point and arc's center.

During the drilling tool's crosscut the following button controls are available:

Add – Adds a new entry into the crosscut definition; its type can be selected from the drop-down menu.

Delete last – Deletes the last entry in the crosscut definition.

Update – Some changes to the crosscut definition do not force the model to be updated. In such cases the Update button shall be used.

Download tool crosscut – Saves the crosscut definition onto your hard drive. The saved definition can be used later or work as a backup.

Browse… / Load crosscut – This pair of buttons allows replacing the current crosscut definition by one loaded from you local hard drive.

Note: *If any of the end points lies out of the circle of the workpiece defined by the editing radius, the editor tries to scale the crosscut such that the point lies on the circle. In such case, it is possible that the first point does not lie on the circle exactly.*

2.2 Computation Execution and Analysis of Results

After all parameters defining the task are set you can execute the computation on the [**Parameters**] control panel. When the computation completes, 4 new figures and several links appear at the lower part of the screen (in the **Computation results** section).

Download tool report – System generates a report about the computation in a pdf format. The document contains the parameter values, abrasive disc's crosscut and the resulting tool's crosscut.

Tool crosscut – To allow a more detailed view on the defined tool's crosscut you can download a pdf document with the crosscut in a vector graphics form.

Cutting edge – This figure shows the shape of the tool's cutting edge which was designed to follow the overall geometry of the task, the drilling tool's crosscut and the angle of the tip. Figure can be saved as a pdf document.

Disc crosscut – Abrasive disc's crosscut which allows the specified drilling tool's creation is shown. It can be saved both as a pdf document and as a csv file with point representation. The point representation enables a creation of a CNC program to control the abrasive disc. Automated generation of CNC programs in the application can be optionally enabled for users on demand.

Disc passage – A simulation of the process of grinding of the drilling tool with the designed abrasive disc is shown and can be saved for further analysis in a pdf format.

Test of agreement – Figure shows a comparison between the desired tool's crosscut and the crosscut achievable in practice with the specified limiting conditions and designed abrasive disc. The quality of agreement is affected by the practical impossibility of grinding some profiles with defined geometry and manually limited number of defining points of the abrasive crosscut. The figure can be saved as a pdf document for further analysis.

Note: *The system is always searching for an abrasive disc which can create the first groove of the crosscut. The first groove means the region from the start point of the first element to the point where the groove first touches the workpiece circle.*

Note: *Even though the system works only with the first groove, it is necessary for the computation quality to model the whole crosscut including the number of repetitions.*

Note: *There are combinations of settings (task geometry – drilling tool's crosscut) for which it is not possible to find a satisfactory result. Yet, the algorithm gives a solution which cannot be used directly but it can help in the search for the cause of the problem (e.g., too sharp edges, incorrect disc angle, etc.)*

Note: *The application allows defining even technologically infeasible crosscuts and a user is responsible for setting the parameters in a realistic way and checking the results.*

This document was created by a team of experts at **inSophy s.r.o.** and shall be used as a manual for the inDrill application. In case you have any questions or need help with the application please contact inSophy directly.

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