

# mCAM & mCAM Lite & mCAM Pipe+

### **USER MANUAL**

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## Using the manual

The manual is organized into several parts that individually deal with particular section or topic of the program. The first part deals with introductory information about the basic program principles and possibilities.

The second section *Installation* specifies basic system requirements, describes installation procedure and the verification system.

The next part *File formats* specify available input and output formats, all supported shapes, as well as the databases that can be involved in input formats.

The section *User interface* contains fundamental information about the program, program appearance and model rendering possibilities.

The section *Application workflow* introduces a basic procedure of working process summarised in few steps starting from loading of input files until generation of CNC program.

The next section *Cutting path modifications* describes how cut paths can be modified.

Section *Cutting plan preparation* that deals with program task (*Import, Job task, Library*), the function Drag and drop, machine and WebService setup, expert tables setup – kerf width compensation, nesting or cutting plan generation.

The section *Settings* describes all properties and configurations of *machine*, *technology*, *tool codes*, *expert tables of cutting parameters*, *transformations* and other presets.

The section *Troubleshooting* contains the program information, access to program documentation, describes *shape geometry data* inspection and *Reporting* system.

The last section *Working with MPM* describes standard working procedure in *mCAM* integrated in *MPM*.

Note: The mCAM is in the state of permanent development, so this user guide describes version 2.0. Different versions might contain some new functions, some functions can be removed or modified. The version number and release date can be checked in the menu: "Help  $\rightarrow$  About...".

## **Introduction to mCAM Lite**

mCAM Lite is an easy-to-use CAM software tool combining the powerful mCAM engine with a user-friendly interface for easy and professional preparation of cutting plans for straight cutting of any supported part – by means of cutting with straight cutting head only (not bevelling heads). By using mCAM Lite it is possible to process any workpiece shapes standardly supported by mCAM –pipes, tubes, profiles, domes, but they are limited only to straight cutting with straight cutting torch (not possible to process beams as H-beams/I-beams, Uchannels or L-bars as the bevelling is needed).

Note: In case the 3D model contains welding preparations (bevels) mCAM will limit these contours and generate them in straight cutting path only. Contours which are supposed to be bevelled or chamfered after straight cutting (by manual grinding or manual chamfering) can be marked (marking of ideal bevelled contour) in order to visualize the area for subsequent grinding (possible to use only for top side bevels = V-type and Y-type bevel).

## Supported Automation level – manual loading only

*mCAM Lite* is designed for advanced straight cutting, using energy-beam technologies (e.g. plasma, laser, oxy-fuel, water jet) and supports only machines with manual loading of workpiece into the cutting area (tubes, profiles, beams, etc.). Machines with extended level of automation of workpieces are not supported (tube loaders, beam loaders, etc.).

### Supported formats – STEP and IGES formats only

The software can process any supported 3D model geometry generated by commonly used CAD softwares (such as SolidWorks, 3D Inventor, Autodesk 3D, CATIA, Parasolid, PTC Creo or any other CAD SW) with possibility to export STEP or IGES formats (STEP format - \*.step, \*.stp; IGES format - \*.iges, \*igs).

Additional "mCAM friendly formats" that are standardly supported (exported) by structural BIM Softwares (such as TEKLA, Aveva BoCAD, Revit, Rhinoceros or many other), such as format DSTV (\*.nc, \*.nc1) or parametrized tube connections ( \*.xlm), are available only in higher versions of mCAM (not supported by mCAM Lite).





## Simple shapes and standardized connections (notches) – *mCAM macros*

*mCAM Lite* integrates also the functionality to prepare standardized connections and notches by using *mCAM macros*. Integrated library contains standard and most-commonly used types of connections for pipes, tubes and profiles (similar to SolidSel or PipeSel). In case of using macros, the cutting path generated after will still be limited to straight cutting only. Most common types of macros are already included in mCAM and mCAM Lite, and new shapes and types will be added gradually to the mCAM library with following updates.



Fig. 1: An example of macro – Cylindrical hole

## mCAM Lite functionality – standard mCAM functionality included

Rest of *mCAM* functionality including the marking process (Ink-jet, Laser marking, etc.), additional operations such as Drilling or Punching, 2D/3D visualization of parts, 3D cutting simulation, WebServices (connection to machine) is available and fully supported by *mCAM Lite* version.

## **Introduction to mCAM Pipe+**

mCAM Pipe+ is a CAM (Computer Aided Manufacturing) software that is capable of preparing cutting plans only for cutting of circular pipe, circular pipe segments and sheets in a full 3D mode.



Fig. 2: Imported circular pipe from STEP file

mCAM Pipe+ can process 3D geometry, has support for bevel cutting and for preparations for welding; also supports cutting sheets at an angle and supports Additional Bevel Processing (ABP) for sheets.

Supported are only STEP or IGES formats (STEP format - \*.step, \*.stp; IGES format - \*.iges, \*igs).





Fig. 3: Nested circular pipes in a Temporary job

This software also contains a library for macros. All macros contained in this library are only for circular pipe.



Fig. 4 Examples of macros for Circular pipe in Macro feature

## Introduction

*mCAM* is a CAM (Computer Aided Manufacturing) software for professionals preparing cutting plans for 3D cutting. *mCAM* is designed for advanced automated 3D machining using energy-beam technologies (e.g. plasma, oxy-fuel, water jet, laser, etc.).

The software processes any supported 3D model generated by commonly used CAD software (Computer Aided Design) or any model–based software for steel constructions (e.g. Tekla) that can export steel structures in DSTV or xml. formats but generates cutting paths only for those shapes that are supported by mCAM.

The software creates libraries of frequently used parts, offers advanced visualization and helpful previews. Well-arranged user interface with variety of settings allows simple, highly efficient, and precise manipulation and setup of cutting paths and its features. The software includes also a built-in CNC simulator that simulates generated CNC code so user can check cutting paths.

#### **Program features**

The *mCAM* uses boundary representation (B–rep) for processing true realistic 3D shapes. *mCAM* supports several options for import of shape data:

- 3D CAD models
- Model-based steel structures (DSTV, xml)
- 2D surfaces geometrically projected on 3D parametrized shapes
- libraries of standard shapes

The *mCAM* analyzes the shape of 3D models and automatically generates all cut paths. The program provides useful and powerful functions such as tool kerf compensation, placement of microjoints, management of lead—in s/–outs, simulation of machining, as well as interconnection of *mCAM* with *MPM* (*MicroStep Production Management*). The functions in combination with used framework and user – friendly interface make the program efficient, simple, and well organized.

#### **Boundary representation**

Boundary representation is a method for representing shapes using the bounds. A SOLID is represented as a collection of connected surface elements, the boundary between solid and non–solid. The 3D space inside SOLID is bounded by FACES. Every single FACE is defined analytically as bounded surface, e.g. cylindrical, spherical or BSPLINE surface. These faces put together form encapsulated solid. A face is bounded by one WIRE that consists at least of one EDGE. Every EDGE is defined analytically (lines, arcs, splines) and has two ending points (VERTEX).

The *mCAM* approach is based on a tree structure that describes the details of a 3D shape. SHELL contains several FACE-s, every FACE contains several WIRE-s. FACE could possibly contain some holes that are also defined by WIREs. Every WIRE contains at least of two EDGEs and an EDGE has two VERTEX-es (end points).



Fig. 5: B-rep model using 12 faces

#### In-depth shape analysis

By analysing raw geometrical data of 3D model, mCAM is able to recognize shape type and process cutting faces automatically. Due to shape type analysis and deep processing of all faces in solid geometry (that defines B–rep structure), *mCAM* is able to process almost any cutting surfaces and shapes including complex variable bevel cuts, Y, K or X–cuts.

After all cutting faces are processed, user is able to prepare a cutting plan in few steps. All cutting features, modifiers and tools are easily accessible in interface and it's possible to modify them according to user requirements.

	Name	Value
	a 🍋 0137+013	Circle pipe D: 219.100 T: 12.500
		SOLID: volume=2.41596e+006
	ASHELL 7 F	SHELL:
	DEACE 8 R	INNER cylinder B= 97 05000
	FACE 46 F	OUTER cylinder R= 109.55000
	FACE 84 F	OUTER cylinder R= 109.55000
	PEACE 143 R	CUT plane
	▶FACE 157 R	CUT plane
	▶FACE 177 R	CUT plane
	▶FACE 191 F	CUT plane
	▶FACE 217 R	CUT plane
	▷FACE 231 F	CUT plane
	▶FACE 251 R	CUT plane
	▷FACE 265 F	CUT plane
	▶FACE 291 R	CUT plane
	▶FACE 305 R	INNER cylinder R= 97.05000
	▷FACE 352 R	CUT plane
	ÞFACE 366 R	CUT plane
	▶FACE 380 R	CUT plane
	FACE 394 R	CUT plane
	▷ FACE 408 F	CUT plane
	▶ FACE 428 R	CUT plane
	▶FACE 442 R	CUT plane
	▶FACE 462 R	CUT plane
	▷FACE 476 R	CUT plane
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	▶FACE 559 F	CUT BSPline surface (Plane)
	▷FACE 573 R	CUT BSPline surface
	▷FACE 593 R	CUT BSPline surface
	PFACE 616 F	CUT BSPline surface (Plane)
	PFACE 630 F	CUT BSPline surface (Plane)
	Difaces	
	Pedges	
	edges	
	Pedges cut #85	
	p faces cut #688	1
	Cut Paths #1	
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	¥	
	/	
	X	

Fig. 6: In-depth shape analysis

#### Assembly importing

In mCAM it's possible to import a whole assembly of 3D models (STEP/IGES) and process every single part individually. It is necessary to save the assembly as separate solids when exporting from SolidWorks or another 3D CAD software. All imported parts are sorted according to type and dimensions, making the nesting, reports and generation of cutting plans very effective.



Fig. 7: Assembly import

#### WebService connectivity

WebService is a mandatory network application tool that connects a machine, its technology and tools database with *mCAM* via company network. With WebService user can take advantage of expert system of cutting parameters, download tool database from iMSNC automatically and fully integrate technological setup for particular machine and technology within company.

WebService is very useful when working with several machines, several technologies or advanced cutting because it increases effectivity when preparing CNC programs.

## Installation

*mCAM* can be installed only under certain conditions. All necessary system requirements are specified in the next sections including a brief description of the installation procedure.

#### System requirements

*mCAM* program can be used on any commonly used personal computer under 64 bit version of operating system Windows 10 (version 1607 and above) and Windows 11. A necessary condition is a presence of a graphic card that supports OpenGL interface in version 2.0 or higher. Microsoft .NET framework 4.5 has to be installed. A storage disk drive has to have at least 500 MB free space.

Note: There are no minimum hardware requirements and *mCAM* can be installed on any computer with previously mentioned software requirements but due to high advanced graphic visualizations, complex nesting procedures and sophisticated limitation algorithms it is highly recommended to install the application on computers with sufficient performance as for standardly used 3D CAD software.

#### Installation procedure

Installation file can be downloaded from <u>https://customer.microstep.sk/</u>. It is possible to choose stable or beta version of the program in "Type" field on the website. Name of installation file looks like this: mcam\_YYYY\_MM\_DD\_8XX.release.x\_64\_setup.exe. YYYY is year, MM month and DD day when the built was created, 8XX.release.x refers to mCAM version and number of the release.



#### Fig. 8: MicroStep Customer portal

To install the *mCAM*, run the installation file from downloaded files folder in computer. In this procedure user selects which components should be installed, e.g. *MPM* and destination folder for application. The default installation folder is *C*:\*msnc*\*mcam*. The option *Clean installation* removes already existing files from previous installation.

Note: The installation target directory should not contain international characters.

#### **Types of licenses**

License is issued forever (except for service license). License is registered for specific computer. Therefore, user can have installed multiple versions of the program in different directories and use the same license for them. To release a license from a PC is possible in the mCAM program or by using the customer portal.

For proper functionality it is necessary to allow access via https protocol, to the addresses - "license.microstep.sk" and "auth.microstep.sk".

#### • Online license

Online license is registered on servers and transferred to PC. It requires internet connection for proper functioning. Without Internet access the online license stored in the license client program directory is valid for 30 days.

#### • Offline license

Offline license is generated in the mCAM/Asper program and stored as a file in license client program directory. The file can be transferred to an internet connected device and uploaded to MicroStep customer portal from where user will get the response in form of a file that is used for registration. Validity of this license is one year. Offline activation process must be done at the customers environment (it is possible to assist by using TeamViewer).

#### Procedure for creating an offline license:

1. In the mCAM program, by clicking on the license client icon (lower left), open the licensing information and choose "Offline activation" - "Save license request"

Machinac d	Licensing information	×
Machines 🔛	Log in	
Imports	Logged in as (Logout) Subscription Subscription valid until 3110.2023	
~ Recent imports / Folders	Active licence	
lobs	Licence #1 Release	
Drop shapes here to create new job	Features       mCAM         Activation method       Valid until (prolongs automatically if online).         Online       4.1.2023         ✓ Offline activation         ↓ Save licence request	)
$\hat{\Gamma}$		
	Service licence Ok	

- 2. Select the folder, where the file will be saved
- 3. Log in to the Customer portal using your login data and select Manual activation



- 4. Click the "Upload license request" button to upload the file with the extension".json" that you have downloaded in the mCAM program
- 5. You will receive the activation file, select the folder for its location
- In the mCAM program, click on the license client icon (bottom left), choose
   "Offline activation" "Load license file" and upload the activation file that has been downloaded in the previous step
- **7.** Offline activation is complete

#### • Floating license

Floating licenses are similar to online licenses with the difference that they are registered for a very short time - a few minutes, so they are easy to share between several computers. If the program is correctly terminated, it is automatically logged out of the floating license, which is immediately accessible to another computer.

#### • Service license

This license is available only for MicroStep employees. It is only valid for a few days. This license is the only one that does not transfer automatically to another installation on the same PC.

#### • Releasable license

A license that binds to a given PC upon the first registration and cannot be transferred to another PC. Serves as a machine license.

## **Supported shapes**

By using in depth analysis of imported shapes, mCAM processes all cutting faces and generate cutting paths automatically. Shape type recognition is based on a principle of geometry detection of imported 3D shapes, so the geometry of any imported 3D shape has to meet geometrical parameters determined by each shape type. Current version of the mCAM supports detection of these 3D shapes:

- plane shape
- pipe (circle pipe) + circle pipe segments
- rectangular profile pipe
- torispherical domes this includes all types of domes with various heights and radiuses ratios e.g. elliptical domes, elliptical domes (1,9:1 and 2:1) torispherical domes (DIN 28011), semi-elliptical domes (DIN 28013), tank domes for single and double skin tanks (DIN 6608/6616, DIN 6608/2, 6616/2) etc.
- EHA/EHB Elliptical domes ISO9001:2008; GB/T25198-2010 (these domes have to be designed in a special way, for more information contact support team)
- conical dome
- dished discs
- dished bottom domes
- flat bottom domes
- inverted head domes
- H-beam (HE, HEA, HEB, HEM, HEAA, HD, HL)
- I-beam (IPN, IPE, IPEA, IPEAA, IPEAO)
- U-beam (UE, UPE, UPN, UAP)
- bent U-beam
- L-beam (equal/unequal angles sizes EN 10056, EN 10162)
- Bent L-beam



#### Fig. 9: Plane shape



Fig. 11: Rectangular profile pipe



Fig. 12: I profile - IPN beam (non – parallel flanges)



Fig. 13: H Beam - HEA, HEB, HEM and IPE beams (parallel flanges)



Fig. 14: UPE, UAP beams (parallel flanges)



Fig. 15: UPN beams (non – parallel flanges)



Fig. 16: Bent U-beam



Fig. 17: L beams (equal / unequal leg angles)







Fig. 20: Conical dome















Fig. 24 Inverted head dome

#### Special recognition of shapes

When importing cones, it is necessary for correct recognition of shape type and all cut paths to define parameters of all types of cone semiproducts that are being used. This is done by manually editing a *shape\_type.ini document located in "C:/msnc/mcam/config/"* folder.

#### Example:

#### [domecone] domecone\_thickness:3.00\_cylinderRadius:1154.0\_torusMinorRadius:100.00\_apexHole Radius:20.00\_openingAngle:130.0=DOMECONE 1154 domecone\_thickness:3.00\_cylinderRadius:1154.0\_torusMinorRadius:50.00\_apexHole Radius:20.00\_openingAngle:140.0=DOMECONE 1154 ------- domecone

Each row represents one type of cone and its parameters – thickness, cylinder radius, torus minor radius, apex hole radius and opening angle. All dimensions are in [mm] except angle [°].

## **File formats**

This section defines all input and output formats supported by the mCAM. Input formats are divided in groups according to their type.

#### **Input formats**

All supported input formats can be divided into four groups:

- CAD models (\*.step, \*stp, \*.iges, \*.igs)
- Model-based steel structures (\*.nc1, \*.nc, \*. xml, \*.ifc)
- Surfaces (\*.cnc, \*.dxf)

#### CAD models

To define a geometry of 3D shapes the *mCAM* supports commonly used STEP and IGES formats. STEP and IGES formats are generally included as export formats of all commonly used CAD software. Format names, file extension, and its descriptions are summarized in the table below:

Format name	File extension	Description
STEP	*.step, *.stp	Standard of Exchange of Product Data Model
IGES	*.iges, *.igs	Initial Graphics Exchange Specification neutral data format

Tab. 1: CAD models – Input formats

#### Model-based steel structures

Model-based steel structure data represents some commonly used formats that are possible to export from BIM software (Building Information Modelling) such as Tekla Structures or Tekla BIM sight. Exported model-based structure data contains geometry of each part, position in structure (in assembly) and information about used intersection type with another part in assembly nodal point.

Format name	File extension	Description
DSTV	*.nc, *.nc1	Industrial standard defined by the German Steel Construction Association (Deutsche Stahlbau– Verband)
XML	*.xml	Standardly used NC files for creation tubular hollow sections, tube-to-tube and tube-to-plate connections
IFC	*.ifc	IFC (Industry Foundation Classes) data format is intended to described building and construction industry data

Tab. 2: Model-based steel structures - Input formats

**Note:** Processing of these formats in mCAM is limited by their capabilities and limitations, therefore we recommend to use STEP format as main input format.

#### Surfaces – CAD drawings and SolidSel library

Final 3D model can be also defined by 2D drawing that is projected or wrapped around a solid shape. The *mCAM* supports projection or wrapping of 2D drawing on round pipes, rectangular pipes, and domes.

Creation of 3D model by using 2D surfaces originated from the SolidSel library and is similar to the case of 2D surfaces from DXF file. A surface shape generated by SolidSel in CNC code can be created by parametrized models defined by group of particular parameters as intersections of round pipe or other 3D shapes included in the SolidSel library. There are limited possibilities of bevelled cuts in case of DXF format, and limited feature set for CNC format.

Format name	File extension	Description
DXF	*.dxf	AutoCAD open format available in most CAD programs
CNC	*.cnc	G–codes and M–codes

Tab. 3: 2D	surfaces –	Input	formats
------------	------------	-------	---------

### **Output formats**

The *mCAM* offers the output in form of a CNC code that is sent or used directly on a machine.

Format name	File extension	Description
CNC	*.cnc	G–codes and M–codes

Tab. 4: Output formats

## **User interface**

It is possible to access and edit simultaneously several working tasks due to MDI structure of the program (MDI – Multiple Document Interface). The main menu bar of the program is displayed on the top of the screen. This menu contains basic functions of mCAM. The content of the menu bar is variable and it changes depending on the active task bar (import/job...)

The layout of the program screen can be edited to make it convenient for a user by several window appearance options and by modifying the size of each area (*master panel*, properties, *working tree* or visualization screen).

#### **Program areas**

User interface is divided into four main areas in order to provide simple manipulation with all items.



Status bar

Fig. 25: Appearance of mCAM

#### **Basic controls**

This section just describes commonly used control elements.

• **Context menu** – when user performs right click with mouse on the element in the working tree in import or job tab (e.g. on template, stock or part) a context menu appears with various actions, depending on the clicked element.

The Mirror function in Context menu is capable of creating a mirror image of an imported 3D shape.



Fig. 26: Context menu with actions for part in Import tab



Fig. 27: The original imported 3D shape and its mirror image



Fig. 28: Context menu with actions for template in job tab

- **Shortcuts** Shortcuts provide an efficient way to work without continually moving the pointer to the main menus or the toolbar buttons:
  - → Alt + F Opens File menu
  - $\rightarrow$  Alt + W Opens Windows menu
  - $\rightarrow$  Alt + H Opens Help menu
  - → Ctrl + I Opens Import dialog window
- → Ctrl + S Opens Raw view
- $\rightarrow$  Alt + X Exits mCAM
- $\rightarrow$  **F1** Views Help (user guide)
- $\rightarrow$  **F9** Opens Console
- ightarrow F11 Opens debug tools window
#### Master panel

Master panel is on the left side of the screen. It displays an overview of all connected machines, recently imported shapes, favourite folders and opened jobs. *Drag and drop* function is described in more details in section Drag and drop on page 192.

Machine connections	Ъ
9999 MicroStep D	emo Machine
Import shape	🛞 Create shape
C Recent imports	Folders
<pre></pre>	is.STEP non_cut.STEP
Drop shapes here to	o create new job
Temporary	job7 ×

#### Fig. 29: Master panel

#### **Properties**

The Properties area displays details and all important properties of currently selected task tab (import, job, full view, library, etc.), template, stock, stock part, or cutting path.

**Note:** The editable features of the properties menu are changing according to currently selected part, stock, template, cutting path or any feature that is possible to modify.

One of the main purposes of properties bar is to adjust different features of cutting paths as lead–ins/-outs, microjoints, transformations, text marking, contour marking or define

used operation (for laser and water jet cutting). All cutting path editing functions are displayed in Properties area when cutting path is selected in Import task tab, Library or in Shape tab in Job task tab.

Property inspector	
✓ Solid	
Name	H beam
W:	200.00 mm
H:	190.00 mm
R:	18.00 mm
T:	10.00 mm
CT:	6.50 mm
Ŀ	527.00 mm
<ul> <li>Technical summary</li> </ul>	
Lowest cut depth	0.00 mm
Highest cut depth	23.17 mm
<ul> <li>Technology setup</li> </ul>	0
Machine	9999 MicroStep Demo Machine 🔗
Technology	11 xpr 🗸 🗸
Material	
Power	
Tool	XPR300-MST- 10.000- 80-02+Air-: ~
<ul> <li>Nesting settings</li> </ul>	
Nesting gap	5.00 mm
Startpoint X offset	0.00 mm
Use part envelope only	
Surface mapping quality	Normal ~
Enable part rotations and	d flipping
✓ Job stock	
🗹 Virtual stock	
Unlimited count	
Count	1
Length	527.00 mm
<ul> <li>Plan generation</li> </ul>	
Program name	
Output format	Cnc ~
Cutting mode	Static cutting (on supports/roll ~
Chuck location	At X min ~
🗹 Marking	
✓ Transformations	
🗹 Text marking	
✓ Cutting	
Remark	
Cut end of pipe	

Fig. 30: Stock properties menu

### Working tree

The *Working tree* is next to Properties and it displays all items that you are working with including parts, shapes, stocks, libraries and jobs. Selected item is displayed in the *Visualization screen* and its properties in the *Properties area*.

User can drag and drop parts from the *Working tree* into the job in *Master panel* (see section Job task creation) or drop parts on the stock.



Fig. 31: Selected stock item in working tree – properties editing

# Visualization screen

Visualization screen displays 3D model of the active item, part, stock, etc. It is possible to zoom–in and zoom–out the model by turning a mouse–wheel, when the mouse–wheel is pressed and held, it is possible to move the model.

Coordinate system of the active view is displayed in the bottom right corner.



Fig. 32: Cutting path selection in visualization screen

After selecting a cutting path by clicking on it, you can choose another one by holding **Shift** and clicking on it, like this you can select any number of cutting paths you want.

#### **Visualization screen controls**

The view in visualization screen is controlled with standard mouse controls and special control elements at the top and bottom of the visualization screen.

#### **Mouse controls**

- Left mouse button rotates the view of a part
- Shift + Left mouse button zooms in selected area (fast zoom)

- **Ctrl + Left mouse button** moves the item in visualization screen
- Middle mouse button (scroll) Zooms the view of part or group of nested parts on stock material





Fig. 33: Controls of visualization screen with active 3D view.

lcon	Description
53	Fit to window
	Opens Select cut dialog
0	Displays menu with settings for visualization screen
2	Undo action
C <sup>4</sup>	Redo action
😭 3D	3D view
📋 YZ	YZ plane view (locked)
🕎 ХҮ	XY plane view (locked)
🎓 xz	XZ view (locked)

Rotation of model is disabled with YZ, XY and XZ view selected. Only panning and zooming in/out of the model is active.

When 2D view is selected, it is possible to access measuring tool by clicking and holding ALT key and clicking and dragging mouse pointer across the screen (e.g. to measure a hole diameter, thickness etc.). The measurement is displayed in the bottom right corner of the screen.



Fig. 34: Measuring the diameter of the hole

User can also switch between individual views with the radial view widget, that will pop out by right clicking in visualization screen. Without releasing the mouse button, it has to be dragged over and through the desired view to change it.



*Fig. 35: Without releasing the right mouse button it has to be dragged over the view user wants to select (in this case, XZ view would be selected)* 

Individual settings for what is displayed in the visualization screen are located in the

combo box with eye icon <sup>(2)</sup> in the bottom panel of visualization screen. After clicking on the icon with left mouse button a list of settings appears. Active settings are displayed in bright blue color with white text, disabled settings are displayed in grey-blue color with grey text.

	lcon	Description
<b>()</b>	Show wireframe	When activated, displays the model (including the tool in simulation) in wireframe rendering
$\odot$	Show/hide stock	Displays the stock (in light blue color)
1	Show/hide edge markers	Show/hide edge markers (edge markers are described in more detail in section Edge markers on page 133)
•	Show/hide decorations	Displays decorations – e.g. measuring points ( <i>only in simulation</i> )
Ŧ	Show/hide tool	Displays the tool (only in simulation)
J	Flags to downpoints	Displays cutting points along the entire thickness of the material



Fig. 36: Cutting points are displayed along entire thickness of the material

#### Selection of cutting paths using Lasso

This feature is best used when you are dealing with a lot of cutting paths on one shape. To select a certain amount of cutting paths you can press Shift, clicking the right mouse button and by dragging you can choose which cutting paths you wish to edit.



Fig. 37: Selecting the cutting paths

These selected paths will become highlighted in yellow color.



#### Fig. 38: Highlighted cutting paths

By pressing Alt alongside Shift, right mouse button and dragging you can unselect previously selected cutting paths, choosing only a few particular ones you need.



Fig. 39: Unselecting particular cutting paths

#### Rendering

There are two rendering modes that allows user to choose proper and more clear displaying mode - Shaded view or Wireframe view. Shaded rendering is considered as standard rendering option where a model is displayed without highlighting edges, corners or other sharp shapes.



*Fig. 40: The option to display the part in wireframe rendering is located in viewer menu under the eye icon* 

Wireframe rendering is useful if any detail associated with contours needs to be displayed and shaded mode does not make the situation sufficiently clear. The object is displayed as a wire model that consists of contours, edges, auxiliary edges, and significant contours, so-called wires. Compared to a shaded model that displays complete material, a wireframe model is transparent. The option to display the part in wireframe rendering is located under the eye icon that contains the various settings for visualization screen.



Fig. 41: Wireframe rendering

# Status bar

The status bar at the very bottom of the screen displays information about validity of program registration, build version of the program, customer name and icon for complaints.

OK Unlimited trial | Registration OK | CustomerName | #623 🛹

#### Fig. 42: Status bar

- No complaints/No new unread complaints
- Information
- Moderate warnings
- Fatal

# **Application workflow**

This section describes typical sequence of activities to illustrate proper usage of the program. Every partial step is described in more details in particular section. The basic sequence consists of these operations:

- 1. importing new parts
- 2. cutting path editing
- 3. job task creation
- 4. job stock and part editing
- 5. nesting of parts
- 6. machine and tool selection
- 7. expert tables setup
- 8. simulation and saving of CNC program and related reports



Fig. 43: Standard working procedure schema

# Importing

The first step usually begins with importing data. There are several ways of loading data. *mCAM* enables to read parts is all formats specified in section Input formats on page 31). List of supported formats:

- STEP (\*.step, \*.stp) used for all supported shapes
- IGES (\*.iges, \*.igs) used for all supported shapes
- DXF (\*.dxf) used only for straight pipe cutting (circular or square pipes)
- CNC (\*.cnc) used for pipe cutting (including bevel cutting) by SolidSel NC code
- DSTV (\*.nc, \*.nc1) used for profile cutting (HEA, HEB, HEM, IPE, IPN, UPE, UPN, and square pipes)
- IFC (\*.ifc) used for all supported shapes (quality of processing is given by possibilities and limitations of ifcOpenShell open source library)

# Import 3D shape

Direct import (*File – Import*) (key shortcut: Ctrl+I) of any file in supported format from a selected directory enables to load files in new Import task (temporary library).



Fig. 44: Import new shapes

## Import 2D surface

Default dimensions of the generated shapes match the dimensions of the 2D surface. Shape dimensions can be manually modified in the *Shape type menu* in the *properties menu*, in subsection of selected shape type.



Fig. 45: Parametrized 3D shape (import 2D surface - \*.dxf)

Imported 2D surface is used for projection onto or wrapping around a solid shape and so it brings few differences.

At first, the *mCAM* imports selected 2D surfaces into a database. Assignment of the surfaces to particular available shapes (round pipe, rectangular pipe, or sphere) should be executed manually. After selecting a shape type, it is possible to change pre–set dimensions of the assigned stock material manually, even if it was previously set automatically by *mCAM*. Dimensions of automatically selected stock material fit the smallest possible dimensions of the 2D surface.

It is possible to create a preview of 3D model defined by specified shape type with projected or wrapped surface by pressing button Create preview under the *working tree*. The final import of particular shape with projected or wrapped surface is executed by the button *Import shape*.

#### Coordinate systems during import surface

The *mCAM* uses two different coordinate systems according to the shape type that is used at import. The coordinate system for a spherical shape is located in the centre of the sphere when viewed from the top. It is important to set the coordinate system correctly and to match this attribute to the DXF file during preparation of the model created in a CAD

software. In the example, the coordinate system of the imported geometry (DXF file with the ellipse) has been set to the centre of the ellipse.



Fig. 46: Coordinate system of imported surface (projection on sphere-cap)



Fig. 47: Importing of projected 2D surface on sphere-cap

Another example illustrates a situation where imported surface is wrapped around a round pipe or a rectangular pipe. The *mCAM* uses the coordinate system as displayed in Fig. 48. Round or rectangular pipes are unwrapped to the planar shape (rectangular sheet) and the imported surface is projected on the shape according to coordinate system of DXF. The

coordinate system of the DXF file with the ellipse is not set in the centre of the ellipse but in the area displayed in the bottom left corner.



Fig. 48: Coordinate system of imported surface (wrap around a circle pipe)



Fig. 49: Importing of wrapped 2D surface around circle pipe

Note: Coordinate systems for imported ellipses and the used shape types are identical. It means that DXF coordinate systems of both ellipses are set according to the. In the first case, it is located in the centre of the ellipse and in the second case it is placed approximately at coordinates: x = 60; y = 30.

When importing 2D surface (\*.cnc or \*.dxf) intended for wrapping around or projection on a part, Surface importing formats needs to be selected.

•	Open				
🗲 🌛 + 🕆 👢 « La	ocal Disk (C:)  ▶ msnc  ▶ mcam  ▶ examples	✓ C See	arch examples	٩	
Organize • New fold	er		811	• 🗆 😐	
🚖 Favorites 🔷	Name	Date modified	Туре		
bownloads	CHS_610x10.STEP	08-Oct-15 02:26 PM	STEP File		
Desktop	circle_pipe_sliced.nc1	16-Jan-15 11:52 AM	NC1 File		
🐉 Recent places	Dome_80.STEP	08-Oct-15 04:54 PM	STEP File		
b Dropbox	Dome_80_hole.STEP	08-Oct-15 04:54 PM	STEP File		
	two_holes.STEP	04-Mar-14 03:49 P	STEP File		
🔧 Homegroup	h_beam_holes.STEP	22-Jan-15 08:32 AM	STEP File	Select a file to	
	h_sliced_rotated_measured.nc1	28-Jul-14 03:07 PM	NC1 File		
📥 This PC	NEA_200.STEP	08-Oct-15 02:26 PM	STEP File	preview.	
属 Desktop	HEA_200_2sq_holes.STEP	08-Oct-15 02:26 PM	STEP File		
Documents	N IPN_180.STEP	08-Oct-15 02:26 PM	STEP File		
👃 Downloads	No. 180_features.STEP	08-Oct-15 02:26 PM	STEP File		
Music	L_60x40x5.STEP	08-Oct-15 02:26 PM	STEP File		
E Pictures	pipe_4_holes.STEP	04-Mar-14 03:49 P	STEP Fil€		
Videos	Pipe_30x5_assembly2.STEP	09-Oct-15 10:31 AM	STEP File		
bocal Disk (C:)	Pipe_48x10_4_holes.STEP	09-Oct-15 10:31 AM	STEP File 🗸		
Installs (\\192.168 ∨	<		>		
File na	me:	~	3D Model(*.ste	ep;*.stp;*.iges;' v	
	з		3D Model(*.ste mCAM(*.mcan	ep;*.stp;*.iges;*.igs;*.mcan 1)	n;*.ifc;*.nc;*.nc1
			Surface(*.cnc;*.	.dxf)	

Fig. 50: Import file format selection

# **Cutting path editing**

Cutting path editing includes these operations:

- splitting paths and loops creation
- lead-ins/outs modifying
- start point modifying (on cyclical paths)
- microjoints creation
- text marking
- transformations assignment or disabling (drilling/ punching/ quality hole cutting),
- marking of contours
- user ordering (priority cutting)
- assignment of cutting operation for each cutting path (Q1/Q2/Q3/Q4/Q5; Large/Medium/Small contours).

Note: It is possible to edit part and cut-paths also in shape tab in *Job task* the same way as in *Import tab*.

It is possible to edit each feature by selecting respective cutting path or multiple cutting paths at once. Multiselecting more cutting paths at once is performed (as in all commonly used Windows applications) by ctrl/shift + left mouse click. Cutting paths are

possible to multiselect also by using *Select cut* wizard (opened by pressing the H-key or via button at the bottom bar in the visualization screen) where cutting paths are grouped by set filter.

#### Select cut dialog

In Select cut dialog it is possible to select multiple paths at once according to various parameters:

- None displays list of all cuts without division according to parameters
- Hole displays hole as one item even if they are composed of multiple cut paths (e.e. complex cuts Y/K/X)
- Type (Hole/slice/gap) groups hole according to type of contour
- **Bounding box size** groups hole according to the size of the area of the rectangle (box) that is circumscribed about individual cuts.
- Path length groups cuts according to the path length.
- Web/Flange groups cuts according to their position on the part
- Polar angle –
- Cut type groups cuts according to cut type straight/bevel

Property inspec	<b>Ø</b> :	Settings 💐 Imported 1 🛛		
Shape select cut Test	Impo	rted shape Imported surface Modeller		
Description			A A A	
Source name			🔰 3D 📕 YZ 💜 XY	🖤 XZ
Drawing No.		and and the set of the		
Position No.	<	Select_cut_lest		
Text marking	Add			
✓ Technical summary				
Lowes 10.00 mm				
Highe 10.00 mm				
✓ Solid				
Name Plane	Calves Con			
T: 10.00 mm	Select Cut			
W: 400.04 mm	Group by	Cut Paths		
H: 500.03 mm	None	✓ [[141.33 mm]]		
<ul> <li>Tool path #2 #4 #9</li> </ul>	Hole	Tool path #3 3 HOLE UP 0		
✓ More items	Tune (hele (slice (st	Tool path #5 5 HOLE UP 0		
Patn Automatic	Type (note/stice/ge	Tool path #7 7 HOLE UP 0		Ū
Kerr compensation	Bounding box siz	e Tool path #8 8 HOLE UP 0		V <sup>III</sup>
Cutting		V [204.17 mm]		2
Transformations	Path length	Tool path #4 4 HOLE UP 0		
Laver Automatic transform	ati	✓ Tool path #9 9 HOLE UP 0		
Laser Large contours		Tool path #10 10 HOLE UP 0		
Water Q5	Web/Flange	Tool path #11 11 HOLE UP 0		
Stop (M0) before cutting	Polar angle	Tool path #12 12 HOLE UP 0		
Techn Default		Tool path #11 OUTER UP 0		
User order	Cut type			
Normal limit	cuctype			
Technology modifications				
Us 100%	History of selections			
Microjoints	13:57:34 [2 4 9]			
✓ Lead-in		$\forall $	Close	
Type Linear (1 section)				
Le 32.50 mm				
Ta 91.8 deg				
Io Straight to bevel 1	~			Y
U bynamic piercing				1
Type Path conforming				<u>z x</u>
Le 300 mm	-			
		[] 💥 💿	[X:106./	40, Y:-149.84]

Fig. 51: Select cut wizard

# Right control panel

After selecting the cutting path, the panel pops out on the right side of the screen. This cut path editing widget contains several buttons with various functions for changing some attributes of cut paths.



Fig. 52: Cut path editing panel on the right side of the visualization screen

lcon	Description
<b>V</b> IIII	Set lead-in/out to custom position (described in section Lead-in s/-outs)
A	Set lead-in/out to automatic position as generated by mCAM
2	Revert the cut path (described in section Reversing a cut path)
φ	Add loop on selected cut point (described in section Loops)
¢	Split path on selected point (described in section Splitting paths and creating loops)
ø	Join non-circular path points (described in section Splitting paths and creating loops)
∐¥I	Erase selected cut point
Û	Delete cut path

There are also welding preparations, that are described in section <u>Welding</u> preparations.

Properties and features that modify selected cutting path/s are displayed in *Properties menu*. All selected cutting paths are highlighted by yellow colour.

Editing of all cutting path features is described in more details in section <u>Cutting path</u> <u>modifications.</u>



Fig. 53: Cutting path editing

# Job task creation

The next step is to create a *Job task*. Job can be created in two ways:

- Using drag&drop function this is a preferred method. Required shapes are dragged from Working tree in Import to designated area in Master panel. This method creates Temporary job task. *Temporary job task* is the same type of database as standard *Job task*, but the \*.job file with all settings, parts, nestings, and generated CNC programs is possible to save to hard drive only when user closes particular *Temporary Job task*.
- 2. In function Menu File Created/Load job This type of Job task is saved as a database, so all applied settings and modified features including cutting paths, lead-ins/outs and all other data are saved automatically. When creating a job task, its name has to be defined.

After creation of job, mCAM automatically sets a template (e.g. Circle pipe D219.100 mm T 16.000 mm) and stock with default length (e.g. L:3003.000 mm). More details about parts, stocks and templates are in section <u>Job task</u>).

More parts can be easily added to particular *Job* by drag and drop selected parts from *Working tree of Import tab* to Master panel to respective job.



Fig. 54: Creating a new job or loading existing job

Imported 1 - mCAM	-	σ×
File Import Windows Help		
Property inspec	Settions Imported 1 A Temporaryinh 1	
Marchine connections 2		
Shape n Pipe_220x10_t	Imported shape Imported surface Modeller	
9999 MicroStep Demo Machine Description	ک ( a c a c a c a c a c a c a c a c a c a	👘 xz
Source name		
Drawing No.	Tubert40	
Import shape & Create shape Position No.		
Text marking Add	Tubero	
<ul> <li>■ Technical summary</li> <li>Lower 10.00 mm</li> </ul>		
C Recent imports Folders Highe 1121 mm	Pipe_220x10_test_nest_8	
× Solid		
> Today V Last week Circle pipe	Pipe_220x10_test_nest_8_	
Pipe_220x10_test_nest_8.STEP D: 220.00 mm		
dome_2500_holes.step T: 10.00 mm	Pipe_220x10_test_nest_8.7	
L: 356.68 mm		
	Pipe_220x10_test_nest_8.	
	Ring 20040 text per 4.5	
	A she store is a	
	Pine 220v10 text next 8	
	Pipe 220x10_test_nest_6_3	
Drop shapes here to create new job	Pipe_220x10_test_nest_8.2	
	Pipe_220:10_test_nest_8	
Temporanuloh 2		
(chipotary)ou 5	dome_2500_holes	
1x 1x 1x 1x 1x Pipe_zzuxio_test_nest_a_		
Dine 20040 kert west 0.7		
Pipe_220xi0_test_Hest_6_7		
Pine 220x10 test nest 8		
· he_comme_com_mem_em_		
Pipe_220x10_test_nest_8_5		
		Z
		×x
	F1	
< >		

Fig. 55: Adding parts to Job task



Fig. 56: Temporary job task creation



Fig. 57: Saving temporary job task

# Job stock and part editing

After a job is created or loaded, it is possible to:

- add new stocks (with different length than existing stocks within one template material and dimensions)
- change a count of stocks
- modify length of stock material
- change quantity of shapes



Fig. 58: Adding a new stock

Ĩ
8
8
×3
2
0.00 mm T: 5.00 mr

Fig. 59: Stock editing (count and length)



Fig. 60: Defining count of selected part

Note: Other Job stock operations are described in more detail in section <u>Stock (stock material)</u>.

# **Nesting of parts**

Nesting is a function used to create optimal placement of parts on the stock material. The function employs a sophisticated algorithm to place parts so that maximum utilisation of the stock material is achieved. The algorithm rotates, mirrors, shifts, and orders the parts to use the minimum amount of the stock material for particular job. Minimum gap between neighbouring parts as well as other nesting settings are defined *Profile nesting* settings in particular *Job task*. Other settings that define type of the machine, supports and general nesting parameters as *Chuck length* or *Chuck location* are set in *Nesting* (*File – Settings – Nesting/supports*) in *Application* configuration level with no machine selected.

Property inspector		🛱 Settings	Import	ed 1 🖾 🖌	Tempora	ary job	9 🛛
∨ Solid		W occurryo	- import		· ·		_
Name D: T: Y Technology setup Machine	Circle pipe 140.00 mm 5.00 mm 9999 MicroStep Dem v	<ul> <li>✓ Orcle pip</li> <li>✓ Orcle pip</li> <li>✓ Orcle pip</li> <li>✓ Orcle pip</li> <li>L: 2500.0</li> <li>✓ Orcle pip</li> <li>✓ Stock</li> </ul>	e D: 140.00 mi 00 mm 1 part 1415.1	m T: 5 00 <b>db</b> Nest this Nest this with Free all Add stock	View s	Shape	Tool p
Technology Nesting settings	~	*	3 x Tube14	Remove tem	plate	_	
Nesting gap Startpoint X offset □ Use part envelope only	5.00 mm 0.00 mm	C A	Tube140	Save plan Simulate plar Simulate and	n I save plan		
☐ Use common-cut Surface mapping quality ☑ Enable part rotations an	Normal ~ d flipping		Tube140	Apply mesh		1	

Fig. 61: Nesting settings and nesting execution

Settings		Imported 1 🗵	🖋 Temporary job	9 🗵							
Application Cu	it path	Machine limits	Tool operations	Nesting / su	pports	Lead in/out	Measure	Generate	Intensity		
Nesting	sting ga	ap 5.00 mm									
-Supports and re	ests pport p	lacement			Su	pport only cut a	irea	~			
수 수 🕺 Su 수 수 🐺 Ch	pport ci uck leng	ut-off part gth			33	0 not support cu 0.00 mm	t-off part				
	Image: Constraint of all supports       Image: Constraint of all supports       Image: Constraint of all supports				2	2 0					
수 수 🐺 Su 수 수 🐺 Su	pport b pport b	locked area for cut locked area for cut	tting X+ tting X-		60 60	0.00 mm 0.00 mm					
	ngth of s	support base support			50 70	0.00 mm .00 mm			]		
수 수 <mark></mark> Ma	ximum ximum	support-support o	listance nce		30	00.00 mm 00.00 mm					
	n length	of the cut-off par	t to be supported w	vith one suppo	ort 12	00.00 mm					
<ul> <li>♀</li> <li>♀</li> <li>♀</li> <li>₽</li> <li>₩</li> <li>Mi</li> </ul>	n lengtr n length	i of the cut-off par i of the cut-off par	t to be supported w t that must be man	ually removed	10	00.00 mm					
\$ \$ \$ So	rt cuts i	n groups for comp	act support positio	ning	$\checkmark$						

Fig. 62: General nesting and supports parameters

# **Expert tables setup**

Expert table of each tool operation:



Fig. 194: Font type in Text marking section of Properties menu

**Tool operations** directly affects the processing of cutting paths, cutting speed control and kerf width compensation in each cut-point of cutting contour. mCAM controls cutting speed and compensates cutting path according to set Expert tables of particular tool which define exact cutting parameters for each technological group of parameters = operations. Cutting tool can be assigned to stock or whole template.

Expert table initial setup is described in more details in section Expert tables.



Fig. 63: Expert cutting tables – cutting parameters (kerf width/cutting speed)

# Machine and tool selection

Machine and tool have to be selected every time when preparing cutting plan in *Job task*.

Machine limitations (according to the type of the cutting head and range of rotator axes) and technology limitations (given by maximum angle that is possible to reach between torch and material normal while cutting) for each cutting path are based on a *machine* – *technology* (with defined ranges and limitations) that is assigned to particular *stock* or whole *template*.

Machine and machine limitations are described in more details in section WebService or Virtual machine on page 194 and section Machine limits.

Selection of tool directly affects the kerf width compensation (according to *expert tables* of particular tool). Principles of *kerf width compensation* and initial setup of *expert tables* are described in section Expert tables.

Note: Machine and tool can be set for each stock individually or for whole template at once (all stocks within template shares template's machine settings, technology and tool). Cutting parameters of chosen tool (with applied expert tables) while generating CNC program are defined/possible to edit in Settings – Expert table.

Property inspector		the continue	<b>Fi</b> to a start		Tompo	orany iob 9				
✓ Solid		Settings	S Imported		rempt	Jiary job >				
Name	Circle pipe	<b>A</b>			View	Shape	Tool pat	h processin	g	
D:	140.00 mm	Circle p	ipe D: 140.00 mm 1	:5.00 @@	Stock	informatic				
Т:	5.00 mm	✓ 1 L: 250	0.00 mm 1	M 🖪	Stock	mormatic	/11.			
Ŀ	2500.00 mm		k n a st 1 / 15 02 mm			49615 r	nm	49615 mm	49	615 mm
<ul> <li>Technical summary</li> </ul>		* 🎽 SLOC	k part 1415.83 mm		-		/ /		-/	1
Lowest cut depth	5.00 mm	× 00	3 x Tube140							
Highest cut depth	12.58 mm	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	>			Tube1	40	Tube140	T	ube140
<ul> <li>Technology setup</li> </ul>	<u>.</u>		Tube140							
Machine	9999 MicroStep Dem  ~		\$		Heat	Number:			Serial Num	iber:
Technology	11 xpr 🗸 🗸		Tube140						Rest: 1084.	17 mm (43%) (Chuck lengt
Material	~		\$							
Power	~		Tube140		Parts	on stock:				
Tool	XPR300-MST- 10.000- $ \sim$	4	\$		Shap	e number		Shape n	ame	Copies in stock
<ul> <li>Nesting settings</li> </ul>					#1			Tube140		3
Nesting gap	5.00 mm									
Startpoint X offset	0.00 mm									
Use part envelope only					L					
Use common-cut										
Surface mapping quality	Normal ~									
Enable part rotations and	l flipping									

Fig. 64: Machine and tool selection

**Displaying final cutting paths (Tool path processing)** – because all cutting paths (kerf width compensation, technological and machine limitations) are processed during CNC generation, final cutting paths can be displayed only in Tool path processing tab in Job task.

If necessary, machine and tool can be selected for each cut individually by selecting the cut path and assigning a desired machine and tool to in "Technology setup (cut path)" in Properties area.



Fig. 65: Tool path processing – limited and compensated according to set machine and tool

# Simulation of CNC program and graphical visualization

The *mCAM* contains a machining simulator for verification of the CNC code. The simulator displays a stock material defined in the program, outline of a cutting tool, all cutting paths and a graph that helps to detect undesirable and inappropriate motion of tool or paths. Functions of the simulator and graphs are described in more details in section Cutting simulation of CNC program.

CNC program is generated by clicking on one of two buttons located next to the stock piece in *working tree* of particular Job. Left button generates and simulates CNC program and right button only generates and saves CNC program without running cutting simulation.



H

generates and simulates CNC program

generates and saves CNC program without running cutting simulation

Nesting report can be saved via button located in the bottom right corner in the View tab when respective stock is selected.

Stock information:         Stock part 1415.83 mm         Stock part 1415.83 mm         Stock part 1415.83 mm         Tube140         Stock information:         Dimensions: Circle pipe D: 140.00 mm T: Smm         Tube140         Rest: 1084.17 mm (43%) (Chuck length: 330.00 mm)         Parts on stock:         Shape number       Shape name         Copies in stock       Part length         #1       Tube140       3	Settings Imported 1 I / T	Temporary job 9 🛛	processin	В				
Stock part 1415.83 mm       49615 mm       49615 mm       1084.17 mm         Image: Stock part 1415.83 mm       Tube140       Tube140       Rest         Image: Tube140       Tube140       Rest       Image: Tube140         Image: Tube140       Tube140       Rest       Image: Tube140       Rest         Image: Tube140       Rest       Image: Tube140       Rest       Image: Tube140       Rest         Image: Tube140       Rest       Tube140       Rest       Rest       Image: Tube140       Rest	√ 🚺 L: 2500.00 mm 1 🕅 🕅 💾	Stock information:						
3 x Tube140         Rest         Tube140         Rest         Tube140         Rest         Tube140         Rest         Tube140         Rest         Rest </th <th>∽ 🖉 Stock part 1415.83 mm</th> <th>496.15 mm 4</th> <th>96:15 mm</th> <th>496.15 mr</th> <th>n #</th> <th>1084.17 mm</th> <th>/</th> <th></th>	∽ 🖉 Stock part 1415.83 mm	496.15 mm 4	96:15 mm	496.15 mr	n #	1084.17 mm	/	
Tuberto     Tuberto     Tuberto     Tuberto     Tuberto     Tuberto       Tuberto     Tuberto     Tuberto	→ 3 x Tube140	Tube140	Tubo140	Tubatto		Bart		
Tube140     Serial number.     Dimensions: circle pipe 0, 140.00 mm it is mm       Tube140     Rest: 1084.17 mm (43%) (Chuck length: 330.00 mm)       Parts on stock:       Shape number     Shape name       Copies in stock       #1	Tube140	Hast Number	Tube 140	Tuber40		Rest	o D: 1/ 0.00 mm T:	E 00
Yube140       Yube140         Parts on stock:       Shape name       Copies in stock       Part length         #1       Tube140       3       496.15 mm		Heat Number:		Serial Number:		Dimensions: Circle pipe D: 140.00 mm T: 5.00 mm		
Shape number Shape name Copies in stock Part length #1 Tube140 3 496.15 mm		Parts on stock:		Rest: 1084.17 mm (	43%) (Cnuck leng	tn: 330.00 mm)		
#1 Tube140 3 496.15 mm	*	Shape number	Shape na	me	Copies in stock	Part length		
		#1	Tube140		3	496.15 mm		
	L							

*Fig. 66: Cutting simulation, saving CNC plan to the right of selected stock, saving nesting report in pdf. file in the bottom right corner* 



Fig. 67: Cutting simulation and plotting A, B and C axes movements

Related cutting reports are automatically saved in \*.html file format into directory of saved CNC program, so it is possible to open it in any Web Browser.

#### mCAM report

Created:	08.01.2019 10:20:29
Name:	Tube140 + 2
File:	C:/Users/AB/Desktop\Tube140 + 2.cnc
Stock:	Circle pipe D: 140.00 mm T: 5.00 mm
Stock:	L: 2500.00 mm
Material:	
Chuck location:	At X min

	Starts	Length
Cutting	12	7 m 587.404 mm
Detection	12	
Total	24	7 m 587.404 mm

Preview	Info			Part name
$\frown$		Starts	Length	Tube140
	Cutting	4	2 m 195.801 mm	
	Detection	4		
	Total	8	2 m 195.801 mm	
			Value	
	Count		3	
	Size		L: 496.15 mm	

Fig. 68: Cutting report
## Report customization in mCAM

## **Reports in mCAM**

mCAM currently supports two kinds of reports.

#### The job report:

				i	ob report	t	-		×
Settings	🖋 Temporary job 3  🗵								
✓ ₼ Circle pip	e D: 70.00 mm T: 1.50 m 🦚	View Shape	Tool path pro	cessing					
✓ ↓ L: 485.00	0 mm 1 🕅 🕅 🖓			Mio		ton®			
✓	part 112.95 mm	Stock:			05	lep			
	:6 c1								7
		/	mm //		372.0	5 mm			
								8	
								8	
		c1			Re	est			
		Heat Number:							
		Serial Number:							-
		Dimensions: C			372 05 mm	n (77) (Chuck length:	mm 330.00 mm)		-
		Parts: Shape number	Shape name	Copies in stock	Part length	]			
		#1	c1	1	108.93 mm				
	•	88*							

Fig. 69: The job report located in the View section

#### And the Shape cut report: shape cut report 🖋 Temporary job 3 🗵 Simulation - c1 🗵 Settings (mcam.ver=2.0.0.701 DEBUG 2020.03.30 cp: 1252 customer: Matej Kosik) (mcam.date=01.04.2020 09:20:18) (mcam.grip=X\_MIN X) (mcam.stock=Circle pipe D: 70.00 mm T: 1.50 mm; L: 485.00 mm) (mcam.stock=Circle pipe D: 70.00 mm T: 1.50 mm; L: 485.00 mm) (mcam.item=1'c'': C/Users' manc500/3D Objects/bug0/c1.step':1) (01.04.2020 09:20 'msnc500') (MACHINE 1 Virtual machine) (TECHNOLOGY 11 Plasma pantographic rotator 90 degrees \_type R4 v1.0\_) (TOOL 11 tool) (SEMIPROD 1; 1.570; 485) (SEMIPROD 1; 1.570; 485) (SEMIPROD 1; 1.570; 445) (SEMIPROD 1; 1.570; 443) (SEMIPROD MIN: 1:1570; 443) (SEMIPROD, MIN: 1:1570; 443) (MODE ROTATOR XY:0.0 VER2) (START X\_MAX) (USAGE cut) (MIN\_MAX\_THICKNESS 1:5 2:1) (mcam.debug.fixAi;8R01(2;30):0) M12 2X11 D1:500 070:000 L485,000 (CIRCLE PIPE) Configuration Analyse 3D 2D Report MicroStep mCAM report 01.04.2020 09:20:19 Created Name: c1 Circle pipe D: 70.00 mm T: 1.50 mm Stock: Stock 1 · 485 00 mm Material: Heat number: M122 K11 D1.500 D70.000 L485.000 (CIRCLE\_PIPE) (mcam.part mode=CUT item=1 holeID=3 cut= 4/DEFAULT/0/UP blocker=OTHER cutID=9) (mcam.info1 type=MAX\_X grip=X\_MIN) (mcam.info2 cutHints=CUT\_END\_PART quality=O5|LARGE kerf=2.4 length=291.4) (mcam.info3 cut mode=Z\_CONSTIB\_CONSTIHORIZONTAL) (mcam.info3 cut mode=Z\_CONSTIB\_CONSTIHORIZONTAL) (mcam.info3 no lead=Z\_CONSTIB\_CONSTIHORIZONTAL) (mcam.info3 no lead=Z\_CONSTIB\_CONSTIHORIZONTAL) (mcam.info3 no lead=Z\_CONSTIB\_CONSTIHORIZONTAL) (mcam.info3 no lead=Z\_CONSTIB\_CONSTIHORIZONTAL) (mcam.tech path\_cut\_data kerf:ON limitA= 45.0 A/w-VM\_AM HW= 90.0) (FART'cit] 125663) (SIZE: CirclePipe Thickness=1.5 Diameter=70; Length=108.933) (mcam.debug.measure.scanner.id=1) (mcam.debug.measure.scanner.id=1) (mcam.debug.measure.slocks=9) M6 T311 (CUT BEVELE\_A3) G0 C-2:709 M94 D7 X=8285 M38 L0.0000 L0.000 (Corr A from B 0.0. Add=0.0) M30 D2 (cort down) M3 (tool on CCW) M90 K159 L200.000 (el.speed.act=2.000; 4000.00) M90 K159 L200.000 (rel.speed.act=2.00; 4000.00) M90 K159 L200.000 (rel.speed.act=2.00; 4000.00) M90 K159 L200.000 (rel.speed.act=2.00; 4000.00) M122 K11 D1.500 D70.000 L485.000 (CIRCLE\_PIPE) Serial number Chuck location At X min Machine number: Tool name: tool Starts Length Cutting 5 937.552 mm 5 Detection Total 10 937.552 mm Preview Starts Length Part name c1 Cutting 5 937.552 mm Detectio 5 10 937.552 mm Total 90 D2.122 G1 X-0.285 Y0.000 Z0.000 A8.301 B0.000 C-6.182 (lead\_in:UNDEF; B=0.0) 90 D2.12 G1 X-0.285 Y0.000 Z0.000 A16.602 B0.000 C-9.655 (lead\_in:BEVEL; B=0.0) Count G1 X-0.285 Y0.000 Z0.000 A16.602 B0.000 C-13128 (lead\_in:UNDEF; B=0.0) Size L: 108.93 mm G1 X-0.285 Y0.000 Z0.000 A16.602 B0.000 C-16.602 (B=0.0) M90 K147 L88.457 (rel.pov Line:1 Q Search ⊜ 💾 🌣 ٠

Fig. 70: The shape cut report in Simulation located in Report section

In the bottom left corner of each report is located a tool bar:



Through this tool bar it is possible to print, save or customize the report.

#### **The Print button**

For the moment, mCAM only has indirect support for printing. By clicking on the Print button, the report is opened in the user's default browser. The browser then can be used for printing the report in the best available quality.

#### The Save button

The Save button 🕒 enables saving the current report to the disk as a single HTML

file.

#### The Settings button

The Settings button Reason makes it possible to customize the report. Pressing this button, a new window will appear:

🙆 Customization of the job report appearance. –						
I want to customize the <b>appearance</b> of the report and I have some knowledge of <u>HTML, CSS, XML, XSLT, XPath</u> and <u>XQuery</u> .						
XML	XSLT 5	HTML (with embedded CSS)				
Apply XSLT 🔡 Reset XSLT						

Fig. 71: Check box for confirmation for report customization

After checking the box and by it confirming that the user wishes to customize the report and has at least some previous experience with the technologies mCAM uses for generating reports (HTML, CSS, XSLT, XPath, XQuery), the window will change.



Fig. 72: The XML, XSLT and HTML text areas

The text area on the left shows an XML document that contains the data, that are supposed to appear in the report.

The text area in the middle contains XSLT transformation that defines how to create HTML document on the right from the XML data on the left.

The text area on the right shows HTML encoding of the actual report that will appear on the screen.

#### **Trivial changes of the XSLT document**

Trivial changes of the XSLT document can be done as follow:

- by directly modifying the XSLT code shown in the central text area
- and then pressing the "Apply XSLT" button

These modifications will be saved and will not be affected by mCAM restart.

#### Nontrivial changes of the XSLT document

Nontrivial changes of the XSLT document can be done as follow:

- by exporting the relevant files out of mCAM by pressing 💾 the Save button
- editing the XSLT code in the development environment of the user's choice
- pasting the final XSLT code back to the central window
- pressing "Apply XSLT" button.

To revert the changes in XSLT instructions, simply press the "Reset XSLT" button.

# **Cutting in practice**

Several conditions have to be met for the part to be cut correctly:

Profiles have to be placed correctly on the machine. There are different initial positions for beams depending on whether the beams are cut using rotary positioner or stationary beam holder. This position is defined by mCAM and has to be preserved.

Initial beam position in rotary positioner (if C=0) and *Initial beam position in stationary beam holder*).

The starting positions needs to be fine-tuned by operator before the start of cutting:

- → X-coordinate of cutting head has to be aligned with the end of beam. Some machines are equipped with optical sensor, which can fine-tune X-position of head on operators command.
- → R-axis should also be fine positioned, so that beam exactly conforms to required initial position. Mostly this means, that top surface of beam is in level
- $\rightarrow$  Technological parameters on the machine has to be set exactly in the same way as parameters that were used in mCAM while generating CNC program

## M122 – initial beam position

Initial beam position was changed in April 2017 for some shapes, to make it clearer how the beam should be loaded correctly on the machine. The original placement was changed for H, I and U profiles. Due to these changes, the new instruction M122 was added, that defines the position used for generating CNC code in mCAM.

M122 parameter is intended only for ROTPOL\_MODE2, because only in this mode it is possible to cut all profiles. ROTPOL\_MODE1 is used for cutting pipes, where the M122 is not necessary.

The setting for which initial position should be used is located in Settings -> Internal -> Position type and is automatically set according to parameter from flashbin. It should only be changed by Microstep staff.

The parameter in flashbin has four versions:

- p\_M122\_VERSION=0 represents the most recent version (now it's the version 3, if in the future there will be version 4, it will represent version 4 etc.)
- p\_M122\_VERSION=1 M122 is ignored

- p\_M122\_VERSION=2 original placement of profiles as was before the change in 04/2017
- p\_M122\_VERSION=3 new placement of profiles after the change in 04/2017

Setting for Position type in mCAM contains two options:

- → Version 1 without M122 p\_M122\_VERSION=2
- → Version 1 with M122 M122 is generated into the CNC code, but the positions of beams are as before the change in 04/2017
- → Version 2 with M122 p\_M122\_VERSION=3

Position	Version 1 (without M122)	Version 2 (with M122 v3)
I/H beam		
U beam		

There are two scenarios:

- Older machines with old fikus don't recognize the M122 instruction In this case, at installation of mCAM, the Position type is automatically set to Version 1. The CNC code will be generated with original initial position, without using the M122 instruction. If Version 2 is selected and the machine does not recognize the M122 instruction, it will display error message.
- 2. New machines with new fikus recognize the M122 instruction the setting for Position type in mCAM is automatically set to Version 2 and the CNC code is generated with new initial positions of beams.

### Initial beam position in rotary positioner (if C=0)

Listed below are default starting positions of different types on beams in rotary positioner on machines as generated by mCAM, if C is 0.

Due to the change in default position in april 2017, mCAM will generate M122 instruction with information about what is the default position in generated CNC. The machine will have defined which M122 are compatible and will reject all that aren't. If this happens, it is necessary to check, if mCAM is set correctly. Otherwise, it is possible that mCAM or fikus should be updated – in this case, please, contact MicroStep support team.



Fig. 73: Square pipe – longer side is in Y-axis



Fig. 74: H-bar – (older position) top edge of cutting contour, where the cutting starts, needs to be in Y+ direction, the flanges are in Y-axis



Fig. 75: Flanges are in Z-axis direction (new position)



Fig. 76: U-bar (old position) Flanges are in Y axis with web facing in Y- direction



Fig. 77: U-bar – Flanges are in Z-axis, with web facing Z+ direction (new position)



Fig. 78: UPN bar (old position) Flanges are in Y axis with web facing in Y- direction



Fig. 79: UPN-bar – Flanges are in Z-axis, with web facing Z+ direction (new position)



*Fig. 80: I-bar – (older position) top edge of cutting contour, where the cutting starts, needs to be in Y+ direction* 



Fig. 81: Flanges are in Z-axis direction (new position)



*Fig. 82: L-bar – shorter side has to be on the Y+ side, longer side is facing upward in Z+ direction* 

## Initial beam position in stationary beam holder

Listed below are default starting positions of different types on beams in plane cutting.



Fig. 83: H-bar – Flanges are in Z-axis direction



Fig. 84: U-bar – Flanges are in Z-axis, with web facing Z+ direction



Fig. 85: UPN-bar – Flanges are in Z-axis, with web facing Z+ direction



Fig. 86: I-bar – flanges are in Z-axis



Fig. 87: L-bar – shorter side has to be in Y+ direction

## Modeller

Modeller is a simple cad design feature, where you can design simple parts as subtraction of one shape from another. It is located in menu File -> Modeller or in Import tab as third sub-tab. Modeller is not replacement of any complex CAD programs as it only allows to create shapes based on supported shapes with straight cut-outs.

Add a new base shape by clicking on the right mouse button in the work area and selecting "Add". It will add a default shape - circular pipe. This part acts as a parent (result, base) part. Adding a second shape (by clicking with right mouse button in the work area) will create a helper shape that is automatically subtracted from a parent part. Position of helper shape can be adjusted by applying individual steps of movement or rotation in one of the three axes X, Y and Z in Transformation part in Properties area to create a desired part.



Fig. 88: Modeller

Helper shape is displayed in light blue color, result shape is dark blue. Options for specifying the setting for each shape are displayed in a properties area.

- 1. Model you can specify Name, Role, Operation and Type
  - **Role** specifies if the selected shape is result or helper shape. It is set automatically.
  - **Operation** two operations are available Nothing and Subtract. Nothing is intended only for result shape, that acts as a base shape for designing a new

part. Subtract is intended for helper shapes, that are subtracted from result shape to create the desired part.

- **Type** specifies the form of the added shape. A new shape can be added as a Shape type, Solid, Macro or a Multiplier
  - → Shape type added shape is a general shape that you can further specify
  - $\rightarrow$  Solid adds a shape from imported shapes in active import tab
  - → Macro added shape is a premade shape with special characteristics. Right now, only one macro is available – Circle pipe cut to demonstrate the use of Macros. If needed, more shapes can be added.
  - $\rightarrow$  **Multiplier** described in more details on the next page
- 2. Shape type you can select various shapes from the dropdown menu and adjust the dimensions of the respective type.
- **3.** Transformation visible only when helper shape is selected. Transformation commands allows you to move or rotate the shape to the desired position.

#### Multiplier

Multiplier automatically multiplies respective helper shape/shapes according to the given instructions.

- 1. To add a multiplier right click on a result shape and select "Add".
- 2. In a Model section in Properties area change the Type to Multiplier
- 3. Add a helper shape by right clicking on Multiplier shape in Work area to assign it to Multiplier. You can add more shapes than one.
- 4. Adjust the dimensions of a helper shape and its position on a result shape, from which you want to start multiplying it across the result shape
- 5. Select Multiplier and change how many times you want to multiply the helper shape.
- 6. In transformation add steps that define the movement and/or rotation of multiplied shapes. The helper shapes will automatically multiply and distribute evenly according to this instruction. If you have more helper shapes assigned to one Multiplier, all will follow these set of instructions. If you want different quantity or shapes spaced out differently, you have to create separate multipliers for them.



Fig. 89: Three circle pipes spaced out across the result shape by 120mm

## **Macro features**

Macro features is a simple and time saving feature where you can design basic shapes. New shapes and macros are being added gradually.

To create a new shape, go to the Import tab, click **Create shape**  $\rightarrow$  **Macro features**. To edit a previously imported shape, go to the visualization screen and click the **Macro features** button at the top. Like this you can edit shapes made in Create shape, but also imported shapes, such as the ones from Step files.

Imported 1 - Unnamed shape - mCAM File Import Windows Help			- • ×
Imported 1 - Unnamed shape - mCAM File Import Windows Help Machines  103 ProfileCut 450115SPpk+P Imports Imports Telecut 100 Modeler Macro features Jobs Drop shapes here to create new job	Shape name     Unnamed shape       Description     Source name       Drawing No.     Position No.       ✓ Technical summary     Intervention No.       ✓ Solid     Name       Object of the state of	Settings Imported I - Unamed shape I Unamed shape I Unamed shape	- 0 X
Q			×

Fig. 90: Macro features

## Create shape

Click Create shape and then Macro features, a table shows up and you can choose from the currently supported shapes categorized in "Domes" and "Profiles" groups. By clicking on one of them you will get a default shape.

mcam						
Domes						
$\bigcirc$			$\frown$	$ \land $	$\frown$	$\frown$
Dome	Flat bottom dome	Dished bottom dome	Elliptical dome	Conical dome	Inverted head dome	Dished disc
Plane	Circle pipe	Rectangular profile	Bulb profile	H beam	I profile	

Fig. 91: Basic shapes table in Macro features



Fig. 92: Default shape - dome

The selected shape is then displayed on a visualization screen (C), the 3D view with visualization behaves the same as the other views in mCAM. The middle screen (B) shows the shape from two different angles, from top (B1) and from the side/cross section (B2).

## Shape definition

If you are editing an already existing shape (previously imported or saved), shape dimensions cannot be changed.

When creating a new shape, its dimensions can be changed. You can do it like this:

• You can change the parameters of the shape by clicking on a desired dimension or change it in the Shape definition on the left screen (A1).

Macro Features		- 🗆 X
Circle pipe:         Unnamed shape           Length         1000.00 mm           Radius         101.60 mm           Thickness         20.00 mm	View from top	🗳 3D 💼 VZ 🔮 XY 🔮 XZ
⊕ Add ⊗ Remove Multiply =	1000.00 mm	
	View from side	l l l l l l l l l l l l l l l l l l l
Save		[] <b>⊙</b>

Fig. 93: How to change shape's dimensions

## **Adding Macros**

The **add button** on the left-most screen (A2) gives you a choice to add one of the supported macro features. Each shape of the stock enables you to add a different set of macros.

#### Macros available for dome

- → **Cylindrical hole** is a macro of a circular shape, which properties such as diameter, distance, angle and tilt can be changed.
- → **Cross marking** is a cross shaped type of marking, which properties can be changed. These are diameter, distance, angle and rotation.

- → N gon hole is a macro of polygon character where the number of sides is possible to adjust as needed. Other adjustable properties are diameter, distance, angle, rotation, tilt and an option to place the hole perpendicular to the surface. By checking the option for perpendicular hole, the hole is cut at right angle (90°) to the surface of the dome.
- → Splitting in half is a macro that allows for the dome to be cut in half. The parameters are side offset, center offset, rotation. If the side offset and center offset are zero the dome is cut completely in half. Side offset determines how many millimeters from the edge should be left uncut. Center offset determines how many millimeters from the center should be left uncut.
- → Side cylindrical hole is a macro of cylindrical shape, with properties such as diameter, offset, angle, rotation, tilt and an option for the hole to be placed perpendicular to the dome.
- $\rightarrow$  Side cross marking is a cross shaped type of marking, with properties such as diameter, offset, angle and rotation. This type of marking is placed on the side of the shape.
- → Side line marking is a line marked on the side of the shape, with properties such as length, offset, angle and rotation.
- → **Cut around** is a macro that allows the shape to be cut around its circumference. The parameter for this macro that can be changed is height.



Fig. 94: The properties of Cylindrical hole



Fig. 95: The properties of N – gon hole



Fig. 96: Splitting in half for Dome in Macro features

#### Macros available for circle pipe

- $\rightarrow$  Cylindrical hole the same as a cylindrical hole on a dome.
- → **Rectangular hole** is a macro of a rectangular shape, which properties (width, height, distance, angle, offset, rotation) can be edited.
- → **Slot hole** is a macro in a shape of an oval hole with properties such as width, height, offset, distance, angle, rotation and tilt.
- → Laying pipe from top is a macro that allows to cut a hole in the shape of a pipe where it is possible then later in production to attach a desired pipe. The properties that can be changed are diameter, distance, angle, offset, rotation.
- → **Cross pipe** is a macro that cuts two holes through the top and bottom side of the circle pipe. Both holes are circular in shape and their properties can be changed (diameter, distance, offset, angle, rotation, tilt).

#### Trimmings

Both ends of the circle pipe have the option for trimmings or no trimmings at all.

- No trimming
- Plane trimming the cut off is straight and perpendicular (90°) to the cross section of the circle pipe
- Cylinder trimming the cut off is in the shape of a pipe applied perpendicular (90°) to the cross section of the circle pipe
- Two-cylinder trimming the cut off is in shape of two pipes which are perpendicular to each other and by default in 45° angle to the shape. The angle can be adjusted.



Fig. 97: Properties of a Rectangular hole



Fig. 98: Trimmings and properties of Slot hole for circle pipe



Fig. 99: Properties for Laying pipe from top in Macro features

💋 Macro	Features				– 🗆 ×
<b>Circle pi</b> Length Diamete Thicknes	pe:         Unnamed shape           1000.00 mm			View from top	🔮 3D 📄 YZ 🌒 XY 🌒 XZ
Trimmi Trimmi Holes (*) Add	Ings Beginning - Plane trimming It te 900 deg Cross pipe Dianeter: 4000 mm, Distance: 300.00 mm	Cross pipe         (2) Diamete         (D) Distance         (O) Offset         (B) Angle         (α2) Tilt	f 60.00 mm 550.00 mm 10.00 mm 120.0 deg 30.0 deg 30.0 deg	View from side	
Save				0 []	

Fig. 100: Properties for Cross pipe in Macro features

#### Macros available for rectangular profile

- → **Cylindrical hole** is a macro of a circular shape, which properties such as diameter, distance, angle and tilt can be changed.
- → **Rectangular hole** is a macro of a rectangular shape, which properties (width, height, distance, angle, offset, rotation) can be edited.

→ **Slot hole** – is a macro in a shape of an oval hole with properties such as width, height, offset, distance, angle, rotation and tilt.

#### Trimmings

Both ends of the rectangular profile have the option for trimmings or no trimmings at all.

- No trimming
- Plane trimming the cut off is straight and perpendicular (90°) to the cross section of the rectangular profile.

Macro Featur	res				- a ×
Rectangula	r profile: Unnamed shape				😭 3D 📄 VZ 📦 XY 📦 XZ
Inner radius: Outer radius: Width Height Length Thickness	2.00 mm 12.00 mm 400.00 mm 300.00 mm 10.00 mm			View from Cop DI-500.00 mm	
Trimmings			Cylindrical hole		
Holes	Heginning - Plane trimming Tilt: 0.0000 deg Inding - Plane trimming Tilt: 0.0000 deg	↓ ↓ Duplicate	(c) Diameter 100.00 mm (DI) Distance 300.00 mm (c) Offste 0.00 mm (a1) Rotation 0.0000 deg (a2) Titt 0.0000 deg Side 1 •	View from cross sectiona2=0.0000 deg	
Save				View from side	

Fig. 101:Example of cylindrical hole on rectangular profile

#### Macros available for bulb profile

- → Circular hole is a macro of a circular shape, which properties such as diameter, distance (X) and height (Y), rotation and tilt can be edited.
- → Half circle is a macro that cuts a half circle to the straight (non rounded) side of the bulb profile. Parameters that can be edited are distance (X) and the radius of the half circle.
- → N1 is a macro that can cut a rectangle shaped cut out to the straight (non rounded) side of the bulb profile. Parameters that can be changed are distance (X), width (A), length (B) and radius (R1).



Fig. 102: Properties of Circular hole for Bulb profile



Fig. 103: Half circle macro for Bulb profile in Macro features



Fig. 104: N1 macro for Bulb profile in Macro features

#### Macros available for H beam

- **Web circular hole** is a macro of a circular shape, with properties such as diameter, distance and offset that can be changed.
- **Flange circular hole** is a macro of a circular shape, with properties such as diameter, distance, offset and side (Positive Z/Negative Z) where the hole can be added

#### Trimmings

- **Beginning/Ending Corner cut** this type of macro cuts off selected corners of the shape. Parameters for this macro are Z+ bevel and Z- bevel.
- Beginning/Ending Tongue this type of macro trims away a part of the shape so it can be fitted into another and welded together. Parameters that can be changed are X Offset (Z+), Top bevel (Z+), Nose height (Z+), Bottom bevel (Z+), Rathole type (Z+), X Offset (Z-), Top bevel (Z-), Nose height (Z-), Bottom bevel (Z-), Rathole type (Z-), Tongue length, Corner radius, Z Offset (Z-), Z Offset (Z+), Web top bevel.



Fig. 105: Example of Web circular hole macro placed on H beam



Fig. 106: Example of Beginning – Corner cut in Trimmings for H beam

Macro Features						- o ×
H beam: Unnai	med shape					 😵 3D 📄 YZ 🌒 XY 🌒 XZ
Width	300.00 mm			View from top		
Height	790.00 mm					
Radius	30.00 mm					
Thickness	28.00 mm					
Center thickness	s 15.00 mm					
Length	300.00 mm					
Trimmings		Beginning - Tong	Je	Ę	28.00 mm E	
End - THE ADD THE ADD Holes ⊕Add ⊗R	ning - Tongue exegti: 14230 mm V Plane trimming v leg, Y avis V temove Multiply V Duplicate	X Offset (2-) Top bevel (2-) Nose height (2-) Bottom bevel (2-) Athole type (2-) X Offset (2-) Top bevel (2-) Rathole type (2-) Bottom bevel (2-) Tongue length Corner radius Z Offset (2-) Web top bevel	0.00 mm 0.0 deg 0.00 mm 0.0 deg 0.00 mm 0.0 deg 0.00 mm 0.0 deg Standard ~ 142.50 mm 28.00 mm 28.00 mm 28.00 mm	हु 283 ्र View from side		
Save						C ●

Fig. 107: Example of a Tongue in Trimmings for H beam

### Macros available for I profile

- **Web circular hole** is a macro of a circular shape, with properties such as diameter, distance and offset that can be changed.
- **Flange circular hole** is a macro of a circular shape, with properties such as diameter, distance, offset and side (Positive Z/Negative Z) where the hole can be added.



Fig. 108: Example of Flange circular hole macro placed on I beam

#### Macros available for Flat bottom dome

- → **Cylindrical hole** is a macro of a circular shape, which properties such as diameter, distance, angle and tilt can be changed.
- → **Cross marking** is a cross shaped type of marking, which properties can be changed. These are diameter, distance, angle and rotation.
- → **N** gon hole is a macro of polygon character where the number of sides is possible to adjust as needed. Other adjustable properties are diameter, distance, angle, rotation, tilt and an option to place the hole perpendicular to the surface. By checking the option for perpendicular hole, the hole is cut at right angle (90°) to the surface of the dome.
- → Splitting in half is a macro that allows for the dome to be cut in half. The parameters are side offset, center offset, rotation. If the side offset and center offset are zero the dome is cut completely in half. Side offset determines how many millimeters from the edge should be left uncut. Center offset determines how many millimeters from the center should be left uncut.
- **Side cylindrical hole** is a macro of cylindrical shape, with properties such as diameter, offset, angle, rotation, tilt and an option for the hole to be placed perpendicular to the dome.
- **Side cross marking** is a cross shaped type of marking, with properties such as diameter, offset, angle and rotation. This type of marking is placed on the side of the shape.
- **Side line marking** is a line marked on the side of the shape, with properties such as length, offset, angle and rotation.
- **Cut around** is a macro that allows the shape to be cut around its circumference. The parameter for this macro that can be changed is height.

Macro Features		-
Flat bottom dome: Unnamed shape Cylinder height [25.00 mm] Thickness [10.00 mm] Cylinder diameter [200.00 mm] Torus minor radius (60.00 mm] Holes € Add ® Remove Multiply • Duplicate (H) Height (42.50 mm] Cut around Neight 4230 mm]	View from top	→ 30  Y2  XY  XX
	View from side	

Fig. 109: Example of Cut around macro placed on Flat bottom dome

#### Macros available for Dished bottom dome

- → **Cylindrical hole** is a macro of a circular shape, which properties such as diameter, distance, angle and tilt can be changed.
- → **Cross marking** is a cross shaped type of marking, which properties can be changed. These are diameter, distance, angle and rotation.
- $\rightarrow$  **N** gon hole is a macro of polygon character where the number of sides is possible to adjust as needed. Other adjustable properties are diameter, distance, angle, rotation, tilt and an option to place the hole perpendicular to the surface. By checking the option for perpendicular hole, the hole is cut at right angle (90°) to the surface of the dome.
- → Splitting in half is a macro that allows for the dome to be cut in half. The parameters are side offset, center offset, rotation. If the side offset and center offset are zero the dome is cut completely in half. Side offset determines how many millimeters from the edge should be left uncut. Center offset determines how many millimeters from the center should be left uncut.
- **Side cylindrical hole -** is a macro of cylindrical shape, with properties such as diameter, offset, angle, rotation, tilt and an option for the hole to be placed perpendicular to the dome.
- Side cross marking is a cross shaped type of marking, with properties such as diameter, offset, angle and rotation. This type of marking is placed on the side of the shape.

- **Side line marking** is a line marked on the side of the shape, with properties such as length, offset, angle and rotation.
- **Cut around** is a macro that allows the shape to be cut around its circumference. The parameter for this macro that can be changed is height.



Fig. 110: Example of Cylindrical hole macro on Dished bottom dome

#### Macros available for Elliptical dome

- → **Cylindrical hole** is a macro of a circular shape, which properties such as diameter, distance, angle and tilt can be changed.
- → **Cross marking** is a cross shaped type of marking, which properties can be changed. These are diameter, distance, angle and rotation.
- $\rightarrow$  **N** gon hole is a macro of polygon character where the number of sides is possible to adjust as needed. Other adjustable properties are diameter, distance, angle, rotation, tilt and an option to place the hole perpendicular to the surface. By checking the option for perpendicular hole, the hole is cut at right angle (90°) to the surface of the dome.
- → Splitting in half is a macro that allows for the dome to be cut in half. The parameters are side offset, center offset, rotation. If the side offset and center offset are zero the dome is cut completely in half. Side offset determines how many millimeters from the edge should be left uncut. Center offset determines how many millimeters from the center should be left uncut.

- **Side cylindrical hole -** is a macro of cylindrical shape, with properties such as diameter, offset, angle, rotation, tilt and an option for the hole to be placed perpendicular to the dome.
- **Side cross marking** is a cross shaped type of marking, with properties such as diameter, offset, angle and rotation. This type of marking is placed on the side of the shape.
- **Side line marking** is a line marked on the side of the shape, with properties such as length, offset, angle and rotation.
- **Cut around** is a macro that allows the shape to be cut around its circumference. The parameter for this macro that can be changed is height.

Stipical dense:       Under religing:       0 mm       0 mo	Macro Features				– a ×
Optimet right       Soo m         Dido min       Soo min         Cipiter diameter       Soo min         Optimet diameter       Soo min         Optimeter diameter       Soo diameter         Optimeter diameter       Optimeter         Optimeter diameter       Soo diameter         Optimeter diameter       Soo diameter         Optimeter diameter       Soo diameter         Optimeter diameter       Soo diameter         View from side       Optimeter         Optimeter       Optimeter         Optimeter       Optimeter         O	Elliptical dome: Unna	amed shape			😌 3D 📲 YZ 📦 XY 📦 XZ
Incluse   Quinder diameter   20000 mm   Cluse raises to 6.00     Image: to 0.00 mm   Image: to 0.00 mm <td>Cylinder height 25.0</td> <td>.00 mm</td> <td></td> <td>View from top</td> <td></td>	Cylinder height 25.0	.00 mm		View from top	
Cycline drainater       DOD 00 mm         Ellipse radius ratio       6:50            •••••••••••••••••••••••••••••	Thickness 10.0	.00 mm		orm	
Tillper radius ratio       0.600         Web       With the product of the state of the product of the state of the product of	Cytinder diameter 200	00.00 mm		×	
Holes The diagonal of the cost of the cos	Ellipse radius ratio 0.6	500		β=45.0 deg	
Circular multiplication   (a) 0 Offset   (b) 0 offset   (c) 0 offse	Holes	-	Side cross marking		
Count & Spacing 450 deg	+Add (SRemove	Multiply Duplicate	(b) Diameter 100.00 mm		
Count & spacing 4x0 org	ြင်းcular mu	ltiplication	(B) Angle 45.0 deg		
Side cross marking	ீடீ Count: 8, Spac	cing: 45.0 deg	(a1) Rotation 0.0 deg		
View from side	Side cros	is marking		× ×	
				View from side	+ +
Save	Save				11 o

Fig. 111: Example of Side cross marking macro placed on Elliptical dome

#### Macros available for Conical dome

- **Cylindrical hole** is a macro of a circular shape, which properties such as diameter, distance, angle and tilt can be changed.
- **Cross marking** is a cross shaped type of marking, which properties can be changed. These are diameter, distance, angle and rotation.
- N gon hole is a macro of polygon character where the number of sides is possible to adjust as needed. Other adjustable properties are diameter, distance, angle, rotation, tilt and an option to place the hole perpendicular to the surface. By checking

the option for perpendicular hole, the hole is cut at right angle (90°) to the surface of the dome.

**Side cylindrical hole** - is a macro of cylindrical shape, with properties such as diameter, offset, angle, rotation, tilt and an option for the hole to be placed perpendicular to the dome.

- Side cross marking is a cross shaped type of marking, with properties such as diameter, offset, angle and rotation. This type of marking is placed on the side of the shape.
- **Side line marking** is a line marked on the side of the shape, with properties such as length, offset, angle and rotation.
- **Cut around** is a macro that allows the shape to be cut around its circumference. The parameter for this macro that can be changed is height.



Fig. 112: Example of Side line marking macro placed on Conical dome

#### Macros available for Inverted head dome

- → **Cylindrical hole** is a macro of a circular shape, which properties such as diameter, distance, angle and tilt can be changed.
- → Cross marking is a cross shaped type of marking, which properties can be changed. These are diameter, distance, angle and rotation.

- $\rightarrow$  **N** gon hole is a macro of polygon character where the number of sides is possible to adjust as needed. Other adjustable properties are diameter, distance, angle, rotation, tilt and an option to place the hole perpendicular to the surface. By checking the option for perpendicular hole, the hole is cut at right angle (90°) to the surface of the dome.
- → Splitting in half is a macro that allows for the dome to be cut in half. The parameters are side offset, center offset, rotation. If the side offset and center offset are zero the dome is cut completely in half. Side offset determines how many millimeters from the edge should be left uncut. Center offset determines how many millimeters from the center should be left uncut.
- **Side cylindrical hole** is a macro of cylindrical shape, with properties such as diameter, offset, angle, rotation, tilt and an option for the hole to be placed perpendicular to the dome.
- **Side cross marking** is a cross shaped type of marking, with properties such as diameter, offset, angle and rotation. This type of marking is placed on the side of the shape.
- **Side line marking** is a line marked on the side of the shape, with properties such as length, offset, angle and rotation.
- **Cut around –** is a macro that allows the shape to be cut around its circumference. The parameter for this macro that can be changed is height.



Fig. 113: Example of Side cylindrical hole macro placed on Inverted head dome
#### Macros available for Plane shape

- **Cylindrical hole** – macro of a circular shape with specific parameters. Diameter, angle, offset position and tilt can be modified.



Fig. 114: Example of cylindrical hole macro placed on circular plane profile

#### Macros available for Dished disc

- **Cylindrical hole** is a macro of a circular shape, which properties such as diameter, distance, angle and tilt can be changed.
- **Cross marking** is a cross shaped type of marking, which properties can be changed. These are diameter, distance, angle and rotation.
- N Gon hole is a macro of polygon character where the number of sides is possible to adjust as needed. Other adjustable properties are diameter, distance, angle, rotation, tilt and an option to place the hole perpendicular to the surface. By checking the option for perpendicular hole, the hole is cut at right angle (90°) to the surface.
- Splitting in half is a macro that allows cutting in half. The parameters are side offset, center offset, rotation. If the side offset and center offset are zero the disc will be cut in half. Side offset determines how many millimeters from the edge should be left uncut. Center offset determines how many millimeters from the center should be left uncut.
- **Side cylindrical hole -** is a macro of cylindrical shape, with properties such as diameter, offset, angle, rotation, tilt and an option for the hole to be placed perpendicular to the disc.

- **Side cross marking** is a cross shaped type of marking, with properties such as diameter, offset, angle and rotation. This type of marking is placed on the side of the disc.
- **Side line marking** is a line marked on the side of the shape, with properties such as length, offset, angle and rotation.
- **Cut around** is a macro that allows the shape to be cut around its circumference. The parameter for this macro that can be changed is height.



Fig. 115: Example of cylindrical hole macro placed on dished disc dome

To change properties of a macro, first you have to select the desired macro. You can do so by selecting it in the List of macro features (A2), by clicking on the desired macro on the 2D preview screen (B1) or by clicking on it on the 3D preview screen (C). After selecting the macro, you can choose the property you want to change by clicking on it in the Property inspector (A3) or by clicking on the property on the 2D preview screen (B1).

If you see this message "Error: Invalid macro, please change the parameters" under the macro's properties, it means the dimensions you put in for the macro are incorrect (e.g.: the macro would protrude outside the shape's edges). In this case you have to change the macro's parameters.

+ Add Remove Multiply -					
Cylindrical hole	Cylindrica	indrical hole			
Diameter: 65.00 mm, Tilt: 90.0 deg	Diameter	65.00 mm			
	Distance	1000.00 mm			
	Angle	45.0 deg			
	Tilt	90.0 deg			
	Error: Invalid the paramete	macro, please change rs			

Fig. 116: Invalid macro warning

# Adding multiplications

Multiplication is used when you need to add the same macro several times. To use multiplication option first choose a macro you wish to multiply by clicking on it on one of the screens or in the List of Macro features (A2). After choosing a macro, click on the Multiply button on the left screen (A2) and select desired multiplication.

→ Circular multiplication - the number of multiplied macros can be changed and the spacing between two macros can be chosen too, in the Property Inspector after clicking on a circular multiplication or by clicking on a macro in the 2D preview screen (B1).



Fig.117: Circular multiplication

# **Removing features**

**Remove button** will remove a previously selected macro or a multiplication by either choosing it on 2D preview screen (B1) or in the List of Macro features (A2). To remove a desired macro, you can also click a chosen macro/multiplication on the 2D preview (B1)/ in the List of Macro features (A2) and use a delete key on your keyboard.

Multiplications can be removed either by clicking on a macro on the 2D preview screen (B1) or on the Circular multiplication in the List of Macro features (A2) and either clicking the remove button or pressing the delete key.

# Saving shapes

The created shape can be Saved by clicking the button on the bottom of the List of Macro features screen (A2). The mCAM also automatically saves the shape when you press X to leave. This shape, containing the cutting paths, can be further edited afterwards if you wish so.



Fig. 118: Save button and the final shape

The final shape is imported into mCAM as a default shape and can be used and edited like the other imported shapes. Its cutting paths can be edited, lead ins/outs can be changed, text markings can be added, the preparation for welding can be added and so on.



Fig. 119: Final shape used in a job

# H-beam welding connection macros

mCAM supports several types of welding connections for H-profiles, that are automatically recognized at import.

- 1. Tongue ending
- 2. Inverse tongue ending
- 3. Corner ending

Each type of welding connection has its set of parameters that are automatically set according to the imported shape. They are of informative character and do not need to be adjusted.

Each macro for welding connection ending can be oriented in X+ or X- direction, depending on which end of the part it is located. Each part contains maximum of two macros – one for each end of the part.



Fig. 120: Each part can contain maximum of two macros – One in X+ and one in X- direction

#### 1. Tongue ending parameters

- → *Flange definition Z+/Flange definition Z* – defines the length and shape of respective flanges. Contains several parameters:
  - X junction Point on an inner edge of the Z+/Z- flange, which defines the length of the respective flanges.
  - Top bevel angle defines shape of the respective flange
  - Bottom bevel angle defines shape of the respective flange
  - Bevel nose height defines shape of the respective flange
  - *Rathole type* None, standard, None with grinding
- → <u>Tongue ending X</u> defines the length of the web. Unlike the inverse tongue ending, this type can have only straight ending with Z+ and Z- value the same (hence only one parameter instead of two as is in inverse tongue ending)
- $\rightarrow$  <u>Z+ offset</u> offset of web from outer edge of Z+ flange
- $\rightarrow$  <u>Z- offset</u> offset of web from outer edge of Z- flange
- $\rightarrow$  <u>Web corner radius</u> rounding of the corners on tongue ending

If Z offset is bigger than the cutting tool diameter, flanges don't need to be cut, because the cutting head will fit between the flange and the cutting contour. The cutting paths are automatically generated for each flange separately with regard to this information.



Fig. 121: Tongue ending and its parameters in Properties area



Fig. 122: Parameters for Tongue ending welding connection



*Fig. 123: Z+ flange with bevel parameters* 



Fig. 124: Rathole Standard is cut in 45 degrees angle



Fig. 125: Rathole None is cut in direction of bottom bevel angle



Fig. 126: Rathole - None with grinding



Fig. 127: Rathole - None with grinding

#### 2. Inverse tongue ending parameters

- → *Flange definition Z+/Flange definition Z-* defines the length and shape of respective flanges. Contains several parameters:
  - X junction Point on an inner edge of the Z+/Z- flange, which defines the length of the respective flanges.
  - Top bevel angle
  - Bottom bevel angle
  - Bevel nose height

Bevel angle parameters (Top and bottom bevel angle, bevel nose height) are the same as for Tongue ending welding connection

- *Rathole type* None and standard
- $\rightarrow$  <u>Z+ tongue ending X</u> defines the length of the Z+ side of the web
- $\rightarrow$  <u>Z-tongue ending X</u> defines the length of the Z- side of the web.

*Z*+ and *Z*- tongue ending X parameters can be different values each. Because it is inverse tongue ending welding connection type, the position of Tongue ending X must be located in direction of material away from position of Junction X.



Fig. 128: Inverse tongue ending and its parameters in Properties area



#### Fig. 129: Inverse tongue ending with parameters

All bevels on web for both tongue ending and inverse tongue ending are being ignored, even if they are designed in 3D model of the part. mCAM will ignore them, and generate basic straight cut on the web, regardless of the drawing.

#### 3. Corner ending parameters

- $\rightarrow$  <u>X position</u> defines the length of the web
- $\rightarrow$  <u>Z+ bevel angle</u> defines the bevel angle of Z+ flange
- $\rightarrow$  <u>Z- bevel angle</u> defines the bevel angle of Z- flange



Fig. 130: Corner ending and its parameters in Properties area



#### Fig. 131: Top view of corner ending welding connection with its parameters

Corner ending <u>has to be designed with X-cut</u> on the web for mCAM to identify correctly the welding connection, but it will be ignored and the final product will have only straight cut on the web.



Fig. 132: Step file is designed with X cut on the web, but the final cut is straight

# Limitations on H-beam welding connections macros

There are some limitations on what type of cuts are supported on H-beam welding connections.

 Y/X/K cuts on web – Because of the dimensions of the cutting head it is not possible to cut the bevel cuts on web. If they are designed in step, they will be ignored and replaced with straight cut. It doesn't matter if they are designed in step file. The exception is Corner ending macro, where, for the correct recognition of the welding connection, X-cut must be on the web.



Fig. 133: Detail of the web on tongue ending with K-cut replaced with straight cut

2. In case of inverse tongue ending macro, due to technology limits, it is not possible to cut the web completely off the flange. There will be a section of the web that will remain attached to the flange. It is not possible to cut exactly near the flange due to the dimensions of the cutting head.



Fig. 134: Difference between the 3D model and the real outcome of cutting

3. The height of the nose on the flanges should be consulted with technology department to determine what size of the nose is the best for given thickness.



Fig. 135: It is recommended to consult the height of the nose with technology department

4. It is recommended not to draw radiuses on the inner side of the web, where the rathole is located.



Fig. 136: The model should be drawn without the radiuses

5. If the Z offset (+ and -) is bigger than the diameter of the cutting head, the tongue ending could be cut without using the macros. If this is the case, the inner radiuses (as mentioned in previous point) should be drawn in step file (if they need to be cut). Also, if the tongue ending is cut using standardly generated cutting path, the flanges have to be without bevels.



Fig. 137: Cutting the tongue without using the macros

# **Cutting path modifications**

Cutting paths are displayed as a set of lines that represent the path of the tool during machining process. Every single line represents mutual position of the cutting head and the work piece. The top of each mark is oriented forward with respect to the direction of motion.

Lead—ins are displayed in blue colour and lead—outs in red colour. Selected cutting path is displayed in yellow colour. When selected, user can edit its features that are displayed in Properties area. Some features can be changed using cut path editing widget.



#### Fig. 138: Cutting path and its sections

Cut path editing includes these operations:

- splitting paths and loops creation
- lead-ins/outs modifying
- start point modifying (on cyclical paths)
- microjoints creation
- text marking
- enabling or disabling transformations (drilling/ punching/ quality hole cutting)
- marking of contours
- user ordering (priority cutting)
- assignment of cutting operation for each cutting path (Q1/Q2/Q3/Q4/Q5; Large/Medium/Small contours)
- alignments of cuts
- applying common–cut (during nesting procedure)

# **Right control panel**

After selecting the cutting path, the panel pops out on the right side of the screen. This cut path editing widget contains several buttons with various functions for changing some attributes of cut paths.



Fig. 139: Cut path editing panel on the right side of the visualization screen

lcon	Description
<b>k</b> nn	Set lead-in/out to custom position (described in section Lead-in s/-outs)
MA A	Set lead-in/out to automatic position as generated by mCAM
27	Revert the cut path (described in section Reversing a cut path)
þ	Add loop on selected cut point (described in section Loops)
¢	Split path on selected point (described in section Splitting paths and creating loops)
-¢-	Join path points (described in section Splitting paths and creating loops)
ШЖ	Erase selected cut point
创	Delete cut path

There are also welding attributes, that are described in section *Welding preparations*.

#### **Cutting path editing shortcuts:**

- E erase cutting path point on selected cutting path
- L add loop on selected cut-point
- Shift + L add loop between two points on cutting path
- **R** remove selected loop
- **T** delete selected cutting path
- Y disable all technologies on selected cutting path
- H open select cut dialog
- **B** split path on selected cutting point

## Alignments on beams

Alignments are used when machine uses laser scanner for beam measurement/ (H– beams, U–beams, L–beams, Square pipes). Laser scanner measures the exact size of beams (width, height and Web offset) and adapts the size or position of *cutting contours* to measured beams. Laser scanning of beams partially solves the problem of unprecise dimensions of beams by the stretching or positioning the cuts along the whole width of flanges or web.

*Alignments* function allows to *align* cuts to positive or negative edge of flange/web, *align* cuts to middle of flange/web (centering holes) or *stretch* them along the whole width (trim cuts).

Note: *Stretch* function should be used on all trim cuts to make sure that parts will be completely cut–off. It is not recommended to use *stretch* function on closed holes and closed features with special geometry due to possible deformation of required shape – when beam size differs from 3D model too much.

Alignments functions:

- stretch stretches cuts along whole width affects the length of cut
- align positive aligns cuts to positive edge of side (FACE) affects only position of the cut (not dimensions)
- align middle aligns cuts to middle of side affects only position of the cut (not dimensions)
- *align negative* aligns cuts to negative edge of side affects only position of cut (not dimensions).
- align to top point used when cut is passing through two or three sides of a part (square pipe U-profile, L-profile) and align cuts to top point of the edge through which the cut is passing. Affects only position of cut (not dimensions).

Trim cuts on beams are set to *stretch* by default and closed holes are set to *align to middle* by default.

Align functions (to positive/middle/negative) are used to keep the same distance of cut from the edges/from middle position as modelled in 3D model and defined in drawing of part.



Fig. 140: Align to positive – hole will maintain the distance from the top edge



Fig. 141: Align to middle – hole will maintain the distance from the middle of flange



Fig. 142: Align to negative – hole will maintain the distance from the bottom edge



*Fig. 143: Align to top point – hole will maintain the distance from the edge that it is passing through* 

# Edge markers

Edge markers serve for selecting suitable transition type on edges. To display edge markers, they need to be enabled in the visualization screen settings menu located in the bottom panel under the eye icon.



Fig. 144: Show /hide edge markers. The edge markers are enabled.



Fig. 145: Edge marker on corner of the shape



Fig. 146: Selected edge marker with its settings

After selecting a marker, its settings appear in Properties area. There are three transition types for edges:

- 1. Smooth transition
- 2. Split to lead-in/-out path will be split on selected edge
- **3.** Join with loop loop will be added on corner. It is possible, that instead of loop, the lead-in/-out will be moved to the selected edge. Loops are described in more detail in section <u>Splitting paths and creating loops</u>.

# Fitting cut path to a real shape

mCam now cooperates with mScan, another software developed by MicroStep, that serves for mapping a real shape and creating digital representation of a manufactured part by using data from a scanner. By applying this digital representation onto an ideal shape in mCAM, it adjusts all cutting paths and generates modified CNC instructions according to the new data.

The direction in which the cutting paths are shifted is determined via hole axis.

### Hole axis

Hole axis determines the direction in which a cutting path is shifted from 3D model to a real surface. If mCAM detects a hole and is able to generate the hole axis automatically, the cutting path will shift according to the generated hole axis as pictured below, unless the hole axis is changed manually.



Fig. 147: Direction of shifting the cutting path with generated hole axis

The direction of hole axis can be changed manually by changing the corresponding values in X, Y and Z in cartesian coordinate system or  $\phi$  and  $\theta$  in polar coordinate system in Properties area.

There are cases when holes either don't have hole axis (e.g. gaps) or mCAM can't generate them automatically. If a hole doesn't have a hole axis generated, the cutting path will shift in the tool direction as pictured below.



#### Fig. 148: Direction of shifting the cutting path without generated hole axis

After the import of the 3D shape to the mCAM, the program automatically detects holes and generates hole axes if it's possible. User can manually check if the axes are

generated and if it's done correctly by selecting a cutting path. The hole axis settings show up in Properties area and hole axis of the hole appears on a visualization screen if present. If the box beside Hole axis is unchecked, the hole axis was not generated.



Fig. 149: Hole axis properties

In case of complex cuts, such as Y and K cuts, hole axis will be generated only for one part of cut – most likely on straight cut. The remaining cuts will then assume the same axis and the cutting path will be shifted accordingly.

If some holes don't have hole axis (e.g. holes with welding preparation) you can manually generate them by pressing J. The direction of the hole axis is then a normal of a best plane fitted to the selected cut path. In this instance pressing J is the same as clicking on a picture of the hole axis in the top right corner of Hole axis settings. In other cases, when the hole axis is generated automatically at import, the Reset hole axis button uses default algorithm and reverts the hole axis direction to its original placement.

If there are any holes without hole axis and you'll generate CNC code, a complaint will pop up with announcement that "Missing hole axis for some cut path(s).". If that was not your intention, you can recheck the holes, generate missing hole axes and then re-generate CNC code to ensure the correct and desired result.

You can change the type of the coordinate system in which the axis direction is displayed from cartesian to polar by clicking on a picture of the coordinate system.

TMinR:	130.00		
CH:	35.00		
✓ Hole axis		12	Ø
Х	0.00 mm		
γ	0.00 mm		
Z	-1.00 mm		
Tool path #3			
Path generation mode	automatic		•
Kerf compensation			

Fig. 150: Hole axis properties



Resets hole axis

Displays axis direction in polar coordinate system

Displays axis direction in cartesian coordinate system

#### **Useful shortcuts**

These keyboard shortcuts provide quick and easy way to set a hole axis in the two most occuring ways.

**N** – sets the direction of the hole axis according to the Z-axis.

J – the direction of the hole axis is based on a normal of a plane, that is fitted between points belonging to the cut path.

# Lead-in s/-outs

In the process of piercing, most energy-beam machining technologies damage a small area around the piercing point. To eliminate the damage on the final work–piece, the piercing process is started on the outer part of the contour (in the waste area). Starting point can be manually placed by selecting a cut path, clicking on a set a lead-in/out on custom position

button We located in the cut path editing widget on the left side of the screen. The second button We with letter A returns a lead-in/out to the automatic default position as set by mCAM with default settings as set by user in Settings.



#### Fig. 151: Buttons for setting the lead-ins/outs to custom and default position

*mCAM* displays individual features of a cutting path in several colours. Lead-ins are displayed in blue colour, lead-outs in red colour and cutting path is in white colour.



#### Fig. 152: Lead-ins/outs are displayed in individual colors

Default lead-in/-out parameters as type, length, tangential angle, tool orientation and user speed are defined in Settings -> Lead-in/-out section or can be changed individually for each cut path in Properties menu of selected cutting path. All parameters of lead-ins/outs are described in more detail in section <u>Lead in/out.</u>

There is also possibility to use **Dynamic piercing** on plates, where the tool moves from side to side until the material is pierced through, and only then it continues cutting respective cutpath. This technique is used when cutting plates that are too thick with water-jet. Dynamic piercing has these parameters:

• Length – specifies the length of piercing area

- **Repeat** how many times does the tool move along the piercing area
- **Direction** in which direction the tool is moving X or Y axis

Property inspector		Settings	Imported 1	🖉 Temporary job 8  🛛
> Shape		a occurso	S imported i -	
✓ Solid		View Shape	Tool path processing	
Name	Plane			
T:	10.00 mm			
W:	600.02 mm			
H:	500.03 mm			
🕆 🗹 Hole axis	×			
Φ	0.0 deg			
Θ	180.0 deg			
Y Tool path #12				
Path generation mode	Automatic $\sim$			
Kerf compensation				
Marking				
Cutting				
Transformations				
Layer	Automatic transformation $~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~$			
Laser operations	Large contours $\sim$			
Waterjet operations	Q5 ~			
Stop (M0) before cutting				
User order				
Normal limit				
<ul> <li>Technology modifications</li> </ul>				
User speed	100%			
Microjoints				
✓ Lead-in				
Туре	Linear (1 section) $\checkmark$			
Length	10.00 mm			
Tangential angle	60.0 deg			
Tool orientation	Straight to bevel 2 $\sim$			
Dynamic piercing				
✓ Lead-out				
Туре	Path conforming ~			
Length	4.00 mm			
<ul> <li>Cutting technology setup</li> </ul>				
Machine	~			
<ul> <li>Marking technology setup</li> </ul>				
Machine	~			
		<b>F 3 3 W</b>	•	
			$\sim$	

Fig. 153: Lead-in with disabled dynamic piercing



Fig. 154: Lead-in with enabled dynamic piercing



Fig. 155: Setting the lead-in/out for selected cutting path in Properties area

# M0 – Stop before cutting

This setting can be checked on or off for each cut path individually. If checked, the instruction M0 is generated into CNC code before respective cut path.

Y Tool path #12	
Path generation mode	Automatic ~
Kerf compensation	
Marking	
Cutting	
✓ Transformations	
Layer	Automatic transformation $~~$ $\sim$
Laser operations	Large contours $$
Waterjet operations	Q5 ~
Stop (M0) before cutting	
User order	
Normal limit	
<ul> <li>Technology modifications</li> </ul>	
User speed	100%
Microjoints	
✓ Lead-in	
Туре	Arc (90 deg) $\checkmark$
Length	10.00 mm
Tool orientation	Straight to bevel 2 $$
Dynamic piercing	
✓ Lead-out	
Type	Path conforming $\sim$
Length	4.00 mm
<ul> <li>Cutting technology setup</li> </ul>	
Machine	~
Marking technology setup	
Machine	~

Fig. 156: Stop (M0) before cutting

# Marking (contour marking)

Marking is a technological operation used in energy beam cutting technologies where reduced power, pressure, current or different type of gases needs to be used. Marking operation affects only few millimetres (or less) of material and is mainly used to mark cutting contours or cutting features that are intended to be machined by other machining method (e.g. drilling or milling holes, etc.).

There are several cases when marking is useful. It is frequently used in laser cutting when semiproducts (pipes, sheets or beams) are too rusty for cutting and all contours (intender for cutting) need to be marked first.

Marking is also used for marking the cutting contours that have been limited due to maximum angle of torch to material normal that is possible to reach. Standardly used torch tip in plasma bevel cutting is able to reach 45 degrees (or 50 degrees for special torch tips). Laser cutting head standardly uses nozzles that are able to reach 20 degrees to material normal. Maximum angle between torch and material normal while cutting is defined in *Settings – Cut path – Technology limits*.

Marking operation is enabled or disabled by using the *Marking* checkmark option in *properties* of selected cutting path. Marking is disabled for all contours by the default.



Fig. 157: Marking of cutting contour

Application of marking instruction (all contours that have been set to mark) into CNC program has to be confirmed in the *stock properties* in *Job task*. Generation of all required marking instructions into CNC program is enabled by the default.

Property inspector		🔹 Settings 🛛 Imported 1 🖾	И Te	mporary job 5  🛛					
✓ Solid									
Name	Circle pipe	x A Circle pipe D: 140.00 mm T: 5.00 #	5 VI	ew Shape Tool pa	th processi	ng			
D:	140.00 mm	Circle pipe b. 140.00 min 1. 5.00 4	s	tock information:					
T:	5.00 mm	∽ 🚺 🔂 L: 873.00 mm 1 🛛 🕅 🖓 🖿	3						
E .	873.00 mm	Y A Stock part 502.67 mm			496.15 m	m		369.33 mm	
<ul> <li>Technical summary</li> </ul>		• g stock part 505.07 mm		/			/ /	(	
Lowest cut depth	5.00 mm	Tube140							
Highest cut depth	12.58 mm	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~							
<ul> <li>Technology setup</li> </ul>	٥								
Machine	9999 MicroStep Demo N $ \smallsetminus $								
Technology	v				Tube14	0		Rest	
<ul> <li>Nesting settings</li> </ul>									
Nesting gap	5.00 mm			Heat Number:		Serial Number:		Dimensions: Circle pipe D: 140.00 m	m T: 5.00 mm
Startpoint X offset	0.00 mm					Rest: 369.33 mm	(42%) (Chuck lengt	h: 330.00 mm)	
Use part envelope	only								
Use common-cut			P	arts on stock:					
Surface mapping q	Normal ~			Shape number	Shape n	name	Copies in stock	Part length	
🗹 Enable part rotati	ons and flipping			11	Tube140	D	1	496.15 mm	
✓ Job stock									
Virtual stock									
Unlimited count									
Count	1								
Length	873.00 mm								
<ul> <li>Plan generation</li> </ul>									
Program name									
Output format	Cnc v								
Cutting mode	Moving in XYZC axes 🛛 🗸								
Axis	X axis 🗸 🗸 🗸								
Chuck location	At X min 🗸 🗸								
🗹 Marking 🔫 🗕									
Transformations									
Text marking									
Cutting									
Remark									
Cut end of pipe									

Fig. 158: Marking instructions generation – enabled

# Microjoints

Microjoints are used when a cutting path needs to be divided into smaller sections separated by uncut segments to preserve integrity of a work-piece and rest of the stock material and to prevent distortions or damage of parts during cutting. Microjoints are defined by their length and quantity. Microjoints are placed regularly on the whole length of selected cutting path. Starting point of the first microjoint is set by *starting point* position. Lead–ins and lead–outs types of all microjoints on particular cutting contour are defined by *Lead–in* and *Lead–out properties* of the selected cutting path.



Fig. 159: Microjoints application

# Path generation mode

Path generation mode determines how the cutting points (tool path) are generated. There are seven modes that can be used in different cases and generates different cutting paths with specific characteristics. Default mode used (for all newly imported parts) is set in *File* -> *Settings* -> *Cut* path -> Path generation mode with no machine/technology selected.

Path generation mode can be changed for each selected path individually according to the contour properties and cutting edge shape type in *Properties menu* in section *Path generation mode*.

There are seven path generation modes:

- automatic
- smooth cut
- tangential
- minimal distance
- linear mapping
- surface normal
- face tangential
### Automatic (recommended to use)

This mode is the combination of several modes: minimal distance, surface normal, linear mapping, and face tangential. It combines algorithms according to actual shape of the cutting face. Due to the combination of the four modes, it generates the best possible cutting path in most cases.



Fig. 160: Complex surfaces and weld edge preparation – automatic mode

### Smooth cut (2D planar cutting)

Smooth cut mode is a very precise method for contours that are perfectly trackable by one beam from top to bottom edge of the shape. It is not recommended to use on convex or concave surfaces (e.g.: intersection of pipes and other rounded shapes) or for shapes with Y and K cuts.

This method is recommended to use especially in water-jet cutting of complex shapes where cutting faces are completely traceable by one straight beam in all sections of contour. Another important characteristic of this method is its speed.



Fig. 161: Complex cutting surfaces – planar shapes – smooth cut mode

#### Tangential

Tangential mode generates cutting path that connects two points. The first point is defined as an intersection of the top contour and the plane given by the axis of the angle between two cut-path points belonging to the top contour. The second point is defined as an intersection of that particular plane with the bottom contour.



Fig. 162: Tangential tracking of cutting path – tangential mode

## **Minimal distance**

Minimal distance creates a cutting path as the shortest path from a top cutting point to the bottom cutting edge.



Fig. 163: Minimal distance mode

### Linear mapping

Linear mapping mode creates the cut-path as a linear movement with linear speed at the top and the bottom cutting edges from the starting cutting point.



Fig. 164: Linear mapping mode

## Surface normal (straight cutting)

Surface normal mode creates a cut-path as the normal to the surface on top edge of cutting contour. This mode is recommended to use only with straight cutting and straight contours.



Fig. 165: Surface normal mode

## **Face tangential**

Face tangential mode is similar as the tangential but it uses a different algorithm.



Fig. 166: Face tangential mode

Keep in mind that using other path generation modes (except Automatic path generation mode) may cause non–smooth cut especially on sharp cutting edges, too complex shapes or weld edge preparations.

#### **Erasing cut path points**

When cutting path crosses another cutting path in the wrong way, there is an option to erase some cutting points manually by selecting respective cutting path and using function

*Erase* cutting path points (key shortcut: "E") or  $\parallel \times \mid$  icon in cut path editing widget.



Fig. 167: Erase cutpoint icon in cut path editing widget

Erasing cutting points will cause that cut path will be generated by linear interpolation between previous and next cutting point surrounding the erased cutting point, therefore it can cause problems especially in variable bevel cutting.



Fig. 168: Selection of cutting path points to be erased

# Punching

Punching is a special technological operation when a cutting tool, typically a plasma torch, is used as a marking tool to create mark points on the surface. These are used for preparation of subsequent operation (*drilling, boring*, etc.). The centre point of a future hole is marked on the work–piece surface by a short punch of a machining tool. Identification of holes for punching as well as quality hole cutting or drilling is managed in *Transformations* and defined by *transformation tasks* (*punching, drilling, quality hole cutting*, etc.). *Transformations* are described in more details in section Transformations.

# Reversing a cut path

A cut path can be reversed if the inner part of the hole is a final product. To reverse a cut path, it has to be selected either in Import or in "Shape" tab in Job. More holes can to be selected at once with "Select cut", by pressing an "H" key. When all respective cut paths are

selected, they can be reversed by pressing the "U" key or corresponding button  $\checkmark$  for reversing a cut path in cut path editing widget.

This will cause all lead-ins to be generated on the outer part of the contour. Also, the kerf width is compensated outwardly from the hole so the dimensions of the inner part of the hole will be preserved.



Fig. 169: Reversing cut path button in the cut path editing widget



Fig. 170: Reversed cut path with lead-in on the outer contour



Fig. 171: Kerf width compensation on the inside of the hole while the cut path is not reversed.



Fig. 172: Kerf width compensation on the reversed cut path is on the outer side of the hole thus preserving the desired dimension of the final product.

# Splitting paths and creating loops

Cutting path can be split by selecting a cutting path, clicking on an icon of scissors (or pressing the key shortcut B) and selecting a cutting point where the path has to be split. It is possible to split cutting path on any *cutting point* regardless if there is or isn't an edge.

Division of cutting paths (*Split paths*) is recommended to use especially when cutting special technological features separately (slots, straight cut sections, etc.) where we want to use more precise surface detection and more precise cutting.

Join paths button can be seen only with non-circular paths and can be used to join previously split or otherwise not-connected paths.

Connection of the cutting paths (*Join with loops*) is recommended to use when cutting sharp edges where by using *Spline loops* can user avoid overburn of the material, increase the quality of the edge, reduce number of ignitions or extends lifetime of consumables.

Cutting of joined cuts (with or without *loops joining*) is based on one surface detection procedure (one measurement). Therefore, if the cut path is long with wide X-axis range, it can cause tool collisions due to the inaccuracy of the stock material.



Fig. 173: Splitting path using scissors in cut path editing widget



Fig. 174: Selected cut point is displayed in blue color

#### Loops

Loops are usually used in the corners, where the direction of contour is suddenly changed (i.e. a place of intersection of two linear entities). Loops are located in waste material and they significantly improve corner cutting quality. Besides significant improvement of the accuracy of the cut, loops can be used to reduce cumulative rotation in B-axis to meet its limitation. More information about the limitation in B-axis are specified in the parameter B-axis speed limit definition in section Generate.

Loops can be created in two ways:

- via Edge markers (described in section *Edge markers*)
- manually, using cut path editing widget (described in section Right control panel on page 88) When start position (lead–in /out position) is moved into the place of a loop, the loop is automatically removed.

When loop is selected, its settings are displayed in Properties area. There are parameters that define the type and size of the selected loop and option to reposition B axis.

There are three types of loops:

• corner,

arc arc

• triangle,

• spline

The selection of loops in the visualization screen is available only when the Selection style is switched to displaying Loops. The Selection style option can be found by right clicking in the visualization screen.



Fig. 175: Loop type – corner



Fig. 176: Loop type – triangle



Fig. 177: Loop type – arc



Fig. 178: Loop type – Spline

#### **B**-axis reposition

Loops can be used for backward rotation of rotator in B-axis. The function B-axis reposition is useful when cumulative value of B-axis on cutting path reaches the limit value (which is approximately 400°– depends on type of the CNC machine). If B-axis value exceeds the limit, *mCAM* displays a warning that signals the exceeded range of B-axis. Number and the places of loops to apply can be identified from a cutting simulation graph where the process of B-axis values is displayed. Backward rotation of B-axis is represented as M38 instruction in CNC code.

#### Shortcuts

There are several key–shortcuts and function Cut division wizard that can be used to add or remove loops, split cuts and join cuts. Key – shortcuts used for manual adding loops (on selected cutting path) within visualization screen are:

- add loop on cut-point (on selected path): key shortcut: <L>
- add loop between two cut-points (on selected path): key shortcut: <Shift+L>
- remove loop: key shortcut: <R>

# Start position (cutting contour)

Start position marks the location where cutting head begins cutting into the material and defines the location of lead-in/-out on the cutting path. Starting point can be manually changed by placing the lead-in to the custom position on selected cutting path, clicking on a

set a lead-in/out on custom position button <sup>we</sup> located in the cut path editing widget on the left side of the screen. The second button <sup>we</sup> with letter A returns a lead-in/out to the automatic default position as set by mCAM.

Start position can be changed only on cyclical contour (closed holes or circular trim cuts)



Fig. 179: Function Pick start position



Fig. 180: Selection of cutting point – start position

# Start point (CNC program)

*CNC program* start point is defined by the *shape type* (*circle pipe*, *H–beam*, *U–beam*, etc.) and used *Chuck location*. *CNC program* starting point is displayed in simulation of particular *CNC program* when mouse cursor is placed in the first *NC code line* (not commentaries in brackets).

In special cases when machine is equipped with optical sensor that detects the edge of the pipe (start point), it is possible to use *Startpoint X offset* if the detection was not entirely accurate. The function shifts the start of *CNC code* a bit towards the *Chuck location*. The parameters are defined for whole *Job task* in *Profile nesting properties*.

*Default CNC program* starting point in plate cutting is defined in *Settings – Generate – Ordering – Start point of plate CNC program*.

Ordering		
💠 🔄 👯 Marking-cutting changeover	Start cutting immediately	$\sim$
$\Leftrightarrow \ \  \                              $	Finish part (mark all → cut all)	$\sim$
💠 💠 🐙 Thermal mode	No thermal sorting	$\sim$
🔄 🔄 🐙 Start point of plate CNC program	At X min and Y min	$\sim$
💠 💠 🗏 Movement at program end	No movement	$\sim$

Fig. 181: Start point of plate CNC program



Fig. 182: CNC program starting point

# Technology modifications

This section in Properties area for selected cut path contains the setting for adjusting the user speed for each cut path individually. It is set as percentage of speed that is in expert tables.

Yool path #2	
Path generatio	Automatic ~
🗹 Kerf compensa	ation
Marking	
🗹 Cutting	
🗹 Transformatio	ns
Layer	Automatic transform ~
Laser operatio	Large contours
Waterjet opera	Q5 ~
User order	
Normal limit	
✓ Technology modi	fications
User speed	100%
Microjoints	
Ƴ Lead-in	
Туре	Linear (1 section) 👘 🗸
Length	10.00 mm
Tangential a	58.3 deg
Tool orienta	Straight to bevel 1 🔍 🗸
🗌 Dynamic pi	ercing
✓ Lead-out	
Туре	Path conforming 👘 🗸
Length	3.00 mm
-	

Fig. 183: Setting the user speed for selected cut

# Technology setup (for individual cut-paths)

After selecting the cut path, it is possible to assign different technology and tool for cutting and/or marking or text marking. The shape has to be already loaded in the job. The option to choose separate technology and tool for marking or cutting is not available in Import tab.

- 1. Technology setup for text marking Technology and tool for text marking is assigned in Shape tab in job in section Text marking.
- 2. Technology setup for cutting Different technology and tool for cutting of cut path is assigned at the bottom of the properties area after selecting respective cut path.
- **3.** Technology setup for marking Different technology and tool for marking of cut path is assigned at the bottom of the properties area after selecting respective cut path.

Technology selected for marking has to be different from technology used for cutting the whole plan, otherwise a complain will pop up "Some cut paths have set invalid tool". This is because it is not possible to change tools in iMSNC during cutting, so one technology can have only one tool assigned in one CNC plan. This option is especially useful for machines with inkjet markers.



Fig. 184: Waterjet technology with respective tool is selected for cutting



Fig. 185: Plasma with respective tool is selected for text marking in Shape tab



Fig. 186: Marking is enabled for selected cut path and plasma technology with respective tool is selected in Properties area

(PART 'Pipe_150x20_pipe_intersection' 1 2954400)		Block	5			
(SIZE 1; 20 150; 467.019)	IГ	Id	M94 D	M20	M6	Cut off
(SIZE: UrclePipe Inickness=20 Diameter=150; Lengtn=467.019)	ll-	14	WID4 D	IVILO	1410	Cuton
(mcanilexpercition operation 4, unchiess - 0.00 speed - 3400.00 kerr - 3.00 (mcanilexpercited machine) 0000 technology 10 tool HE-MST- 20.0, 130-568-DerCut 4	ll	.1				
(mcam.key.coormachine.ssss cechnology.ro coordinates rot=0.0 height=20	3		5:2	2	410	marking with plasma
M6 T410 (TEXT TEXT 4)	1	1			410	
G0 C-41.525			74	2	110	
M94 D5	"		7:1	2	114	waste
G94 X-140.473 Y-2.428 Z-0.039 (upAngle=1.9)	4		7:1	2	114	item
G94 X-182.473 Y-7.416 Z-0.368 (upAngle=5.7)	III	3173				cutting with wateriet
M94	IF					
M38 L-5.087 L14.292 (Corr A from B 30.0. Add=1.0)						
GU X-182.4/3 Y-/.416 Z-0.368 A-5.6/5 BU.000 C-41.525 (SetB=0.000) (upAngle=						
M2( bttp://www.action.com/action.						
G1 X-182 473 Y-6 421 7-0 275 A-4 911 B0 000 C-41 525 (unAngle=4 9)						
M90 D1.000						
G1 X-182.473 Y-5.424 Z-0.196 A-4.147 B0.000 C-41.525 (upAngle=4.1)						
M90 D1.000						
G1 X-182.473 Y-4.426 Z-0.131 A-3.383 B0.000 C-41.525 (upAngle=3.4)						
M90 D1.000						
G1 X-182.473 Y-3.427 Z-0.078 A-2.619 B0.000 C-41.525 (upAngle=2.6)						
G1 X-182.4/3 Y-2.428 Z-0.039 A-1.855 B0.000 C-41.525 (upAngle=1.9)						
M90 D1.000						
Mon D1 000						
G1 X-182.473 Y-0.429 7-0.001 A-0.327 B0.000 C-41.525 (upAngle=0.3)						
M90 D1.000						
G1 X-182.473 Y0.571 Z-0.002 A0.437 B0.000 C-41.525 (upAngle=0.4)						
M90 D1.000						
G1 X-182.473 Y1.571 Z-0.016 A1.201 B0.000 C-41.525 (upAngle=1.2)						
M90 D1.000						
G1 X-182.473 Y2.571 Z-0.044 A1.964 B0.000 C-41.525 (upAngle=2.0)						
M90 D1.000						
G1 X-182.4/3 Y3.5/0 Z-0.085 A2.728 B0.000 C-41.525 (upAngle=2.7)						
G1 X-182 473 V4 560 7-0 120 42 402 80 000 C-41 525 (up & pole=2.5)						
Line: 68 Q search						

Fig. 187: Example of CNC code

# Adaptive Bevel Compensation

#### **Bevel Angle Correction in iMSNC:**

The parameter adjusts the distance between the tool and the intersection point of tool axes during tool rotation. The system uses this value to calculate compensation of contour dimensions depending on the tool angle. Then the cut contour is not influenced by the cut angle. Parameter value is dependent on a mechanical structure and adjustment of the rotator. Usually, it is approximately 7-8 mm. When during bevel cutting a deviation from the desired part dimensions is observed it is possible to make corrections of dimensions by modification of this parameter.

The parameter value is obtained experimentally:

- If the part dimension during positive bevel (i.e. the torch is inclined to the left in relation to the direction of movement) is bigger than the required dimension, the correction value must be increased.
- If the part dimension during negative bevel is bigger than required, the correction value must be decreased.
- If the part dimension during negative bevel is smaller than required, the correction value must be increased.

#### Settings in iMSNC:

mCAM uses only parts of MSNC data for adaptive bevel compensation because it can't differentiate between A-V, X and K cuts. For this reason, it views everything as either top bevel (V) or bottom bevel (A).

### Activation of ABC correction:

In mCAM in Technology setup click Tool and choose the one that has the #ABC setting.



Fig. 188: Tool selection - click on the one that has the #ABC setting

Then in Settings click on Generate, find Bevel correction and choose Automatic bevel correction v1.0 (ABC).

🗘 Settings	$\odot$	Imported 2	) () II	mported 10	×	🖉 Tempora	ry job 5		Temporar	ry job 4 🛛 🖾	🖋 Tempo	orary job 6 🗵 🖌	Temporary jo	b 8 🗵 🖌	' Temporary jo	ob 1 🛙
plication C	ut path	Machine limits	s Tool	operations	Nes	ting / suppo	ts Lea	d in/out	Measure	Generate	Intensity	Transformations	Expert table	Telemetry	Internal	
enerate																
5 🖓 🐺 CN	VC usage					Cnc will be	cut			$\sim$						
🔁 🖓 🐺 Su	upports (	positioning by C	NC			Yes (auton	atic veri	fication)		$\sim$						
🗄 🖓 🐺 Al	utomatic	material/lunett	te positi	oning by CN	IC (M11	7) No materi	al/lunett	e positio	ning ·	$\sim$						
> 🗘 🐺 Us	se M121					Use on me	sh			~						
5 🖓 🐺 Co	ollision l	imitations on do	omes													
5 🗘 某 Pl	lasma ar	c checking				Always che	ck plasm	na arc		~						
🔁 存 🐺 Be	evel corr	ection				Automatic	bevel co	rrection	/1.0 (ABC)	~						
🔁 🗘 🕌 SF	peed of s	hift to material				1000 mm/	nin				]					
Caxis moveme	nts															
0 0 🐺 De	efault mo	ode for cutting c	ircle pip	e			Moving i	in XYZC a	kes	~						
5 🗘 🐺 De	efault mo	ode for cutting b	oeams				Static cu	itting (or	supports/i	rollers) 🗸 🗸						
今 今 🐺 Lii	nearize (	C-axis movement	ts on pro	ofile corners	witho	ut rotator										
今 🖓 🐺 Pr	refer to u	ise the same C-a	ixis const	tant value f	or cuts	on one hole	$\checkmark$									
Straight cuttin	g															
0 0 🕺 Mi	ax angle	between torch a	and mate	erial norma	l for str	aight cut 6.0	deg									
0 0 🐺 Mi	ax A to ig	gnore B				4.0	deg									
Ordering																
0 0 × Mi	arking-c	utting changeov	/er	Start cuttin	g imme	diately	~	/								
○ ○ 및 Ite	em finish	ning mode		Finish part	(mark a	ll → cut all)	~	·								
17 × C) C)	nermal m	node		No thermal	sorting		~	·								
(기 (기 🔆 St	art poin	t of plate CNC pr	rogram /	At X min and	d Y min		~	/								
○ ○ <sup>1</sup> / <sub>×</sub> M	ovement	t at program end	4 [I	No moveme	nt		~	/								
Parking mode								_								
(기 (기 🕺 GL	lobal pai	rking mode		Full par	king			~								
२ (२ 🕺 Gl	lobal pai	rking mode in ma	arking te	ext No park	ung			~								
hort distance	parking	mode									1					
	aximum	distance of two :	sequenti	ial cuts 50.	00 mm											
C C 2 Pa	arking m	ode		Fu	l parki	ng		~								

Fig. 189: Bevel correction – Automatic bevel correction v1.0 (ABC)

#### mCAM results review:

The results of adaptive bevel correction can be reviewed by enabling comments. In Settings, Internal section, find Generate plan comments and choose Full comments. The CNC will now include comments, such as:

```
-bevel_size_corr
```

```
-bevel_angle_corr
```

G1 X54.936 Y64.215 Z0.000 A20.539 B241.324 (A=20.5 B=-118.7; I<mT:0.53:s,cA:1.39:s,eS:1.20:s:d,cS:1.41:s:d>; B=-118.7; length=0.15; deep=3.19; speed=136.9%; kerf=3.0; **bevel\_size\_corr**=0.8; **bevel\_angle\_corr**=0.6; kerf-C=LINE\_TOUCH; dir=FaceAxis; CP=10; operT=BEVEL\_A)

Settings	⊖ Imported 2	☑	10 🗵 🖋 Tempor	ry job 5 🗵 🥖	Temporary	/job 4 🗵	🖋 Tempo	rary job 6 🗵 🖋	Temporary job	8 🛛 🥖	Temporary	/job1 🗵	4
Application Cut	path Machine li	mits Tool operation	ns Nesting / suppo	ts Lead in/out	Measure	Generate	Intensity	Transformations	Expert table	Telemetry	Internal		
[Editing is permitt	ed only for MicroSt	ep technical support]	]										^
Machine layout													
今 今 👷 Coe	ff A->B	30.0 deg											
Ф 🖓 🐺 МЗ8	mode	M38 with LL		~									
Coet	ff A->Z	210.00 mm											
🗘 🗘 🦊 Rad	ial acceleration	200 mm/s^2	2										
🗇 🗘 🐺 Tang	gential acceleratio	n 250 mm/s^2	2										
🖓 🖓 🥋 Defa	ault surface detecti	on mode Measure pla	ane with 3 points (pla	sma/water-jet ma	chines) 🗸								
Discretisation													
Cher	ck for angle												
🗘 🗘 🗼 Disc	retise min length	0.10 mm											
🗘 🗘 🐺 Disc	retise max length	2.00 mm											
🗘 🗘 🐺 Disc	retise max angle	6.0 deg											
Generate													
🗘 🗘 🐺 G0 s	plit mode	None		~									
🗘 🗘 🐺 Rela	ative speed CNC mo	de Percentage M90 K	(хх Lуу	~									
🗇 🗘 某 Rela	ative power CNC mo	de Percentage M90 K	(xx Lyy	~									
🗘 🗘 🐺 Line	ar filtering												
🗘 🗘 🐺 Smo	oth filtration AB	0.0 deg											
🗘 🖓 🐺 Com	pensation mode	Compensation is	on	$\sim$									
🗘 🗘 🐺 Max	imum kerf value	6.00 mm											
🗘 🗘 🐺 Posi	ition type	Version 2 with M1	22	$\sim$									
存 🖓 🐺 Gen	erate plan commer	ts Full comments		~									
🔶 🔆 🐺 м11	7/M129 version	M117 with M129		~									
🗘 🗘 🐺 Defl	ector length	2000.00 mm											
Measure													
🗘 🗘 🐺 Limi	it for no K102 meas	urement 180.0 deg											
🗘 🗘 🐺 Sup	ported measure ve	rsion version 1		$\sim$									
Heating													
🗇 🗘 🐺 Mate	erial temperature o	luring cutting	1570 C										
🗇 🗘 🐺 Max	imum required ten	nperature for cutting	300 C										
🗘 🗘 🐺 Coo	ling coefficient in 1	[min]	0.600										
🖓 🖓 🐺 Max	imum distance for	heating up (1%)	500.00 mm										
Quality hole													
🖓 🖓 🐺 Qua	lity hole extension	s Extended Quality h	ole expert										~

Fig. 190: Generate plan settings in Internal section of mCAM Settings

## Method of computing ABC:

- The beveling head is rotated around the top point even for the bottom parts of the X and K cuts.
- The positive angle always means increase of bevel (even for top and bottom bevel).

To 15 degrees – the correction is not performed

For 25 degrees – data <15,35> from iMSNC are being used

For 45 degrees – data <35,55> from iMSNC are being used

Above 45 degrees – extrapolation is used

(This is how Licris does it)

mCAM data can be checked in mCAM application console in View. The angles in mCAM and iMSNC hold the same value. In mCAM size corrections are recalculated into the change of tool diameter.

# Text marking

*Text marking* is a technological operation used for permanent inscription of arbitrary text, e.g. production batch ID number or outlines of contours onto material surface. For marking, energy beam cutting technologies utilise reduced power to affect only the material surface. The marking operation is enabled by using the *Text marking* option. Marking function can be enabled in the same section as *Chuck location, Transformation* or contour *Marking*.

Plan generation		
Program name		
Output format	Cnc	~
Cutting mode	Moving in XYZC axes	~
Axis	X axis	~
Chuck location	At X min	~
🗹 Marking		
🗹 Transformations		
🗹 Text marking 🔫		
Cutting		
Remark		
Cut end of pipe		

Fig. 191: Text marking generation – enabled

Adding a text, changing its position, size, and other parameters is really simple. All individual options are in *Properties menu* of selected part in *Import task*. To add the text, click on the Add button next to Text marking in Properties section. To delete the text, click X button in the upper right corner of Marking element section.

Each marking element can have several parameters defined:

- Marking Type can be defined by three methods:
  - → Text vectorized (G code): this method splits marking text into small sections of vectorized paths and marking is executed by the partial G-code instructions (G0 and G1 as standard cutting instructions).
  - → *Text ASCII writer:* when using this method, the section of marking instructions (G0, G38, G39) is generated in the CNC code according to marking text. This method is suitable only for machine equipped with special ASCII marking unit.
  - → QR code, Data matrix, Pixel matrix: the section of marking instructions (G38, G39) is generated in the CNC code according to marking text. This method is suitable only for machines equipped with special marking unit.
- Font type this feature in Text marking allows you to choose between two font types:

- → *Disjoint* also available in previous versions of mCAM. The text is written one letter at a time, with the tool stopping and traversing between the letters.
- → *Continuous* the text is written in one continuous movement, without the tool having to stop and move to the next letter.
- **Text will be entered on machine**: the marking text intended for marking is defined after loading CNC code to a machine by an operator. To choose this option click on the checkbox *Text will be entered on machine* under the Marking type after choosing the preferred source (ASCII writer, QR code, Data matrix, Pixel matrix).
- **Face** defines on which face the text should be placed (individual options depend on actual shape type)
- Placement (only for domes)
  - $\rightarrow$  From top places text from top view
  - $\rightarrow$  From side places text from side view and rotates it around axis
- **Position** position can be picked manually by clicking on a 'Pick position' button and clicking on a place on a part where the text should be placed or by selecting concrete face and set X and Y coordinates. User can also adjust rotation of text.
- Font size [mm] defines size of a font.



Fig. 192: Text marking element



Fig. 193: Disjointed and Continuous Font type used in Text marking on dome



Fig. 194: Font type in Text marking section of Properties menu

# Tool operations

Tool operations (also known as technological groups of cutting parameters) refer to columns of tool parameters in iMSNC. In plasma cutting machines operation 1 type/operation 1 quality are related to straight cut parameters. In water – jet machines first row is related to Q1 (first column) cutting parameters. In laser machines first operation type row is related to Large contours.

Keep in mind to choose particular machine and technology during the setup *Tool operations*.

Name	Value	
Parameter key		
Machine	993 MG Test (dielna)	-
Technology	11 HPR260	-
Material		-
Power		-
Tool		-

Fig. 195: Machine and technology selection

	- 7-	-	-		1	-					1.4						
Cut	path		Machine limits	Tool operations	Nesting / supports		Lead in/o	out		Me	asure	Generate	a Intensity	Transformations	Expert table	Application	Internal
To	ol on	erat	ions type				Т	ool (	one	rati	ons quality	_					
ф	4	-¢	operation 1 type	Straight cut		*	•		6	÷	operation 1	quality	Undefined				
¢:	φ	4	operation 2 type	Bevel cut top (V-	cut)	٠	\$		Þ.	\$	operation 2	2 quality	Undefined		•		
ф	ф	4	operation 3 type	Bevel cut bottom	(A-cut)	٠	•		6	ą.	operation 3	guality	Undefined		•		
ф	4	4	operation 4 type	Marking + Text n	narking	•	4		Þ	ō.	operation 4	quality	Undefined		•		
4	4	Φ	operation 5 type	Punching		•	•		2	÷.	operation S	5 quality	Undefined		-		
ф	4	÷	operation 6 type	Quality hole cutti	ng (THT/CC)	٠	•	-	¢.	¢.	operation (	6 quality	Undefined		•		
¢:	ф	Φ	operation 7 type	Undefined		٠	4		Þ	÷	operation 3	quality	Undefined		-		
¢-	ф	4	operation 8 type	Undefined		•	4		e I	÷	operation 8	guality	Undefined		•		
4	- 44	6	operation 9 type	Undefined		+	4	114	6	6	operation 9	quality	Undefined		•		

Fig. 196: Standard plasma tool operations setup

Every tool number (e.g. for plasma cutting T111) that is used in every CNC code is created from two numbers: operation (technological group) number and technology number. First number of the tool number (T<u>1</u>11) defines operation (technological group of parameters) that should be used for particular cut, in this case cutting parameters from straight cutting. The other two numbers (T1<u>11</u>) define the technology code that defines used technology. Plasma cutting technology on MicroStep machines standardly uses technology number 11 (laser 17, water jet 14, oxy fuel 12, driller 15).

Settings 🗵															
Cut path	Machine limits	Tool operations	Nesting / supports	Lead i	n/ou	t	Me	asure	Generate	Intensity	Transformations	Expert t	table	Application	Internal
Tool operation	ations type				Too	ol op	erati	ons quality							
\$ \$ 4	operation 1 type	Straight cut		•	\$	\$	\$	operatio	n 1 quality	Large contour	s	-			
\$ <b>\$</b>	operation 2 type	Straight cut		•	\$	•	\$	operatio	n 2 quality	Medium conto	ours	-			
¢ ¢ •	operation 3 type	Straight cut		•	\$	٠	4	operatio	n 3 quality	Small holes		-			
<b>• •</b> •	operation 4 type	Marking + Text m	narking	•	¢	ф	Φ	operation	4 quality	Undefined		•			
<b>\$</b>	operation 5 type	Punching		•	¢	¢	÷	operation	5 quality	Undefined		•			
\$ \$ 4	operation 6 type	Undefined		•	ф	ф	Φ	operation	6 quality	Undefined		-			
φ φ 4	operation 7 type	Undefined		•	ф	ф	$\Phi$	operation	7 quality	Undefined		-			
φ φ 4	operation 8 type	Undefined		•	φ	ф	4	operation	8 quality	Undefined		•			
4 4 4	operation 9 type	Undefined		•	\$	¢	4	operation	9 quality	Undefined		-			

Fig. 197: Standard laser tool operations setup

Cut path	Machine limits	Tool operations	Nesting / supports	Lead i	in/ou	t	Me	asure	Generat	te	Intensity	Transformations	Exper	t table	Application	Interna
Tool opera	tions type				Too	ol op	erati	ons quali	y					_		
ф ф -5	operation 1 type	Straight cut		•	ф	ф	\$	operatio	n 1 quality	Q1			-			
\$ \$	operation 2 type	Straight cut		•	ф	ф	÷	operatio	n 2 quality	Q2			-			
¢ ¢ 4	operation 3 type	Straight cut		•	ф	ф	\$	operatio	n 3 quality	Q3			-			
¢ ¢ 4	operation 4 type	Straight cut		•	ф	ф	\$	operatio	n 4 quality	Q4			-			
¢ ¢ 4	operation 5 type	Straight cut		•	ф	ф	\$	operatio	n 5 quality	Q5			-			
¢ ¢ 8	operation 6 type	Marking + Text m	arking	•	ф	ф	÷	operatio	n 6 quality	Unde	efined		-			
φ φ δ	operation 7 type	Undefined		•	ф	ф	$\Phi$	operatio	n 7 quality	Unde	efined		-			
φ φ δ	operation 8 type	Undefined		•	ф	ф	$\Phi$	operatio	n 8 quality	Unde	efined		-			
4 4 5	operation 9 type	Undefined		•	ф	ф	÷	operatio	n 9 quality	Unde	efined					

Fig. 198: Standard water – jet tool operations setup



Fig. 199: Tool operation settings (for laser or water jet cutting)

# **Transformations**

Transformations are used when cutting path (especially circle holes) is supposed to be processed by some special feature or technological operation such as drilling, tapping, punching, marking or quality hole cutting. Transformation parameters define a class of holes to be transformed and the way of processing classified holes.

Circular holes are very common shapes found in cutting programs and unlike other types of holes they can be processed in several different ways:

- Drilling the holes provided that the machine is equipped with a drilling head using drilling cycles
- Punching of small holes (for subsequent operation manual drilling)
- Quality hole cutting (True Hole Technology and Contour Cut)

#### **Setup transformations**

Transformations are defined in Settings – Transformations. Setting up a transformation rules are described in more detail in section <u>Setup transformations</u>.

Transformations are set for whole application (not for particular machine or technology), therefore it is not necessary to select any machine, technology or tool. All transformations can be edited in program configuration level.

Transformations are processed during generation of CNC program, therefore user is able to see whether transformations were applied as expected only in cutting simulation.

#### **Transformation application**

Transformations are automatically applied on cutting contours that match with defined transformation rule, unless transformation for particular cut is completely disabled, some other transformation is forced on it or transformation rule that matches the cutting contour is completely disabled in Settings – Transformations. All transformations on cut are turned on by the default.

Note: When applying quality hole transformation, selected tool must be intended for THT and for the exact same thickness, as is the thickness of the material.

#### Force transformation without condition matching

Any transformation can be manually forced to be performed on any cutting path, even if this feature does not match any transformation condition in particular transformation rule (when rule is enabled in global).



Fig. 200: Forcing transformation without condition matching

### Disabling transformation for matching cut path

If some feature matches the transformation condition but user does not want to perform related transformation tasks on this particular cut path, all transformations for that particular cut path can be completely disabled by unchecking Transformation's checkbox in properties of selected cut path.



Fig. 201: Disable transformation for matching cut path

# Welding preparations

mCAM allows to add welding preparations to existing cut paths. Adjusting a cutting contour for welding is done simply by selecting a cut path and clicking on an icon of a desired shape of welding preparation in the panel on the right side of the visualization screen. mCAM will then generate all necessary cutting paths accordingly.

Cut paths that are modified for welding preparation are displayed in orange color.

Each type of welding preparation can be further adjusted in Properties area – Welding section. Welding preparation is deleted by selecting a welding preparation cut path and clicking on an icon  $\stackrel{\bullet}{\frown}$  in the cut path widget.



*Fig. 202: Panel with various options including welding preparations shows up on the right side of the screen when the cut path is selected* 

Parameters that can be adjusted depend on the type of the welding:

Nam	ne	Parameters
	V welding	angle top
	Y welding	angle top, nose height
	A welding	angle bottom
	L welding	angle bottom, nose height
	X welding	angle top, angle bottom, positive height
	K welding	angle top, angle bottom, positive height, nose height
1	X - variable nose height welding	angle, offset



Fig. 203: Weld preparation parameters



Fig. 204: Hole with Y welding preparation



Fig. 205: Welding settings in Properties area

### **Automatic Welding preparation**

This function enables imported shapes to have automatic welding preparation. It can be found in *Settings*  $\rightarrow$  *Transformations*. Then in *Conditions*, click the *Add condition* button, choose shape (e.g. plane). In the *Effects*, click *Add effect* button, a pop-up table shows with list of available effects. Choose *Welding preparation*.

Settings										
Application Cut path M	lachine limits	Tool operations	Nesting / supports	Lead in/out	Measure	Generate	Intensity	Transformations	Expert table	Internal
Transformations										
⊕ ⊗ ♠ ⊕		Trar	nsformation							
Plane		Na	me Plane							
Conditions - Shape is Effects -	Plane	Con (±	ditions ) Add condition							
		×	Shape is							
			Circle pipe		🗌 Rectan	gular profil	e	🗌 H beam		
			🗌 U profile		🗌 I profile	e		🗌 L profile		
			🗌 Bent L profile		UPN pr	ofile		🗌 Bulb profile		
			🗌 Circle pipe part	:	Dished	disc		Dome		
			<b>&gt;</b>	Cone d	ome		Dished bottom dome			
			🗌 Flat bottom do	ne	Inverte	d head don	ne	🗌 Elliptical dome	2	
			Eorm pressed		🗌 Oval pi	pe				
		Effe	cts							
		(F)	Add effect Drilling (G81) Drilling with dwell (C Deep drilling (G83) Tapping (G84) Boring with feed retr Boring with spindle an Cutting Punching Quality hole cutting Quality hole cutting Welding preparation Operation quality	382) act (G85) top (G86) d feed retract (G (THT/CC) in axis (THT/CC)	89)					

Fig. 206: Welding preparation in Transformations section of mCAM Settings

The effect can be further customized. The Welding type can be changed, Angle top and Geometry type can be adjusted and an option to Limit points to maximal material angle is available.
\$	Settings												
Ар	lication	Cut path	Machine limits	Tool operation	ons l	Nesting / supports	Lead in/out	Measure	Generate	Intensity	Transformations	Expert table	Internal
Tra	ansformat	ions											
(	Ð 🗙 🕁	)			Trans	formation							
	<b>N</b>				Nam	e Plane							
	Conditio	ns - Shano	is Dlano		Condi	tions							
	Effects -	V welding,	Angle top 30.0 de	eg	$\oplus$	Add condition							
					×	Shape is							
						Circle pipe		Rectan	gular profil	e	🗌 H beam		
					🗌 U profile		🗌 I profil	e		🗌 L profile			
						🗌 Bent L profile		UPN pr	ofile		🗌 Bulb profile		
						Circle pipe part		Dished	disc		🗌 Dome		
						🗹 Plane		Cone d	ome		Dished bottom	dome	
						🗌 Flat bottom dor	ne	Inverte	d head don	пе	🗌 Elliptical dome	2	
						Form pressed		🗌 Oval pi	pe				
					Effect	S							
					$\oplus$	Add effect							
					×	Welding preparation	ı				1		
						Welding type			🖊 V weldi	ng v			
						Angle top			30.0 deg				
						Limit points to	maximal mate	rial angle					
						Geometry type			Constant	angle 🗸			
					<u> </u>						-		
L													

#### Fig. 207: Further customization of Welding preparation

The whole contour will now have all of its edges beveled in preparation for welding. As long as this function is enabled, all imported shapes that has been checked in Conditions (e.g. plane) will automatically have welding preparation.



Fig. 208: Imported shape – Plane with welding preparation

#### Welding preparation for Hole

If a shape is chosen (e.g. plane) and only the hole needs to have welding preparation, the user can go to the *Conditions*. Click *Add condition* button, choose shape (e.g. plane), click *Add condition* button once more and choose *Hole*.

The diameter and thickness ratio of the hole can be changed. By adding the same effect, Welding preparation, now only the hole will have automatic welding preparation every time the same shape is imported and used for a job.



Fig. 209: Automatic Welding preparation for Hole

## Circle pipe with welding denotation

Circular pipes manufactured by welding of rolled sheets may contain the welding line, where cutting of holes and other features may be prohibited for technological reasons.

When users design circle pipes in CAD, they can draw the welding line as a shallow groove into the STEP file. mCAM will then respect position of this welding line in the nesting process and pipe rotation will be disabled. When the pipe is loaded into the machine with welding line on top, produced parts will have the welding line positioned as was designed in the STEP file.

Imported STEP files which contain circle pipe with welding line, now have a **"Welding line...detected"** in the property inspector in **Technical summary** section. This shows the user that mCAM recognized a welding line in the STEP file.

∨ Shape								
Shape name	circle pipe with a welding lir							
Description								
Source name								
Drawing No.								
Position No.								
✓ Technical summary								
Lowest cut depth	10.00 mm							
Highest cut depth	10.00 mm							
Material (file suffix)								
Welding line	detected							

Fig. 210: Property inspector, Technical summary section

The location of the welding line is marked by a groove parallel with the pipe's axis. **This** groove cannot start or end at the edge of the pipe.



Fig. 211: Groove profile on the outer surface of circle pipe

Min. groove depth can be 0.5 mm. Max. groove depth can be 1.5 mm.

Length of the groove should be more than 5mm and there can be at most one groove per part.



Fig. 212 Circle pipe with groove marking the welding line

It is important to load semi-products into the machine with the groove facing the top, because during the nesting process, the parts are oriented so the groove is always on top.



Fig. 213: Nesting of circle pipe with welding line

Pipes in one nesting job all contain the welding line or all are without it. Combination of the two is not supported.

# **Cutting plan preparation**

This section describes major program features and functional *modules* that are utilised through whole process of cutting plan preparation. Sections describe main program *modules* as *WebService* connectivity and utilisation, *machine limits* setup, *expert tables* setup, *1D/2D nesting* or *ordering of cuts*.

## Program tasks

This section describes all utilised *program units/ tasks* as *Import, Library* and *Job task* and their main *items* as *Part, Stock, Stock part* or *Template.* 

#### Import

After importing some shapes, import menu appears in main menu if Import tab is selected. enables to import multiple files at once. The files intended for import can be marked by holding <Shift> and moving by arrow keys, or by simultaneous holding <Ctrl> and clicking on files. offers four options:

- Import more files Imports more parts to the selected import task
- **Import complete directory** enables to import whole directory that may contain multiple files.
- **Promote all shapes to top level** this function is very useful especially when a user works with hundreds or thousands of parts, a lot of tasks (jobs, imports, etc.). The function sorts them and classifies them into a single integrated list.
- Sort according types sorts all shapes according to shape types (with same base dimensions)
- **Close import** the function closes active import task.

All remaining items in the File menu: Load job, Load library, Raw view, contain only one option in the main program menu – closing active task (Close job, Close library, Close view)

#### Job task

A *job task* contains collection of parts intended for cutting (marking, punching, drilling, etc.). *Job task* can be local, i.e. available on a storage device accessible from the computer, or it is already prepared in *MPM*. A *job task* is saved to hard drive as a database file (\*.job) which saves all settings, configuration and parts included in particular *job task*.

The function *Load job* (*File – Load job*) creates a new, or loads some previously saved *job task*. A new *job task* is created by writing a name of the job that does not exists yet in the dialogue window.

3	Open				×
🔄 🌛 🔹 🕇 📕 «	msnc ▶ mcam21.10	~	Ç	Search mcam21.10	ρ
Organize • New fo	lder			# · 🗍	0
This PC Desktop Documents Downloads Music Pictures Videos Local Disk (C:)	<ul> <li>Name</li> <li>config</li> <li>config.nabehy</li> <li>config.nestovanie</li> <li>config.Report 5.11.15</li> <li>crash</li> <li>doc</li> <li>examples</li> <li>exceptions</li> <li>mcam_cfg</li> </ul>	~		Select a file to preview.	
Filer	name: Order_226		,	v Job(*.job)	~
	6			Open Cance	el

Fig. 214: Creation of new job task

A *job task* is a used as a framework for cutting plan preparation, nesting of imported parts. A *job task* contains info about *nesting settings, templates, stocks* and their properties as length or count of *stocks*, assigned *machine/technology/material/tool* to *template* or *stock* and all shape info (*name, drawing number, position number* etc.). A *job task* is also used to define parameters and settings important for *plan generation* such as output format, rotator mode, chuck location and CNC instructions (*cutting/marking/transformations/text marking*) for generation for selected *stock*. The work with a job is described in more details in corresponding section Job task creation.

It is possible to display or save *stock information* (nesting results) in pdf file and edit all cutting paths of shapes in particular *job task* the same way as in the *Import* or in *libraries*. In Tool path processing tab, all cutting paths are displayed with applied kerf compensation and machine and technology limitations.

Property inspector 🔅 Settings 🔋 Imported 1 🔝 🖋 Temporary job 12 💈	
× Solid	
Name Circle pipe View Shape Tool path processing	
D: 220.00 mm Stock information:	
T: 10.00 mm 🗸 👘 🕹 2000.00 mm 1 🛛 🕅 💾	
L: 2000.00 mm 733.89 mm 487.96 mm 486.11 mm 445.79 mm	
Technical summary	
Lowest cut depth 10.00 mm pipe_one_side_cut_2	
Highest cut depth 14.14 mm	
Technology setup	
Machine 9999 MicroStep Demo Machine v pipe_one_side_cut_2 pipe_one_side_cut_3	
Technology	
Nesting settings	m T: 10 00 mm
Nesting gap 5.00 mm	
Startpoint X offset 0.00 mm	
Use part envelope only Parts on stock:	
Use common-cut Shape number Shape name Copies in stock Part length	
Surface mapping quality Normal	
✓ Enable part rotations and flipping	
Job stock	
✓ Virtual stock	
Unlimited count	
Count 1	
Length 2000.00 mm	
Plan generation	
Program name	
Output format Cnc ~	
Cutting mode Moving in XYZC axes ~	
Axis Xaxis ~	
Chuck location At X min ~	
Marking	
Z Transformations	
C Text marking	
Cutting	
Remark	
Cut end of pipe	

Fig. 215: Job task and stock properties

#### Part

A part is an object that is intended for cutting. All parts are defined by an original shape. Three or more identical parts (parts that have been duplicated) are displayed as the group with bold font style and the number of parts in that particular group. When there are multiple parts assigned to *job tasks* and *stocks*, tool path with lead ins and lead–outs are shared and the same as for the original shape. That means when e.g. lead–in for the original shape is modified, the same modification is applied for all parts originating from that shape.



Fig. 216: Original shape defined for all multiple parts



Fig. 217: Part properties

#### Stock (stock material)

A stock is a definition of raw material type, cross section and length. Depending on the specific stock type, the properties bar displays different parameters and dimensions. There are several types that can be machined by 3D cutting (see section Output formats).

Stock is the unit that is considered as *stock material. Stock* is related to its parent *template* (i.e. *Circle pipe D: 220.000 T: 10.000*) and can be refined with length and count. Length and count specify actual length and count of physical stock pieces (on company stock) that *mCAM* can use for *nesting*.

When utilising *mCAM* with *MPM* (*MicroStep Production Management*) actual *stocks* (defined in *MPM* database are used) have to be used, therefore *Virtual stock* function has to be disabled and real *stock* from database has to be loaded.

Function *Unlimited count* is used when user wants to determine, how many *stock parts* (physical stock pieces) with defined length needs to be purchased for particular order (cost calculating, etc.).

Stock properties are defined in *properties menu* on selected *stock* in *working tree* in *View tab*.

Property inspector		Settings 🔋 Imported 1 🖾 🖋	' Temporary job 12 🛛					
✓ Solid	6 L		View Change Teal a					
Name	circle pipe	🗸 🝈 Circle pipe D: 220.00 mm T: 10.0 🌸	view snape loot p	ath processing				
D: T.	220.00 mm		Stock information:					
1	10.00 mm	V 🚺 🔁 L: 3500.00 mm 2						
w Technical summany	3500.00 1111	🗸 🖉 Stock part 3149.89 mm	733.89 mm	487.96 mm	487.96 mm	487.96 mm		
Lowest cut donth	10.00 mm		· · · · ·	487.90	487.90 mm			
Highert out depth	16.00 mm	pipe_one_side_cut_2						
Tochnology sotup	14.14 100		LL					
Machine	9999 MicroSten Demo Machine	o x pipe_one_side_cut_4	pipe_one_side_cu pipe_o	nc_2 pipe_one_side_cut_4 one_side_cut_4 pipe_one_si	4 pipe_one_side_cut_4 p de_cut_4 pipe_one_side	_cut_4 Rest		
Technology	~	Stock part 1598.28 mm						
<ul> <li>Nesting settings</li> </ul>			Heat Number:	Serial Number	n Dim	ensions: Circle pipe D: 220.00 m	nm T: 10.00 mm	
Nesting gap	5.00 mm	pipe_one_side_cut_4		Rest: 350.11 mr	n (10%) (Chuck length: 330	).00 mm)		
Startpoint X offset	0.00 mm				, i i i i i i i i i i i i i i i i i i i			
Use part envelope only		> 3 x pipe_one_side_cut_3	Parts on stock:					
Use common-cut		-	Shape number	Shape name	Copies in stock	Part length		
Surface mapping quality	Normal ~		#1	pipe_one_side_cut_2	1	733.89 mm		
Enable part rotations a	nd flipping	-	#2	pipe_one_side_cut_4	6	487.96 mm		
<ul> <li>Job stock</li> </ul>								
Virtual stock								
Unlimited count								
Count	2		Stock information:					
Length	3500.00 mm							
<ul> <li>Plan generation</li> </ul>			487.96 mm 486.11 m	486.11 mm im 486.11 mm	1901.7	'2 mm		
Program name			* / /					
Output format	Cnc ~							
Cutting mode	Moving in XYZC axes $\sim$	-	nine one side cut 4	nine one side cut 3	Re	est		
Axis	X axis 🗸 🗸		pipe_one_sid	le_cut_3 pipe_one_side_cut	_3			
Chuck location	At X min 🗸							
Marking			Heat Number:	Serial Number	n Dim	ensions: Circle pipe D: 220.00 m	nm T: 10.00 mm	
Transformations				Rest: 1901.72 n	nm (54%) (Chuck length: 3	30.00 mm)		
Text marking								
Cutting			Parts on stock:	Channe manua	Comies in starts	Part lawsth		
Remark			Shape number	Snape name	copies in stock	Part tength		
Cut end of pipe			#1	pipe_one_side_cut_4	1	487.96 mm		
			#2	pipe_one_side_cut_3	3	486.11 mm		
			L					ave Ber a
								ave nepo

Fig. 218: Stock properties editing

#### Stock part (physical stock piece)

Physical *stock part* represents one physical piece of stock material. Number of physical stock piece material is given by *Count* of *stocks* defined in *Stock properties menu*. Physical

stock part represents one CNC program intended for cutting on machine. As long as stock part is the offspring of the stock, all stock parts within the stock share all properties (*length, nesting settings* and all *Plan generation settings*) with the stock. Stock part length that is displayed nearby the stock part is given by exact length of nested parts.



Fig. 219: Stock part – nested parts

#### Template

A template is a definition of a stock material pattern given by dimensions of a cross– section (material type, wall thickness, diameter, etc.) without specification of the length.



Fig. 220: Template – rectangular shaped pipe

## Drag and drop

Drag and drop is a powerful tool that is used for any operations within the working tree, master panel, job tasks, or imports. The main purpose of this tool is to make the work

with the imported files, *job tasks* or *database job tasks* easier by simple dragging items into a job or into any possible location in the program (*working tree, master panel*).

Function Drag and drop allows to:

- move *shapes* from *Import task* to opened *job task*
- assign *shapes* to *stock* within the *job task*



Fig. 221: Create new temporary job task



Fig. 222: Add imported shapes to Job task – option 2

## WebService or Virtual machine

Cutting machine, technology and used tool has to be chosen for each stock (whole template) while generating CNC program. Therefore, connection to machine via company network and WebService needs to be established or virtual machine has to be created. WebService allows using database of tools in iMSNC (library of tools) from particular machine and work with exact cutting parameters from expert system (if machine has such expert system). Virtual machine is option for customers without WebService and for machines, that does not need such an advanced speed controlling and dynamic kerf compensation. Speed controlling and dynamic kerf width compensation are described in more details in section Kerf width compensation.

#### WebService setup

WebService is a network application tool that connects a machine, its technology and tools database with mCAM via company network. WebService connectivity allows using expert system of cutting parameters (if it is available for particular machine). WebService is very useful when working with several machines, several technologies or advanced cutting (which requires higher quality). WebService increases effectivity when preparing CNC programs due to iMSNC and tools library connection, so it is very easy to choose proper tool or to setup expert tables.

To establish the connection between machine and mCAM, WebService application has to be installed on machine (download WebService.zip from server and follow instructions in Installation.txt).

WebService installation – on machine (requires installation from MicroStep technician):

- 1. Sign in to machine computer with account with administrator privileges (account msnc500)
- Copy all files from folder MachineWebService to directory C:\msnc\Intranet\MachineWebService
- 3. Start RUN (as administrator only) with INETMGR order
- 4. Right click on directory in tab SIDES and use CONVERT TO APPLICATION (if needed only)
- 5. Check (choose if needed) Application tool (DefaultAppTool): it has to be set to FRAMEWORK 4.0,
- 6. Installation complete



Fig. 223: WebService connection

#### mCAM setup for WebService machine

WebService machine connection in mCAM is defined IN Settings-> Application->Web service. Another machines are added by "+" button and removed by "-" button to the left of a Web service table. Each machine is characterized by machine number and computer name. Machine computer name is standardly defined in format: msnc500w<u>xxxx</u> (example: msnc500w1703), where <u>xxxx</u> is machine number but should be checked if its name wasn't changed by user.

The list of added machines is then displayed in the table where it is possible to enable/disable them or to enable/disable EkoInfo and MPM feature by rewriting the specific cell. Alternatively, the machine can be enabled by writing a corresponding number in the cell -0 for disabled, 1 for enabled and 2 for offline (same for EkoInfo and MPM).

Settings	Imported 1 🗵	🖋 Temporary joi	3 🗵									
Application Cut pat	th Machine limits	Tool operations	Nesting / supports	Lead in/out	Measure	Generate	Intensity	Transformations	Expert table	Internal		
Application												
Target URL for re	port											
User e-mail addr	ress											
Customer name												
All file open dial	ogs share one currer	nt directory 🗌										
Plan save folder												
Make file preview	v											
Application restart r	equired											
Web service												
Machine number	Computer name	Web service	EkoInfo	MPM								+
	msnc500ww64	Enabled	Disabled	Disabled								-
<ul> <li>Language</li> </ul>		English		~							 	
Keep import ope	ened after applicatio	n restart 🗹										
Inverse mouse w	heel zoom											
Enable access to	MPM											
Enable access to	Machine web servic	e 🗹										
Shared configura	ation folder											
<ul> <li>Simulation anim</li> </ul>	ation level	Cut point	animation	$\sim$								
Virtual machine type												
Virtual machine	type	None		~								
Oumber of tools	for virtual machine	1										
Machine technol	logy (11,12,)	11										
Technology for d	Irill (15,0)	0										
Technology for A	SCII writer (18,0)	0										

Fig. 224: Machine computers (Web – service)

#### mCAM setup for virtual machine

Virtual machine can be used when test cutting is performed or mCAM does not have access to any machine with WebService installed. Virtual machine simulates connection to real machine by WebService but with no access to tools from iMSNC or expert systems with cutting parameters.

To setup virtual machine in mCAM these machine data (Settings – Application – Virtual machine type) need to be defined:

- Virtual machine type (type of cutting head: straight, rotator 45°, pantographic rotator 90°, pantographic rotator 120°)
- Number of tools (created tools)
- Machine technology (number that defines used technology) standardly uses:
  - o plasma = 11
  - laser = 17
  - water jet = 14
  - $\circ$  oxy fuel = 12)
- Drilling technology number (standard = 15)
- ASCII writer technology number (standard = 18)

Default machine type	
Default machine type	Rotator 45 degrees 🔹
Number of tools for default machine	4
♦ ♦ Machine technology (11,12,)	11
<ul> <li>Technology for drill (15,0)</li> </ul>	15
Technology for ascii writer (18,0)	18

Fig. 225: Virtual machine setup

## Machine limits

Machine limits define type of cutting head/rotator and are set in Settings – Machine limits. Parameters of Z-axis and B-axis can be seen in ParamCNC – Coordinate System (Flash.bin).

Parameters of A-axis (*Maximum A for cutting/marking*) and R-axis are in *ParamCNC* defined by motoric range (not angular range), so they need to be set manually according to type of rotator and rotary positioner. Standard R5 plasma, water jet or oxy-fuel rotators (including torch tip limitations) are able to reach 45 degrees (or 50 degrees for special types of torch tips). Pantographic rotators are able to reach 90 or 120 degrees according to type of the rotator (A axis ranges for this rotator are defined in angular values also in *ParamCNC*).

Standard rotary positioner on plasma (RSV 300 / 500 / 700 / 1500) are set to R min = - 400 degrees and R max = +400 degrees. Special rotary positioners (hydraulic / pneumatic control) especially on laser machines may have limited range therefore this range needs to be considered as well. Initial setup of machine parameters is described in more details in section Machine

le Tools Help	
Suction Parameters   Gas console   Milling - Drilling   Ink writer / MPW   Pipe cutting   Beam Extender   Laser   Bevel Cutting   Po	ntal skewing Lubrication Find Plate Water Jet Air cooling Dust Collector Laser Head Calibration
Table auxilianes ALTG Automatic torch lock Internative Parameters Tachnology Tool codes Torch Geometry Internative Parameters	Laser scanner Autoliany IU Machine US
mandal mode   System parameters   Drivin arameters   recrimingy   recreases   recrimingy   merparator radius Parameter	Value Value
undirector	0.000
MACH MAY Y. Yoood upper line tem]	714.000
MACH MINY X coold burger limit [mm]	0.000
MACH MAX Y.Y. coord upper limit (mm)	3702 500
MACH MIX 7.2 coord lowering units	-3000.000
MACH MAX 7 - 2 cond unper limit - unused	3000.000
MACH WIN A - A coord lower limit [dea]	-116 000
MACH MAX A - A coord upper limit [dea]	115,000
MACH MIN B - B coord lower limit [den]	-8000 000-
MACH MAX B - B coord upper limit [dea]	8000,000
MACH MIN R - R coord, lower limit,	-3000.000
MACH MAX R - R coord, upper limit,	3000.000
MACH MIN B 3H - B coord, lower limit, for oxyfuel K-cut head [deg]	0.000
MACH_MAX_B_3H - B coord. upper limit, for oxyfuel K-cut head [deg]	0.000
MACH MIN SPTP1 - SPTP1 Coord, lower limit, for spec serve PTP1 [mm]	0.000
MACH MAX SPTP1 - SPTP1 Coord, upper limit, for spec servo PTP1 Imm1	0.000
MACH MIN SPTP2 - SPTP2 Coord, lower limit, for spec servo PTP2 [mm]	0.000
MACH MAX SPTP2 - SPTP2 Coord, upper limit, for spec serve PTP2 [mm]	0.000
MACH MIN SPTP3 - SPTP3 Coord, lower limit, for spec servo PTP3 [mm]	0.000
MACH MAX SPTP3 - SPTP3 Coord, upper limit, for spec serve PTP3 [mm]	0.000
MACH MIN SPTP4 - SPTP4 Coord, lower limit, for spec servo PTP4 limit	0.000
MACH MAX SPTP4 - SPTP4 Coord, upper limit, for spec servo PTP4 [mm]	0.000
MACH MIN BS - B coord, lower limit for scanner rotation (BS) [deg]	-265.000
MACH MAX BS - B coord, upper limit for scanner rotation (BS) [deg]	270.000
MACH_MAX_KORX - X correction axis - upper limit [mm]	0.000
MACH MIN_KORX - X correction axis - lower limit [mm]	0.000
MACH_MIN_A_WJROT - A coord, lower limit for wij rotator (BHT_WJ_ROT) [deg]	0.000
MACH MAX A WJROT - A coord. upper limit for wij rotator (BHT WJ ROT) [deg]	0.000
MACH_MIN_B_WJROT - B coord, lower limit for wij rotator (BHT_WJ_ROT) [deg]	0.000
MACH MAX B WJROT - B coord, upper limit for wi rotator (BHT WJ ROT) [deq]	0.000
MACH_REF_X - Initialisation point coord, of X axis [mm]	0.000
MACH REF Y1 - Initialisation point coord. of Y1 axis [mm]	-2.200
MACH REF Y2 - Initialisation point coord, of Y2 axis [mm]	579.000
MACH_REF_Y3 - Initialisation point coord, of Y3 axis [mm]	3704.000
MACH_REF_Y4 - Initialisation point coord, of Y4 axis [mm]	0.000
MACH_REF_Y5 - Initialisation point coord. of Y5 axis [mm]	0.000
MACH_REF_Y6 - Initialisation point coord. of Y6 axis [mm]	0.000
MACH_REF_Y7 - Initialisation point coord. of Y7 axis [mm]	0.000
MACH_REF_Y8 - Initialisation point coord. of Y8 axis [mm]	0.000
MACH_REF_A1 - Initialisation point coord. of A1 axis [deg]	9.250
MACH_REF_B1 - Initialisation point coord. of B1 axis [deg]	147.000
MACH_REF_A2 - Initialisation point coord. of A2 axis [deg]	0.000
MACH_REF_B2 - Initialisation point coord. of B2 axis [deg]	0.000
MACH_REF_A3 - Initialisation point coord. of A3 axis [deg]	0.000
MACH_REF_B3 - Initialisation point coord. of B3 axis [deg]	0.000
MACH_REF_A4 - Initialisation point coord. of A4 axis [deg]	0.000
MACH_REF_B4 - Initialisation point coord. of B4 axis [deg]	0.000
MACH_REF_R - Initialisation point coord. of R axis	0.000
MACH_REF_R2 - Initialisation point coord. of R2 axis	0.000
MACH_REF_ZI - Initialisation point coord, of Z axis for true 3D machines [mm]	0.000

Fig. 226: Machine limits in ParamCNC

Output settings that are applied during generation of the CNC program are strictly related to *machine* and its *technology*, therefore all *machine limits*, *technology limits* and *tool operations* (technological groups of tool) needs to be set correctly. To configure any machine settings *Machine* and *Technology* in Parameter key has to be chosen.

Note: Keep in mind that mCAM always generates CNC programs according to set machine, technology and its settings, according to used tool and its expert table, so all limitations needs to be setup correctly.

Name	Value	
Parameter key		
Machine	1416 AquaCut 1501.20WaWr	•
Technology	14 waterjet	•
Material		•
Power		•
Tool		•

Fig. 227: Machine and technology selection

## Standard machine setup

Here are some examples of machine setups for standardly used machine and rotator types.

#### Straight cutting head (plasma/water – jet/laser/oxy – fuel)

• with standard rotary positioner (RSV 100/300/500/1500/etc.)

Name	Value	Sett	ings	×							
Parameter key		Cut	path		Machine limits	Tool of	erations	Nesting / supports	Lead in/out	Measure	Generate
Machine	1969 MSF 3001.15Ltk	▼ Ma	chine	lim	its						
Technology	17 laser	• 0	•	÷	Minimum Z		-400.00 m	m			
Material		- 6	6	4	Maximum A for	outting	0.0 dea				
Power		- 🚆			Maximum A for	curcing	0.0 dee				
Tool		•		A Minimum B     A Maximum B	maximum A for	marking	0.0 deg				
		*	•			0.0 deg					
		4	\$			0.0 deg					
		0 0 0			Minimum R		-400.0 deg				
		4	000	÷	Maximum R		400.0 deg				
		Machine layout									
		\$	4	4	Chuck location	at X min	at X min 👻				
		\$	4	÷	Rest type	No rest		•			
		¢	4	÷	Rotator geometry	Rotator	45 degrees	•			

Fig. 228: Straight cutting head and static rotary positioner

#### Plasma rotator (45 degrees)

• with standard rotary positioner (RSV 100/300/500/1500/etc.)

lame	Value		Settin	gs	×								
Parameter key			Cut p	ath	T	Machine limits	Tool op	erations	Nesting / supports	Lead in/out	Measure	Generate	
Machine	993 MG Test (dielna)	•	Mach	nine	lim	its							
Technology	11 HPR260	•	φ.	ф	÷	Minimum Z		-1000.00 n	nm				
Material		-	6	6	\$	Maximum A for	uttina	45.0 dea					
Power		•		-		Maximum A for		45.0 deg					
Tool		-	<u>م</u>	44	~	Maximum A for i	narking	45.0 deg					
			\$	¢	¢	Minimum B		-720.0 deg					
			\$	¢	₽	Maximum B		720.0 deg					
			\$	ф	\$	Minimum R		-400.0 deg					
			<b>\$</b>	÷	Maximum R		400.0 deg						
			Mach	nine	lay	out							
			φ.	ф	÷	Chuck location	at X min		•				
			ф (	ф	÷	Rest type	No rest		•				
			φ.	ф	÷	Rotator geometry	Rotator	45 degrees	•				

Fig. 229: Plasma rotator and static rotary positioner

#### Water – jet rotator (45 degrees)

• without rotary positioner

Name	Value	Settings 🗵							
Parameter key		Cut path	Machine limits	Tool op	erations	Nesting / supports	Lead in/out	Measure	Generate
Machine	1416 AquaCut 1501.20WaWr	Machine li	mits						
Technology	14 waterjet	6 6 4	Minimum Z		-400.00 m	m			
Material		6 6 4	Maximum A for	cutting	45.0 deg				
Power			Maximum A for	marking	45.0 deg				
Tool				marking	45.0 deg				
		000	Minimum B		-448.0 deg	)			
		\$ \$ <b>4</b>	Maximum B		229.0 deg				
		¢ ¢ 4	Minimum R		0.0 deg				
		¢ ¢ (	Maximum R		0.0 deg				
		Machine la	yout						
		6 6 4	Chuck location	at X min		•	·		
		0.00	Rest type	No rest			•		
		6 6 4	Rotator geometry	Rotator	45 degrees		•		

*Fig. 230: Water – jet rotator without rotatry positioner* 

Minimum/maximum limits of B and Z-axis (of all rotators) can be found in ParamCNC of machine. Other values that define rotator and rotary positioner limits (A, R-axes) are displayed in motoric values (not angular) therefore for standard rotator A-axis has to be set to 45° (instead of 110° as set in ParamCNC).

Plasma pantograph rotator 90°

• with standard rotary positioner

Name	Value	Settings 🗵							
Parameter key		Cut path	Machine limits	Tool opera	ations	Nesting / supports	Lead in/out	Measure	Generate
Machine	993 MG Test (dielna)	<ul> <li>Machine lin</li> </ul>	mits						
Technology	11 HPR260	• • • •	Minimum Z	-1	000.00 r	nm			
Material			Maximum A for	cutting 90	.0 deg				
Power			Maximum A for	marking 90	.0 deg				
1001		<b>\$</b> \$	Minimum B	-7	- 20.0 deg	)			
		<b>\$ \$</b>	Maximum B	72	0.0 deg				
		<b>\$ \$</b>	Minimum R	-4	00.0 deç	9			
		<b>\$ \$</b>	Maximum R	40	0.0 deg				
		Machine la	yout						
		4 4 3	Chuck location	at X min		-			
		4 4 4	Rest type	No rest		-			
		\$ \$ \$	Rotator geometry	Rotator 45	degrees	-			

Fig. 231: Pantograph rotator 90° with standard rotary positioner

#### Plasma pantograph rotator 120°

• with standard rotary positioner

Name	Value		Sett	ings	×	3							
Parameter key			Cut	pat	h	N	fachine limits	Tool op	erations	Nesting / supports	Lead in/out	Measure	Generate
Machine	993 MG Test (dielna)	-	Ma	chin	e lir	imits							
Technology	11 HPR260	-	\$	ф	4	6- M	linimum Z		-1000.00 r	nm			
Material		-	4	4	1	6 M	laximum A for o	uttina	120.0 dea				
Power		-	6	4		A M	avinum A for r	narking	120.0 deg				
Tool		•		-			tinimum P	narking	-720.0 deg				
			-	44		• P1			-720.0 deg				
			¢	ф	4	₿ M	laximum B		720.0 deg				
			ф	ф	-0	ĕ M	linimum R		-400.0 deg				
			ф	ф	-0	6- M	laximum R		400.0 deg				
			Ma	chin	e la	ayout	t						
			¢	ф	4	۰ d	huck location	at X min	1	•			
			ф	ф	4	∂- R	est type	No rest		•			
			¢	ф	-5	e R	otator geometry	Rotator	45 degrees	•			

Fig. 232: Pantograph rotator 120° with standard rotary positioner

Machine layout settings (Chuck location, Rest type and rotator geometry) have to be set according to particular machine and type of rotator.

Mad	chine	lay	out		
¢	Φ	Φ	Chuck location	at X min	•
¢	φ	Φ	Rest type	No rest	-
φ	φ	Φ	Rotator geometry	Rotator 45 degrees	•

Fig. 233: Machine layout settings

#### **B-axis reposition**

Machine limits including B-axis limitations are defined in tab Machine limits in Settings. This tab contains parameters that impose limits of motion on operating range of the machine motion axes.

When generating CNC code, mCAM tries to keep the set B-axis range (depends on type of the CNC machine). In cases, that B-axis value exceeds the limit, *mCAM* displays a warning that signals the exceeded range of B-axis.



Fig. 234: Complaint about exceeded range of B-axis

There are several ways how to solve this problem:

1. Using loops to reduce cumulative rotation in B-axis. Loops are added manually by selecting a cut path, pressing the key L and selecting a cut point where should the loop be located. When the loop is selected, its attributes are displayed in the Properties area of mCAM. Each loop is characterized by Type, Control distance and if it is used for B axis reposition or not. Backward rotation of B-axis is represented as M38 instruction in CNC code. Using loops to reposition B axis can be problematic in plasma cutting, because the backward rotation takes place on one point in the loop and that can cause the plasma torch to turn off. It is safe to use in waterjet cutting.

Property inspector		Settings 🗊 I	Imported 1 🖾 🖋	🖋 Temporary job 4 🛛
✓ Shape				the Share Tablett according
Shape name	lube140	✓ M Circle pipe D: 14	0.00 mm T: 5.00 🖶	View Shape loot path processing
Description				🔄 🌈 🛑 👘 YZ 🗳 XY 🧃
Source name		✓ () () L: 873.00 mm 1	PM 🖬	
Drawing No.		🗸 🖋 Stock part 50	3.11 mm	
Position No.		(a)		
Y Technical summary	LAUU	Tube14	•0	
Lowest cut denth	5.00 mm			
Highest cut denth	12.58 mm			
× Solid	12.55			
Name	Circle nine			
D:	140.00 mm			
T	5.00 mm			
L.	496.15 mm			
V Loop				
Type	Spline 🗸			
Control distance	10.00 mm			
B axis reposition	Yes 🗸			
				Y Y
				[] 🔆 💿

Fig. 235: Example of loop wit B axis reposition enabled

#### 2. Dividing the cut path to smaller fragments

→ Using microjoints – making small microjoints on the cutting contour will allow the cutting head to reposition and with appropriate lead outs selected, the hole will be cut properly.



Fig. 236: Using microjoints to split path to three smaller fragments.

→ Splitting a cut path by selecting it and pressing the keyboard key B or scissors icon from the cut path editing widget and selecting a cut point where it should be split. This can be done multiple times if necessary.



Fig. 237: Cut path split to three parts

# Expert tables

Expert table of each tool operation (see section Tool operations) directly affects the processing of cutting paths, cutting speed control and kerf width compensation in each cutpoint of cutting contour. mCAM processes the cutting path according to related cutting data for real effective thickness in particular cutting point. Expert tables initial setup is described in section Expert table initial setup.

## Kerf width compensation

All cutting tools are characterized by kerf, that represents width of cutting beam for particular energy beam technology. To achieve accurate dimensions of parts, cutting paths need to be compensated for the tool radius. Points of particular cutting path are offset by the tool radius in the direction away from the final machined surface. During this process, some points are removed (especially in short sections of an inner corner – A) and others are added (loops on the outer edges– B).



Fig. 238: Principle of kerf width compensation

In thermal beam cutting technologies where thermal affected zone and real kerf width of used tool increases with increasing of effective cutting thickness (bevel cutting), decreasing cutting feed (bevel cutting), increasing current (plasma cutting) or increasing power (laser cutting). The principle of kerf width compensation in *mCAM* consider all those fact therefore *mCAM* is able to adapt kerf width and cutting parameters according to cutting variables in each cutting point.

Dynamic kerf width compensation and automatic speed control means that mCAM is able to adapt final kerf width compensation according to used cutting speed, effective cutting thickness (which changes variably according to bevel, shape and type of the cut) and cutting modifiers.



Fig. 239: Effective cutting thickness

Automatic calculation of effective cutting thickness, including applied cutting modifiers (such as Slow in corners, Lower power on profile radius, end-section slow down or other cutting modifiers) results in final used cutting speed. Final applied kerf width is related to final used cutting speed.

- effective cutting thickness => cutting speed + cutting speed modifiers => applied cutting speed
- applied cutting speed => kerf width

Application	Cut path	Machine limits	Tool operations	Nesting / supports	Lead in/out	Measure	Generate	Intensity				
-Slow in corr	ners											
\$ \$ <del>0</del>												
\$ \$ \$	🔄 🄄 🐺 Minimum angle of corner 45.0 deg											
\$ \$ <del>\</del>	Contraction of the speed 70.000 %											
\$ \$ <del>\$</del>	Commission Commis											
Slow at end												
\$ \$ \$	Slow at end	d 🗌										
\$ \$ \$	Relative sp	eed 70.000 %										
\$ \$ <del>]</del>	Distance	20.00 mm										
Adjust inter	nsity control	according to effe	ctive cutting thickr	iess								
\$ \$ <del>.</del> .	🔄 🔄 🐙 Adjust intensity control according to effective cutting thickness 🗹											
Cutting area												
\$ \$ <del>.</del> .	🔄 🔄 🖳 Cutting area based intensity control 🗹											
Use accelera	ation in spee	ed counting										
🔄 💠 🗏 Use acceleration in speed counting 🗌												

Fig. 240: Cutting speed modifiers

Note: As you can see on example of standard plasma cutting expert table, kerf width value increases with decreasing of cutting speed in whole range of material thickness. Expert table defines exact kerf width and cutting speed values in relevant range of material thicknesses that could be eventually cut by particular tool.



Fig. 241. Expert table of cutting parameters

Kerf width value is related to cutting speed applied on particular cut – point. If constant kerf width should be used (e.g. water jet cutting), constant kerf values in expert table of particular tool (for each tool operation) have to be defined.

Note: Constant kerf values for water jet machines are set automatically when using WebService. In other cases, it needs to be set manually by editing expert tables.



Fig. 242: Constant kerf width values

Effective cutting thickness changes more significantly especially in H – beam flange middle section where the effective cutting thickness can be 1.5 or 2 times bigger than flange thickness. Range of expert table can be easily extended by function on the right side of the screen. In case that automatically generated (fill from expert/operation/tools) range of cutting parameters does not cover the range of thicknesses to be cut by particular tool, it is necessary to extend this range by adding more rows manually. This fact is important to consider especially in H – beam cutting where a tool has only limited access to T – section where cutting speed can reach 20 - 30% of original flange cutting speed.



#### Fig. 243: H – beam middle section cutting

It is possible to enable or disable kerf width compensation for all cut–paths individually as well as all other parameters of selected tool path such as lead–in s/–outs, microjoints and used technologies.



Fig. 244: Disabling kerf width compensation on selected cutting path

## **Tool path processing**

Final processing of all cutting paths, including *kerf width compensation, machine and technology limitations,* takes place during the CNC program generation. Whole principle of cutting paths processing is based on configuration of chosen *machine* and *technology (machine* and *technology limits)* and *expert tables* of cutting parameters (*kerf width and cutting speed*) defined for chosen *tool. Machine, technology* and *tool settings* are defined in *Parameter key* in *properties* menu of particular *stock.* All parameters, including machine limitations, technology limitations and *kerf width compensation* values are defined in *Settings* when selected correspond *Parameter key. Kerf width compensation* values are defined in *expert tables* of selected tool. *Expert tables* are described in more details in section Expert tables.

Final cutting paths (compensated by kerf width compensation and limited by *technology* and *machine limitations*) are displayed in *Tool path processing* in *Job task*. In *properties* menu, while displaying *Tool path processing* of particular shape, kerf compensation status is displayed.



Fig. 245: Tool path processing (compensated and limited paths)

As long as cutting path processing takes place during the CNC program generation, *import, libraries* and *shape tab* in *Job task* display only raw–processed (non – compensated and non – limited) cutting paths. Therefore, *Import task, libraries* or *Shape tab* in *Job task* display all cutting paths as non – processed (only raw generated cutting paths – affected by applied *path generation mode*).



*Fig. 246: Raw-processed cutting paths (according to input settings and applied path-generation mode)* 



Fig. 247: Side-view on raw-processed cutting paths (bevel cutting)



*Fig. 248: Tool path processing view (processed cutting paths) – straight cutting head limitations* 

## **Expert table initial setup**

Depending on type of machine, expert system disposal and WebService (installed/non – installed), it is possible to fill up expert tables in three ways:

- expert system (if the expert is available on machine)
- **from operation** (controlled as by machine control system by linear extrapolation)
- from existing tools in iMSNC (if machine has created enough range of tools for each material to cut)

Note: It is possible to edit all expert tables by buttons on the right side of the screen regardless the way of creation. Expert table graph display an actual cutting data (kerf width and cutting speed) set for particular thickness of the material.



Fig. 249: Expert tables (generator)

#### Fill from expert system

Fill from expert system is recommended to use for plasma technology with its own expert system (if expert system is purchased) that allows to generate cutting parameters automatically. In this case, expert table is filled up from available range of parameters which could be generated from expert system in iMSNC.

Expert table of each tool operation is created automatically from expert system parameters (expert system tools that could be eventually generated for particular current, type of material and thickness). All related tools share the same identifiers (current, material and consumables). E.g. expert tables of cutting parameters for tool H260 – MSt – 10.000 – 130 – O2+Air – 13 (tool that included in iMSNC library of tools) are created from all available expert system cutting parameters which share the same identifiers: MSt (material), 130 A (current), O2+Air (used gases) and 13 (consumables).

#### Fill from operation (extrapolation)

Fill from operation by automatic extrapolation of reference cutting data (defined for each operation). Cutting parameters extrapolation simulates a mechanism of cutting speed control performed by machine control system on planar cutting where machine controls actual cutting speed according to used bevel angle (tilting angle) during a cut.

If this function is used when mCAM is connected to water jet cutting machine via WebService, constant kerf compensation values are generated (water jet kerf value does not change with the cut thickness of the material) and no dynamic kerf compensation is performed.

#### Fill from related tools (tools from iMSNC library)

Fill from tools in iMSNC (tool library) is possible to use on machine where user has created sufficient range of tools with valid cutting parameters (tested and standardly used). Expert table is filled from tools which are available in tools library in iMSNC and share the same identifiers. That means that expert table for tool H260 – MSt – 10.000 - 130 - O2+Air - 13 is created from all available tools (tools included in iMSNC tool library) with following identifiers: MSt (mild steel), 130 A (current), O2+Air (used gases) and consumables number 13.

Note: All following tools (used for filling the expert table) are included in iMSNC tool library.

Example of grouped tools that share the same identifiers for tool  $\underline{H260 - MSt - 10.000}$ - 130 - O2+Air - 13 (chosen tool for cutting):

Expert tables are filled from actual cutting parameters of these tools:

- H260 MSt 5.000 130 O2+Air 13
- <u>H260 MSt 10.000 130 02+Air 13</u>
- H260 MSt 15.000 130 O2+Air 13
- H260 MSt 20.000 130 O2+Air 13
- H260 MSt 25.000 130 O2+Air 13)

Keep in mind that invalid cutting data (cutting parameters and tools created cutting experiments, etc.) may refer to incorrect expert tables (non – linear curves), so expert tables need to be edited and fixed manually.



Fig. 250: Possibly invalid expert table of cutting parameters

#### **Editing features**

All functions in Expert tables (generator) are applied according to chosen level in Parameter key. If only machine and technology are selected, all tools related to selected technology are affected by used function (fill from, normalize, shift data to tool, etc.). If machine, technology and particular tool are selected, only operations related to selected tool are affected by used functions.

Note: Parameter key material and power are only filters used for displaying particular tools therefore their selection is not considered in previously mentioned functionality.

- Delete selected expert data deletes all cutting expert data related to selected parameter key
- Normalize all deletes non valid cutting parameters (negative or too high kerf/cutting speed), deletes duplicated cutting parameters and sorts all parameters by thickness)

- Shift data to tool if cutting speed or kerf width values in tool parameters in iMSNC have changed (and considered as valid) in iMSNC, reference parameters (downloaded from machine displayed, and also whole range of cutting parameters in expert tables are shifted by the difference of those values.
- **Copy to clipboard/Paste from clipboard** copy/paste all selected data (set by parameter key) to another tool or any text file.



Fig. 251: Shift data to tool

# Ordering

The *mCAM* uses automatic ordering method therefore any user interaction or setting should not cause any serious problem within the *NC code* and cutting. It is possible to define priority cutting for any cut, but the main ordering logic (automatic ordering managed by *mCAM*) is maintained to avoid any technological or machine–based issues in ordering defined by user.

## **Automatic ordering**

Automatic ordering is based on several technological and optimalization principles. Automatic ordering managed by mCAM takes into consideration also a machine layout (has rest/ no rest), used rotator mode (cutting beams in rotary positioner/ on supports) or
dimensions of the *stock piece*. Sophisticated algorithms of *automatic ordering* are based on these principles:

- part at once (cut part by part)
- **nearest cut** (move to nearest cut if possible)
- **technology priorities:** ASCII marking → marking → drilling → punching/straight cutting/bevel cutting
- reduce operation switching (i.e. drill all holes  $D20 \rightarrow$  drill all holes  $D10 \rightarrow$  cutting)
- technological order of grouped cuts (i.e. H−beam trim cut: web → flange → flange)
- reduce rotation of profile (i.e. complete all cuts on side of square pipe, H–beam, etc.)
- **sort cuts to groups** (i.e. group cuts on profiles by X coordinates, to reduce supports repositioning)
- group measurement (perform measurement for several grouped cuts)

### Item finishing mode

Item finishing mode defines the method of ordering cutting parts, it means the sequence of technological operations (e.g. marking, cutting), or individual cutting priority within the equivalent parts.

Except for mode *Any order* when cuts are ordered by the rule of closest cut, the highest ordering priority is assigned to item *finishing mode*. The modes are described in detail in section Generate.

## User ordering (priority cutting)

User ordering should be used only in case of special ordering requirements; e.g. for minimization of thermal deformation of the material or priority processing (*drilling/cutting*) of some cuts. User ordering has lower priority in ordering processing than the *automatic* ordering managed by *mCAM*, therefore it is not possible to change or affect the basic principles of *automatic ordering* or affect the technological integrity of final *CNC program*.

*User order* number sets the priority of cutting particular cut where "1" is the highest priority. When the same *User order* priority is set for two different cuts, the principle of nearest cut manages the final order between then.

**Example**: User order (value = 1) defines that selected cut should be performed as first on that particular part. But if this cut would be performed as first on each part on nesting with using X min Chuck location, two highlighted parts would be cut–off completely without cutting front trim cut and two holes. Therefore, mCAM controls and applies User order priority cutting just after Automatic ordering processing -> Principle of ordering: Automatic ordering  $\rightarrow$  Item finishing mode  $\rightarrow$  User order

User order of equivalent cuts can be defined by priority numbers (1-highest priority, 2-lower priority, etc.). These priority numbers are not superior to main ordering rules managed by *mCAM* automatically. Their function is activated after the primary *mCAM* ordering, so the basic ordering principles are preserved:

- cutting is executed from the edge of the semi-product so cutting off the part with unfinished holes or other parts closer to the edge of semi-product is avoided
- holes first if any part contains holes inside the outer contour, holes have to be cut first

Note: Hole on the top of the dome is cut as last due to continuous measuring the detection point on the top of dome even if other holes in dome have higher priority.



Fig. 252: Priority cutting – User order on selected cut

## Complex cuts ordering (Y, X, K-cuts)

Ordering principle within the complex cuts is performed by the rule: *bottom cut*  $\rightarrow$  *straight cut*  $\rightarrow$  *top cut.* 



Fig. 254: Complex K–cut

# Nesting

Nesting is a function used to create optimal placement of parts on the stock material. The function employs a sophisticated algorithm to place parts so that maximum utilisation of the stock material is achieved. The algorithm rotates, mirrors, shifts, and orders the parts to use the minimum amount of the stock material for particular job. Default minimum gap between neighbouring parts as well as dimensions of supports and length of non-cutting zone near chuck location are defined in *Application configuration level* in *settings* (see section Nesting

Subsection Nesting defines parameters regarding nesting of parts.

Nesting gap - represents the *distance* between individual parts. Nesting gap ignores lead-ins during the nesting so the gap must be larger than lead ins for parts.

Use lead -ins/-outs and bottom contours in 2D **nesting** – this parameter is used to prevent overlapping of adjacent parts caused by lead–in s/–outs or the bottom contours of these parts.

- Limited positioner Defines if machine has a limitation for range of rotation (usually set from -398° to 39°)
- Enable 1D envelope nesting allows to use simplified nesting process of parts that are enclosed by theoretical solid (i.e. pipes are enveloped by simple cylinders, H beam by simple cuboid, etc.)

- Enable common cut is a special feature that enables to employ cutting between two adjacent edges that can be cut simultaneously by a single cut. The method is applicable only for cutting technologies that provide equal cutting quality independent on the side of the tool. Common cut can be used only on circular pipes.
- Enable profile rotations and flipping if enabled, program will rotate and/or flip the material in the best position for cutting of the part.
- **Nesting time sets maximum** time that nesting will run to prevent the algorithm running indefinitely when searching for best solution.
- Precision of common cut detection specifies the value of precision of common cut.

Application	Cut path	Machine limits	Tool operations	Nesting	Supports and rests	Lead in/out						
Nesting												
• • 😾	Nesting ga	р		5.0	5.00 mm							
* * 🐺	🔹 🔹 🐺 Use lead-ins/-outs and bottom contours in 2D nesting 🛛											
• • 😾	Limited po	sitioner		Ο	0							
• • 😾	Enable 1D e	envelope nesting		$\Box$	0							
• • 🛃	Enable con	nmon cut		$\Box$								
• • 🛃	Enable pro	file rotations and	flipping	•	9							
* * 🗼	Nesting tim	ne		10	s							
Common cu	t											
• • 🗜	Precision o	of common cut det	ection 3.00 mm									

• Fig. 312: Nesting settings

## Supports1D nesting

In process of 1D nesting there are several important parameters that define the properties, quality and used nesting mode. These are the nesting properties:

- **Gap between objects** defines the minimal perpendicular distance between nested parts.
- Start point X offset defines an offset between program start point (X position of first cutting contour in NC code) and start point set by operator (or by optical sensor). Start point X offset helps to avoid piercing and cutting on the exact edge of the material by shifting start point (and whole CNC program) towards chuck location.
- Use part envelope only allows to use simplified nesting process of parts that are enclosed by theoretical solid (i.e. pipes are enveloped by simple cylinders, H beam by simple cuboid, etc.).
- Use common-cut is a special feature that enables to employ cutting between two
  adjacent edges that can be cut simultaneously by a single cut. The method is applicable
  only for cutting technologies that provide equal cutting quality independent on the
  side of the tool. The kerf width compensation is performed by a mCAM therefore the
  expert tables of selected tool should be defined precisely. The function can be enabled

or disabled only for the whole *Job task*, including all *stock*s and *templates* in it. Common-cut can be used only on circular pipes.

- Surface map quality this setting is available only in case of nesting of non-enclosed parts (circle pipes, rectangular shaped pipes, etc.). This setting defines the quality of surface mapping (its trim contours) on parts to be nested, so it affects the final quality of nesting of complicated parts. Maximum time length is constant therefore the final nesting results (nesting quality) also depends on computer hardware performance. Surface quality mapping can be set on three levels:
  - $\rightarrow$  Fine (quality oriented)
  - $\rightarrow$  Normal
  - $\rightarrow$  Rough (performance oriented)
- **Enable part rotations and mirroring:** function enable/disable part rotations and mirroring so it increases utilisation of the material in nesting.

Note: Using the function Enable part rotations and mirroring while nesting H-beams, may cause serious problems (reverting of the cutting paths), so it is necessary to disable it.



Fig. 255: Applied common-cut

There are two possible types of nesting:

 Nesting of the whole template. Allows to nest all parts within the same template (with the same dimensions – i.e. diameter and thickness), regardless if they have been already nested, on all available stocks within the template. Each *stock part* is a physical stock piece = one CNC program.



Fig. 256: Nesting of all parts within template Circle pipe D: 220 mm, T: 10 mm

Settings	Imported	1 🛛 🖋	Tempo	orary job	8 🗵
✓ d Circle pip	e D: 220.00 mm T:	10.0 争	View	Shape	Tool path processing
✓ ( L: 2500.0	00 mm 1	<b>M H</b>			
v 🖉 Stock	part 2040.48 mm				
	Pipe_220x10_test	t_nest			
	Pipe_220x10_test	t_nest			
	Pipe_220x10_test	t_nest			
	Pipe_220x10_test	t_nest_8			
	Pipe_220x10_test	t_nest			
L: 1500.0	00 mm	þa 💾			
∽ 🕡 🚺 L: 1800.0	00 mm 1	<b>⋈ Π</b>			
🗸 🖉 Stock	part 1285.92 mm				
	Pipe_220x10_test	t_nest			
	Pipe_220x10_test				
	Pipe_220x10_test	t_nest			
	Pipe_220x10_test	t_nest			

Fig. 257: Nested parts with highlighted unused stock

 Nesting within the selected stock material. This function allows to re-nest all parts within the selected stock material in case that cutting paths were changed in a meanwhile (after previous nesting). Other stocks and related parts remain non– affected by this nesting. Edited parts (i.e. lead–in or lead–out was changed in a meanwhile) are displayed by changed part icon.



Fig. 258: Nesting within the selected stock

The function *Move rest parts to stock* allows to move all unassigned (non-nested) parts to some stock part. All unassigned parts or non–nested parts (parts that did not fit to any stock part during previous process of nesting because of short length of the stock or number of stock parts).

All unassigned parts or non-nested parts are displayed as *grey coloured parts* and are placed at the bottom of the list of parts. This feature makes it easy to identify and highlight parts that have not been processed by nesting (newly imported) or were not nested on any stock part during the nesting.



Fig. 259: Unassigned or non-nested parts (grey parts)

All templates that have been automatically created for particular shape type and dimensions (wall thickness, diameter, etc.) allow to use these functions:

- **Nest this** this function initiates nesting process of all assigned stocks within the template without using remaining parts (all parts can be moved or transferred between all stocks within the template).
- Nest this with all parts this function initiate nesting process of all assigned parts within the selected *stock* or all parts assigned on all *stocks* within selected *template* with using remaining parts (all parts, including remaining parts, can be moved or transferred between all *stocks* within the *template*).
- Free all move all parts assigned to *stocks* within the template to unassigned status under the *template*. This is the same status as just after the import of these parts to the job. These unassigned parts can be assigned to any *stock* again.
- Add stock add new stock piece with default length
- **Remove stock/template** the function removes selected template including all assigned stocks and parts.
- Save plan the function generates and saves cutting plans of all *stock parts* within the selected *stock* or *template*.
- Simulated plan the function generates and simulates cutting plans of all *stock parts* within the selected *stock* or *template*.
- Simulated and save plan the function allows to generate, simulate and save cutting plans of all *stock parts* within the selected *stock* or *template*.

Note: The nesting procedure is a complex and demanding task and duration of the nesting procedure depends on the computer performance and available resources, so it is important to meet at least minimum system requirements (see section System requirements on page 19).



Fig. 260: Nested parts – highlighted selected part and its nesting results

### **2D** nesting

2D nesting is used when working with surface parts and stocks (planar sheets). 2D nesting differs from 1D nesting by the method of usage and its whole nature. *mCAM* utilises so called *indic nesting* that is also implemented in *AsperWin nesting module*.

Plane nesting menu includes functions that are used to create optimal placement of parts available for particular plan. When reasonable, it is possible to modify these parameters in *Plane nesting* settings. Particular nesting settings are used for whole *job task*, which means all nesting settings that are displayed in *Properties* are applied to every *part*, *job stock*, and *template* in *Job task*.

Plane nesting menu contains these functions:

- Nesting gap [mm]- defines the minimum gap between nested objects (parts),
- **Bounding rectangles only** nesting process uses only rectangular circumscription of each part (simplified nesting). This function is turned off by default (recommended).

- Rotation step [°] defines the rotation step that is used in nesting process. Each part in particular can be rotated by this angular step to optimize final positioning on stock part.
- Fit type defines the nesting strategy that is applied for particular job stock:
  - $\rightarrow$  Quickest fit
  - $\rightarrow$  Center of gravity 1
  - $\rightarrow$  Grid 1
  - $\rightarrow$  Center of gravity 2
  - $\rightarrow$  Grid 2
- Use lead-in s/-outs and bottom contours this function is used to prevent overlapping of adjacent parts caused by lead-in s/-outs or the bottom contours of these parts.
- Nest along axis defines a direction of parts nesting (in X axis or Y axis).



Fig. 261: 2D nesting -highlighted Plane nesting settings

### **Manual nesting**

Manual nesting is a feature designed for positioning of plates and circular pipes. It helps user to more efficiently move individual parts on stock to achieve their best placement, if he wasn't satisfied with automatic nesting.

Note: The best and highly recommended way to find an optimal ordering, orientation and placement of all shapes is to use automatic nesting. Overlapping cutting contours and other related issues are not controlled/check by mCAM (when using manual nesting), therefore user takes full responsibility for possible subsequent cutting problems on machine.

Manual nesting is activated in job tab. It's important to adjust the parameters of stock and move all parts to stock first. This is done either by automatically nesting all parts by clicking on puzzle icon or move them manually to the stock (with drag and drop), right clicking on the stock and selecting "Move rest parts to stock". The same manual procedure applies if not all parts were moved to stock at automatic nesting.

All parts that need to be nested has to be on the stock before manual nesting. If another part is added later, the nesting will reset.

Manual nesting is activated by clicking on a manual nesting button at the top left corner of the visualization screen.



Fig. 262: Manual nesting button – manual nesting is not activated



Fig. 263: Manual nesting is activated and the view is locked in 2D top view

After activation of manual nesting, the view is automatically changed into locked 2D view. When nesting 2D parts, the view is locked to XY plane. For pipes, the view can be changed between XY plane and XZ plane.

Selected part is displayed with yellow outline and can be:

- 1. Moved parts are moved by simply clicking and dragging the selected part into its desired position
- Rotated selected part can be rotated with left and right arrow keys by 15°. Holding the ALT key while rotating the parts will rotate them by 5°.
- **3.** Flipped only for pipes, flips the part around Z-axis (by 180°) with up and down arrow keys.

*mCAM* also allows to change the nesting results by manually editing *nesting results* of particular part in *Job part* settings in *properties menu* of selected part. *Nesting results* parameters differs according to nested shape type, i.e. circle pipe part position is determined by *Offset* (X – position), *Rotation* and *Mirror* status.



Fig. 264: Manual nesting of selected part

Next to the manual nesting button at the top left corner of the visualization screen are also two buttons with specific functions intended for more efficient manual nesting of circular pipes. These controls are active only in manual nesting mode for circular pipes.

lcon	Description
$\triangleright$ (	Flip – flips the selected part (also with up and down arrow keys)
]→[	Move – moves selected part closest to the previous part on stock (applies common cut if active)

### **Move function**

Move function is used to move selected part closest to the previous part on stock. The distance is set according to the value in Nesting gap in Properties area. The order of parts is set from the beginning of the stock material to the chuck location. So, in locked view in manual nesting, the parts are moved in X- direction.



Fig. 265: Direction of movement of parts in active manual nesting mode in XZ view

The Move function will also automatically rotate selected part to achieve optimal placement with maximum utilisation of the stock material according to the previous part position.

If common cut is activated for the whole cutting plan (by checking the checkbox in Nesting settings in Properties area) using the Move function will also apply common cut if possible (on straight trim cuts). If common cut was applied, the cutting path will change color to light blue-grey.



Fig. 266: Parts nested with applied common cut

**Note:** Selecting parts in manual nesting in visualization screen won't affect the selection in Working screen. Because the information in Properties area is based on selected part in Working tree, this could not correspond with selected part in visualization screen. We recommend not making any changes in Properties area while the manual nesting is active or to double check if correct part is selected.

#### Kerf compensation on common cut

If common cut will be used, it is necessary to select the specific tool, that will be used for generating CNC, so that respected kerf length can be used to maintain the most precise length of individual parts. Due to kerf compensation, the common cut is not displayed in visualization screen as one cut, but the parts are spaced apart by a length of kerf. Even though, they are displayed as two cuts in job, they will be cut by single cut.

The size of kerf is always the size of kerf for straight cut for respective thickness, even if the actual cut is bevel cut.

## Plan generation settings

Directly affects the way of NC code generating, used *Rotator mode* (3D mode/ fixed Y mode and profile cutting in rotary positioner/ on static support/ in rest), *Chuck location* 

(position of rotary positioner within the machine) and generated NC instructions (technological operations – *Marking/ Transformations/ Text marking/ Cutting*).

### Name

Name of particular *CNC program* is defined by *Name* of *stock*. If *stock* contains more than one *stock parts*, names of all *CNC programs* within the *stock* are numbered (i.e. *name-1; name-2, name-3;* etc.). In example below, defined name results in generated *CNC programs*: Order224-1.cnc; Order224-2.cnc.

If there is not any *stock name* defined, name of *CNC program* is given by name of first *part* nested on particular *stock part* (i.e. *part-1; part-2; part-3,* etc.).



Fig. 267: Defined stock name

## **Chuck location**

Chuck location describes location and orientation of a rotary positioning device. The positioning device can be located either at X min, or X max with respect to machine coordinate system. That means that location of the clamping chuck has to be set up to match the actual coordinate system of the particular machine. The chuck position is defined in *Settings – Machine limits – Machine layout* (as a *Machine – technology* preset) or it can be defined manually in *Plan generation* properties of each *stock* piece.

Name	Value	1	Importe	ed - In	nported 1 🗵	Job - Te	mporary joł	3 🖂	Settings 🗵			
Parameter key			Cut pat	th	Machine limits	Tool op	perations	Nesting	/ supports	Lead in/out	Measure	Generate
Machine	993 MG Test (dielna)	•	Machir	ne limi	ts							
Technology	11 HPR260	•	<b>¢</b>	•	Minimum Z		-100.00 m	m				
Material		•	6 6		Maximum A for	utting	45.0 dea					
Power		-				···	45.0 deg					
Tool		-	<b>\$</b>	*	Maximum A for i	narking	45.0 deg					
			¢ ¢	\$	Minimum B	inimum B -800.0 deg						
			💠 💠 🕹 Maximum B 800.0 deg									
			<b>\$</b>	4	Minimum R		-400.0 deg	)				
		[	\$	4	Maximum R		400.0 deg					
			Machir	ne layo	out							
			\$	$\Phi$	Chuck location	at X min	n		•			
			\$	$\Phi$	Rest type	No rest 👻						
			φ φ	$\Phi$	Rotator geometry	Rotator	45 degrees		•			

Fig. 268: Machine layout presets related to machine and technology

### **Output format**

NC code is the only output from the *mCAM* in form of a text file containing instructions for controlling a technological device that. The *mCAM* supports DIN standard format (so called G–codes and M–codes).

Commentaries in NC code displays information regarding time and date of generating particular NC code, used cutting mode, used cutting tool or stock dimensions. Commentaries before every single cut also contains info about measurement type, applied kerf compensation values, adaptivity mode (on/off) or operation type.

*mCAM* does not allow to edit the generated code because the code for 3D cutting is too complex for manual editing and improper manual changes may lead to potentially dangerous behaviour of a machine.

```
(mcam.ver= 1.3.1.115 2015.10.22)
(mcam.date=29.10.2015 18:00:10)
(PIPE DIM 477.0 220.0 0 10.0 0 -
(mcam.axis.type=ROT_POL_MOD2)
(mcam.grip=X_MIN X)
(mcam.stock=Circle pipe D: 220.000 T: 10.000; L: 477.000)
(mcam.item=1 'Pipe_220x10_test_nest_8_5' 'C:/msnc/mcam21.10/examples/Pipe_220x10_test_nest_8.STEP' :5)
(29.10.2015 18:00 'msnc500'
(MACHINE 1 Virtual machine)
(TECHNOLOGY 11 Pantograph 90 degrees)
TOOL 11 tool)
(SEMIPROD 1: 10 220; 477)
(SEMIPROD: CirclePipe Thickness=10 Diameter=220; Length=477)
(TRSF_0_1_0_1_0_0_1_0_0_1_0_0_)
(SEMIPROD MIN 1; 10 220; 425)
(SEMIPROD_MIN: CirclePipe Thickness=10 Diameter=220; Length=425)
(MODE ROTATOR XY 220.0)
(START X MAX)
(mcam.part mode=CUT item=1 holeID=2 cut=3/DEFAULT/0/UPPER blocker=OTHER cutID=9)
(mcam.info type=MAX_X grip=X_MIN act=R_CONST measure=PLANE adaptivity=OFF
(mcam.info2 cutHints=CUT_DIVISION_BEFORE|CUT_DIVISION_AFTER|CUT_JOIN_AFTER|CUT_BON_AFTER]CUT_END_PART quality=Q5|LARGE kerf=<2.7,2.8>)
(mcam.tech path_cut_data kerf:ON limitA= 45.0 AV=VL_AM HW= 90.0 mJoint=4; )
(PART 'Pipe_220x10_test_nest_8_5' 1 2155254)
(SIZE 1: 10 220: 416.028)
(SIZE: CirclePipe Thickness=10 Diameter=220; Length=416.028)
(mcam.expert.tool Operation 2. thickness= 10.00 speed= 2000.00 kerf= 2.70 power=110 A)
M6 T311 (CUT BEVEL_V 3)
G0 C6.090
M94 D5
G94 X0.000 Y-11.690 Z-0.623
G94 X-30,229 Y-55,077 Z-14,781
G94 X-55.585 Y77.439 Z-31.877
M94
M38 L0.000 L179.389 (Corr A from B 0.0. Add=0.0)
G0 X-53.700 Y89.656 Z-46.268 A55.228 B0.000 C6.090 (setB=0.000)
M20 D2
M3
M90 D1.468
G1 X-55.027 Y89.290 Z-45.756 A51.900 B12.207 C6.090
M90 D1.330
G1 X-56.118 Y88.844 Z-45.140 A50.455 B18.888 C6.090
M90 K159 L95,000
M90 D1.305
G1 X-57.056 Y88.305 Z-44.409 A49.355 B25.747 C6.090
M90 D1.280
G1 X-57.814 Y87.686 Z-43.584 A48.644 B32.728 C6.090
M90 D1.321
G1 X-58.441 Y86.979 Z-42.660 A48.076 B34.224 C6.090
M90 D1.346
G1 X-58.894 Y86.197 Z-41.662 A47.446 B34.616 C6.090
```

Fig. 269: NC code generated by mCAM

### **Cutting mode**

This option defines if the particular part (shape) is cut with rotator *Moving in XYZ* (3D rotator where all axes are controlled) or with rotator *fixed Y*, where Y-axis of rotator is not controlled or with *plane* cutting mode (cutting beams on static supports). This setting match with the setting rotator mode in iMSNC. *Rotator mode* is available to set in the section *Plan generation* in the *Job task* folder for each *stock*.

Y	Plan generation		
	Program name	Order224	
	Output format	Cnc	~
	Cutting mode	Moving in XYZC axes	<
	Axis	Moving in XYZC axes	
	Chuck location	Moving in XYZC axes Fix	(ed in B
	🗹 Marking	Moving in XY axes (Y-is	rotation
	✓ Transformations		
	🗹 Text marking		
	Cutting		
	Remark		
	Cut end of pipe		

Fig. 270: Plan generations settings – Cutting mode

Default *Rotator modes* used for each shape are defined in *Settings – Generate*.

🕼 Settings 🔋 Imported 1 🗵 🖌	Temporary job	11 🗵					
Application Cut path Machine limits Too	oloperations	Nesting / su	oports	Lead in/out	Measure	Generate	Inten
Generate							
💠 💠 💆 CNC usage		Cnc will be cu	t		$\sim$		
💠 🔄 🖳 Supports positioning by CNC		No (support )	oositio	ns ignored)	$\sim$		
💠 🔄 🖳 Automatic material/lunette posit	No material/	lunette	positioning	$\sim$			
					$\sim$		
💠 🔄 🖳 Collision limitations on domes							
C axis movements							
💠 🔄 🖳 Default mode for cutting circle pi	pe		Мо	ving in XYZC ax	es	~	1
💠 🔄 🖳 Default mode for cutting beams		Sta	tic cutting (on	supports/r	ollers) 🗸 🗸		
💠 🔄 🖳 Linearize C-axis movements on pr	rofile corners w	ithout rotato					
💠 🔄 🖳 Prefer to use the same C-axis con	stant value for	cuts on one h	ole 🗹				
Straight cutting							
🗇 🔄 🐺 Max angle between torch and mat	terial normal fo	or straight cut	6.0 deg	ł			
💠 💠 🖳 Max A to ignore B			4.0 deg	ł			
Ordering							
💠 🔄 🖳 Marking-cutting changeover	Start cutting i	mmediately		$\sim$			
	Finish part (m	ark all → cut a	ll)	$\sim$			
💠 🔄 🖳 Thermal mode	No thermal so	orting		$\sim$			
💠 🔄 🐺 Start point of plate CNC program	At X min and Y	(min		$\sim$			
💠 🔄 🖳 Movement at program end	No movement	:		$\sim$			
Parking mode							
💠 🔄 🖳 Global parking mode	Full parki	ng		$\sim$			
💠 🔄 🖳 Global parking mode in marking	text No parkin	g		$\sim$			
Short distance parking mode							
🔶 🔄 🖳 Maximum distance of two sequen	tial cuts 50.00	mm					
🔶 🔄 🖳 Parking mode	Full p	parking		~			

Fig. 271: Predefined rotator modes

Circle pipe cutting is able to use in XYZ mode (so called 3D mode) where all cuts (within the range of particular rotator) are performed only by rotator movements without using rotary positioner (movements of pipe). If cutting plan for circle pipe cutting is generated using *Moving in XYZ* mode, *NC code* contains all movements instructions, including rotator movements and movements of the rotary positioner (X, Y, Z, A, B, C). When using *Moving in XYZ* mode *XY* pipe cutting mode in *iMSNC* have to be enabled.



#### Fig. 272: Pipe cutting mode in iMSNC – Moving in XYZ

If cutting plan for circle pipe cutting is generated using mode *fixed in Y* mode, NC code contains movements without C instruction (angular movements of rotary positioner while cutting) *NC code* contains movement instructions of X, Y, Z, A and B axes. Movements of the rotary positioner are automatically calculated according to Y instructions in *NC code* and set diameter of circle pipe (defined when enabling *pipe cutting mode* in *iMSNC*). When using *fixed in Y* mode *fixed rotator pipe cutting mode* in *iMSNC* have to be enabled.



#### Fig. 273: Pipe cutting mode in iMSNC – fixed in Y

Note: Keep in mind that non-correctly set circle pipe diameter when enabling any pipe cutting mode may result in different cutting speed, not finished trim cuts or not correct dimensions of final parts.

### **Technological operations generation**

Resulting *NC code* instructions (instruction that will be generated to *NC code*) are given as a combination of *cutting path properties* and *stock properties* defined in *Plan generation*. Generation of each technological operation to *NC code* needs to be confirmed (if user wants to generate particular instructions to *NC code*) by checking the checkmarks in *Plan generation*. By default, generation of all instructions to *NC code* is enabled in *stock properties*. By default, generation of all instructions, except *Marking*, in *Cutting path properties* is enabled.

The example below this section shows generation of *Marking* that is enabled for particular cutting contour, but generation of *Marking* instructions in *Plan generation* of particular *stock* is disabled, therefore <u>no *Marking*</u> will be generated to *CNC program*.



Fig. 274: Cutting path properties – marking enabled

Priprint inspection   Name   Circle pipe   D   2000 mm   Technical summary   Lowest cut depth   1.000 mm   Lowest cut depth   1.000 mm   Lowest cut depth   1.000 mm   Lowest cut depth   Lowest cut depth   1.000 mm   Lowest cut depth	Deserves									
Solution         Name       Circle pipe         D:       22000 mm         T:       1000 mm         L       20000 mm         Vesting against       Vesting against         Vesting against	Property inspector		🏟 Settings	🗐 Imported 1 🖾 🖋	' Temporary job 11	×				
Aller       Cifcle pipe       200 om       Cifcle pipe       200 om<	✓ Solid	Circle aires			View Change To	al anth are see	in a			
L: 22000 mm   T: 100 mm   L: 23000 mm   Vestions depth 1000 mm   Highest cut depth 14.30 mm   Fechnology graph 9999 MicroStep Demo Maritic   Pipe_220x10_test_nest_ Pipe_220x10_test_nest_   Vesting geb 500 mm   Startpoint X offset 0.00 mm   Use part envelope only Pipe_220x10_test_nest_   Use part envelope only Pipe_220x10_test_nest_&   Use part envelope only Pipe_2	Name	circle pipe	✓ (n) Circle (	pipe D: 220.00 mm T: 10.0   🖶	shape it	ot path process	sing			
1:       1000 mm         L       2000 0 mm         Vesting depth       1430 mm         Isset cit depth       1430 mm         Vesting settings       500 mm         Nesting settings       500 mm         Vesting settings       1         Vesting settings       1         Vesting settings       1         Vesting setti	-	220.00 mm		1	Stock information					
L       220.00 mm       278.86 mm       512.86 mm       973.94 mm         Itowest cut depth       10.00 mm       Pipe_220x10_test_nest_       Pipe_220x10_test_nest_         Technology       9999 MicroStep Demo Ma       Pipe_220x10_test_nest_       Pipe_220x10_test_nest_         Westing spap       5.00 mm       Pipe_220x10_test_nest_       Pipe_220x10_test_nest_         Westing spap       5.00 mm       Pipe_220x10_test_nest_       Pipe_220x10_test_nest_         Wirking setting       Pipe_220x10_test_nest_       Pipe_220x10_test_nest_       Pipe_220x10_test_nest_         Surface mapping quality       Normal       Pipe_220x10_test_nest_       Pipe_220x10_test_nest_       Pipe_220x10_test_nest_         Virkual stock       0.00 mm       Pipe_220x10_test_nest_	1:	10.00 mm	~ () () L: 250	00.00 mm 1 🛛 🕅 🕅						
I construit dight       10.00 mm         Highest cut depth       14.30 mm         Technology       Statup         Machine       999 MicroStep Demo Ma         Technology       Statup         Nesting gap       500 mm         Stattpoint X offset       0.00 mm         Stattpoint X offset       0.00 mm         Use contron-cut       Pipe_20x10_test_nest         Surface mapping quality Nermal       Pipe_20x10_test_nest         Visconspring quality Nermal       Pipe_20x10_test_nest         Output format       1         Count       1         Length       250.000 mm         Program name       Order224         Output format       Cnc         Marking       Tost marking         Tost marking       Tost marking	Li Testariant summers	2500.00 mm	v 🖉 Sto	ck part 1626.06 mm	378.86 mm	416.40 mm	416.03 mm	512.36 mm	873.94 mm	
Lower Cut dept 10.00 mm   Highest cut dept 1.20 mm      Pipe_20x10_test_nest	<ul> <li>Technical summary</li> </ul>	40.00			í í	Í		í		
Technology   Petringser   Machine   9999 MicroStep Demo Ma   Technology </td <td>Lowest cut depth</td> <td>10.00 mm</td> <td></td> <td>Pipe_220x10_test_nest</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	Lowest cut depth	10.00 mm		Pipe_220x10_test_nest						
Itechnology 2000   Machine   9999 MicroStep Demo Ma   Technology   Westing settings   Nesting sgap   Supper anne   Outge part envelope only   Use part envelope only   Disenable part rotations and flipping   Do stack   Virtual stock   Unimited count   Count   1   Length   250000 mm   Program name   Order224   Outguitfy Mormat   Cutting mode   Making   Transformations   Tansformations   Team king   Cutting mode   Remark	Hignest cut depth	14.30 mm				<u> </u>				
Machine         9999 MICSup Dello Ma ✓           Technology         ✓           Y Nesting sactings         ✓           Nesting sap         5.00 mm           Startpoint Voffet         Outo mm           Use common-cut         ✓         Pipe_220x10_test_nest           V Nesting sap         5.00 mm           Use common-cut         ✓         Pipe_220x10_test_nest           V Nesting saping quality Normal         ✓         Pipe_220x10_test_nest           V Nesting saping quality Normal         ✓         Pipe_220x10_test_nest         Pipe_220x10_test_nest           Is able part rotations and flipping         Outom         Pipe_220x10_test_nest         Pipe_220x10_test_nest         Pipe_220x10_test_nest           Program name         Order224         Outout format         Constant         1         Signe mark           Marking construction         Axis         Xaxis         Xaxi	<ul> <li>Technology setup</li> </ul>	0000 Misso Dama Ma		Pipe_220x10_test_nest	<#1>	<#2>	<#3>	<#4>	Rest	
Westing settings       Dimensions. Cricle pipe D. 220.00 mm T: 10.00 mm         Nesting gap       5.00 mm         Startpoint X offset       0.00 mm         Up ge art torelope only       Dipe220x10_test_nest         Visting settings       Pipe220x10_test_nest         Startpoint X offset       0.00 mm         Up ge art torelope only       Dipe220x10_test_nest         Dispace number       Shape name       Copies in stock       Part length         Startpoint X offset       0.00 mm       Pipe220x10_test_nest       Nesting 3.00 mm         Vistual stock       Pipe_220x10_test_nest       1       27.200 mm       Pipe_220x10_test_nest       Part length         Plan sensation       Program name       Order/224       Output format       Cnc       Part and size on the functions       Noting in XVZC axes vistor of the size on the functions         Maxing mean k       Passestion       Pise mark       Pise mark       Pise mark	Machine	9999 Microstep Demo Ma V								
Nesting sectings   Nesting space   Startpoint X offset   0.00 mm   Startpoint X offset   0.00 mmon-cut   Surface mapping quality   Normal   0 bis common-cut   Surface mapping quality   Normal   0 bis common-cut   0 bis common-cu	Technology	~		Pipe_220x10_test_nest	Heat Number:		Serial Number:	D	mensions: Circle pipe D: 220.00 mm	T: 10.00 mm
Nexting gap Sour min   Starpoint X offset 0.00 mm     Use common-cut   Surface mapping quality   Normal   Virtual stock     Unlimited count   Count   1   Length   2500.00 mm     Plog-am name   Order224:   Output format   Order224:   Output format   Cov   Maxing   Maxing   Transformations	<ul> <li>Nesting settings</li> </ul>	5.00		2			Rest: 873.94 mm	(35%) (Chuck length: 3	330.00 mm)	
Shape name Copies in stock Part length   Use common-cut Shape name Copies in stock Part length   Use common-cut Shape name Copies in stock Part length   Use common-cut Shape name Copies in stock Part length   Use common-cut Shape name Copies in stock Part length   Use common-cut Shape name Copies in stock Part length   Use common-cut Shape name Copies in stock Part length   Use common-cut Normal  46.00 mm   Use common-cut Intervention 1 46.00 mm   Virtual stock Unlimited cont 1 44.00 mm   Count 1 1 502.00 mm   Program name Order224 Output format Cnet Cutting mode Moxing in XYZC axes Axis Xais Xais Xais Xais Xais Transformations Test marking Cutting Remark Intervention Intervention Intervention Shape name Order224 Output format Cnet Cutting mode Moxing in XYZC axes Kasis	Nesting gap	5.00 mm		Pipe_220x10_test_nest	Barts on stock:					
□ Use part envelope only       □<	Startpoint X onset	0.00 mm			Shape number	Shape	name	Conjes in stock	Part length	
□ Use common-cut       Image: Surface mapping quality Normal       Image: Surface mappin	Use part envelope on	ty				0.000			270.05	
genable part totations and flipping               flipping duality faofmat             vip stock               flipping part totations and flipping	Use common-cut	Neward			#1	Pipe_2	220x10_test_nest_8	_0 1	378.86 mm	
Plaubue pair forduoins allo imppling       #3       Pipe_220x10_test_nest_8_5       1       416.03 mm         ✓ Virtual stock <td>Surface mapping quality</td> <td>Normal V</td> <td></td> <td></td> <td>#2</td> <td>Pipe_2</td> <td>220x10_test_nest_8</td> <td>_4 1</td> <td>416.40 mm</td> <td></td>	Surface mapping quality	Normal V			#2	Pipe_2	220x10_test_nest_8	_4 1	416.40 mm	
Jostok       #4       Pipe_220x10_test_nest_8_3       1       \$12.36 mm         Unlimited count       1       1       1       1       1         Count       1       1       1       1       1       1         Plan generation       7       7       7       1	Enable part rotations	and hipping			#3	Pipe_2	220x10_test_nest_8	_5 1	416.03 mm	
i Virtual stock U Uninitied count Count I Uninitied count Count I Uninitied count Count I Uninitied Count I Uninitied I	<ul> <li>Job stock</li> </ul>				#4	Pipe_2	220x10_test_nest_8	_3 1	512.36 mm	
Count 1 Length 2500.00 mm Vengesoration Order224 Output format Cnc ○ Cuting mode Moving in XYZC axes ○ Axis Xaxis Xaxis ○ Cuting mode At X min ○ Cuting mode At X min ○ Cuting mode At X min ○ Cuting cuting Cutin	Virtual Stock									
Cont     I       Length     Z50.00 mm       Plan generation     Order/224       Output fromat     Cnc       Output fromat     Cnc       Cutting mode     Moving in X/ZC axes       Axis     X axis       Chuck location     At X min       Marking	Count									
Vergen     20000 mm       Plan generation     20000 mm       Program name     Order224       Output format     Cnc       Cutting mode     Moxing in XVZC axes       Axis     X axis       Chuck location     At X min       Chuck location     At X min       Imansformations     Imansformations       Imansformations     Imansformations       Imansformations     Imansformations	Longth	1 2500.00 mm								
Program name Order224 Output format Cnc ~ Cutting mode Moving in XVZC axes ~ Axis X axis ~ Chuck location At X min ~ Marking Transformations I text marking Cutting Remark Remark	Dian concertion	2300.00 mm								
Program Haine     Order24       Output fromat     Cnc       Cutting mode     Moving in XYZC axes       Axis     X axis       Chuck location     At X min       Marking	Plan generation	Ordor22/								
Cutting moving in XYZC axes Axis Xaxis Xaxis Chuck location At Xmin Marking Transformations Text marking Cutting Remark Remark	Output format	Cnc v								
Axis Xais V Chuck location At X min V Marking At X min V Transformations V Cutting Cutting Remark	Cutting mode	Moving in XX7C avec								
Chuck location At X min  Chuck location At X min  Chuck locations Transformations Text marking Cuting Remark Remark	Avie	Y avia								
Marking Marking Transformations Text marking Cutifug Remark Remark	Chuck location	At X min								
Transformations     Torstformations     Torstformations     Cutting Remark	Marking	ACA 11111								
Text marking Cutting Remark Remark	Transformations		1							
C Cuting Remark	Text marking									
Remark	Cutting									
	Remark									
	Cut end of nine									

Fig. 275: Stock properties and plan generation options

## Cut end of pipe

This function enables to perform automatic straight trim cut in the end of pipe, so the rest of used *semiproduct* (after cutting of all parts in the *CNC program*) will be suitable for next *nesting* and *cutting* by *mCAM*. Function is able to use for closed profiles (circle pipes, rectangular shaped pipes), not for open profiles (H–beams, U–beams, L–beams, etc.).

# Cutting plan generation

Prior to generation of a NC code, selected stocks, or whole template that may contain several stocks, should be generated to cutting plan. Cutting plan is simulated or saved by using buttons nearby the *Stock*.

🕼 Settings	Imported	1 🗵	ł	Tempo	orary job 1	11 🗵		
✓ Circle pip	e D: 220.00 mm T	: 10.0	*	View	Shape	Tool path	processin	g
✓ ↓ L: 2500.0	00 mm 1	1001	5	Stock	informat	ion:		
V 🖉 Stock	part 1626.06 mm			#	378.86 m	um 416.40 r	mm 4	16.03 mm
	Pipe_220x10_tes	st_nest						
	Pipe_220x10_tes	t_nest			<#1>	<#2>	>	<#3>
	Pipe_220x10_tes	st_nest		Heat	Number:		:	Serial Number:
								<b>Rest</b> : 873.94 mn
	Pipe_220x10_tes	st_nest		Parts	on stock:			
				Shap	e number	•	Shape na	me

#### Fig. 276: Generate – simulate/save

*Functions* Save plan; Simulate plan; Simulate and save plan *are always applied on currently selected* job item (template/stock/stock part)

🔕 Settings 🛛 Imported 1 🗵 🖋	Temporary job 11 🛛 🛛							
✓ ( <sup>™</sup> ) Circle pipe D: 220.00 mm T: 10.0	View Shape Tool path	processi	ng					
✓ 🚺 L: 2500.00 mm 1 🕅 🕅 💾	Stock information:							
Stock part 2147.44 mm	is 378.86 m est parts to stock	m 37	8.86 mm 416.03 mn	n 416.40 mm 378.8	36 mm 352.56 mm			
3 x Pipe_220x1( Remov	e stock							
Pipe_220x10_te Simulat	an te plan		<#1> <#2>	<#3> <	#1> Rest			
Simulat Pipe_220x10_test_nest	te and save plan		Serial Number:	Dimensi	ions: Circle pipe D: 220.00 mm	n T: 10.00 mm		
			Rest: 352.56 mm (149	%) (Chuck length: 330.00	mm)			
Pipe_220x10_test_nest	Parts on stock:							
∽ 🗑 💮 L: 2000.00 mm 1 🛛 🕅 💾	Shape number	Shape n	ame	Copies in stock	Part length			
Stock part 1306.81 mm	#1	Pipe_22	0x10_test_nest_8_6	4	378.86 mm			
	#2	Pipe_22	0x10_test_nest_8_5	1	416.03 mm			
Pipe_220x10_test_nest	#3	Pipe_22	0x10_test_nest_8_4	1	416.40 mm			
Pipe_220x10_test_nest								
Pipe_220x10_test_nest								
-	L							

Fig. 277: Save cutting plans for stock with length 2500 mm



Fig. 278: Save cutting plan for first stock part in stock with 440 mm

Name of each particular plan is defined in *properties* of selected *stock part* in item *Name*. In case that *stock part* name is not defined, name is given by the first part in that particular stock part and the number of other parts in it.



Fig. 279: Plan generation settings (name) – stock properties

# Cutting simulation of CNC program

After a CNC program is generated, the simulation tab task appears. It contains four main sections: visualization screen (simulation/report/configuration), NC code viewer, watch panel (graphs) and blocks panel.

NC code viewer exposes the source code of the generated program. Each contour (feature) is highlighted by coloured line (in right side of the screen) while the line colour depends on used technology. E.g. cutting contours are highlighted by red colour, marking by blue, etc.

Visualization screen in simulation allows to display:

- **3D** simulation where 3D model, surface detection points, actual position and tool movements are displayed
- 2D simulation where all movements are displayed by projection in XY plane
- Report where html report that is generated with CNC program
- Configuration that was used for generation of particular cutting plan

### **3D** simulation

3D simulation displays stock, cutting paths, cutting tool, supports positions, chuck location in three – dimensional space. Simulation allows identifying potential mistakes, imperfection of cutting path, ordering of the cuts, possible collisions with supports.



Fig. 280: 3D simulation with highlighted chuck location and support position

### **3D** simulation controls

It is possible to use touch controls in visualization screen in simulation. Touch controls are activated by clicking on the icon in the top left corner of the visualization screen. After activation, new icons appear, that serve for different kinds of movement.

lcon	Description
+	Move the view
<b>•</b>	Rotate the view
٩	Zooming in/out of the view

Active icons are displayed in blue colour, non-active icons are grey. Zooming in is done by swiping with finger across the area which should be zoomed in. Zooming out is done by tapping anywhere in the visualization screen. Multiple taps may be needed to zoom out completely.

## Visualization of limitation of cutting paths in simulation

Sometimes, it happens you generate a shape with cutting paths that are not possible for the machine to cut (too steep angle, limitations of material or the machine tool, and so on). When this happens mCAM automatically limits the cutting paths to fit the parameters that the machine is able to cut.

The visualization in the simulation now shows these changes by turning **the cutting paths red**. This change of color is meant to warn you, that the desired cut (hole, etc.) will be generated with different geometry and size. The paths that the machine is able to do without the limitation are showed in pink as before.

This limitation can occur in several cases:

A – axis hardware limitation – is a limitation of the rotation angle of a cutting head.
 Every head has a maximum tilt and some can't change their tilt at all (0°, 45°, 90°, 120°).
 In some cases, if the head cannot change its tilt to a specific degree, mCAM will limit it, it will change the angle of the cutting paths. This change will be seen in simulation as red cutting paths.



Fig. 281: A-axis hardware limitation before the simulation and after the limitation in simulation with 0° maximum tilt cutting head

- Limitation of machine angle between tool and material surface normal – after exceeding a maximum tilt between the tool and material surface, the cutting technology loses its effectivity and is not able to cut through the material. In this case mCAM limits the tilt of the cutting paths, so the used technology is able to cut properly. These changes are shown in simulation using red color.



Fig. 282: Limitation of machine angle between tool and material surface before and after the limitation in simulation

 Potential collision limitation – this limitation is applied to avoid a collision between the cutting head and the material/ground. mCAM automatically changes, limits, the tilt of the cutting paths to avoid such situation. This change is shown in simulation by red colored cutting paths.

## **2D** simulation

Cutting paths and tool paths in 2D simulation mode are displayed similarly as on the iMSNC machine system. 2D simulation allows watching CNC instructions for every particular cut–path section in details by mouse cursor on cutting plan.

If iMSNC provides information, simulation can in 2D representation show the whole frame of the machine (in yellow color).



Fig. 283: Frame of the machine displayed in yellow color in 2D view in mCAM simulation

Detailed zoom of particular cut-path section is executed by mouse selection of the area under inspection. Exact line in NC code is displayed by using mouse pointer on particular contour in 2D cutting simulation. Zoom out is executed by click on random place in program desktop.

Zooming-out in 2D representation can be done even above fit-all view. With decorative data (table frame counts as decorative data) zoom-out can be done up to the 10x of their dimensions.

### 2D simulation controls

What is displayed in 2D view of simulation is controlled by activating or deactivating controls at the top and bottom of the screen:

lcon	Description
+	Movie the view
Q	Zoom the view
▶≣	Select line from plan
53	Fit all to screen
	Display uncompensated cutpaths if they are generated by machine control system
a'	Display tool movement
0	Display shape type
0	Display supports
\$	Track tool during cutting

Edit CNC – serves for editing the CNC code

Abort edit – Cancels all changes made to CNC code

Save – saves all changes made to CNC code



Fig. 284: 2D cutting simulation



Fig. 285: Contour zoom

Tooltip shows information such as: length, angle, tool, radius, etc.

3D 20 (X=39.92,Y=3 Items 1 T317 CUT M2 Line:72 G1 Y Line:76 G3 X arc; ccw; ra Line:76 G3 X line; lenght	Configuratio 17.56) 20 36.827(* Li 40.724 Y31 dius=1.50 (40.724 Y36 dius=1.50 (40.227 Y36 t=0.45 mm	n AD IN *) line; lenght=2.50 mm; 1827 140.7241 134.3272(* APC CC mm; lenght=4.71 mm; begin an 1.827 140.7241 134.3272(* ARC CC mm; lenght=4.67 mm; begin ar 5.77 140.7241 134.3272(* LEAD C ; angle=185.7 deg	; angle=90.0 deg W - CONTOUR *) (gle=180.0 deg; arc angl W - CONTOUR *) Igle=360.0 deg; arc ang UIT *)	ie≈180.0 deg le=178.2 deg						
	: :	•	•	•	•	:	•	•	•	
	• •	•	•	•	•	•	0	•	•	
AV.										
ÂY X							-	200.0	00 mm	
11 I.										

Fig. 286: Tooltip information in mCAM simulation

Some machines have different layout, because of this Simulation can rotate its view according to the iMSNC settings.



Fig. 287: Different machine layout in mCAM simulation

6414		(mcam.info2cutHints=CUT_END_PARI quality=COLLARGE Keri (mcam.info3cut mode=2_CONSTI B_CONSTI HORIZONTAL) (mcam.info3b no lead=2_CONSTI B_CONSTI HORIZONTAL) (mcam.info4m mode=CHEAN mode=DIANE cohate(CARA)ED h	<2.5,2
mCAM r	sport	(mcam.tech path_cut_data kerf:ON limitA= 76.0 AV=VM_AM H	W= 4
Created:	21.01.2019 10:52:47	(PART 'Pipe_220x10_test_nest_8_5' 4 2155254)	
Name: Pipe_22	0x10_test_nest_8_5 + 9	(SIZE 1; 10 220; 410.028) (SIZE: CirclePipe Thickness=10 Diameter=220; Length=416.028)	
Stock: Circle pipe D:	220.00 mm T: 10.00 mm	(mcam.expert.tool Operation 3. thickness= 10.00 speed= 214	4.00
Stock:	L: 5000.00 mm	M108 X-2601.771 (1200)	
Material:		M6 1311 (CUT BEVEL_A 3)	
Chuck location:	At X min	M94 D7 X-1492.994	
		M38 L-27.593 L26.433 (Corr A from B 30.0. Add=1.0)	
Starts Length		G0 X-1573.802 Y0.000 Z0.000 A0.669 B0.000 C-56.839 (setB=0.00)	))
Cutting 20 20 m 985 48	2 mm	M20 D2 M3	
Detection 30		M90 K159 L97.740 (rel.speed.act=0.977; 2095.54)	
Detection 20	_	M90 D2.500	
Total 40 20 m 985.48	2 mm	→ G1 X-1571.302 Y0.000 Z0.000 A11.454 B0.000 C-56.826	
		M90 K129 L90.295 (rel.speed.act=0.903; 1935.92)	
Preview	Info Part	name M90 02.502	
	Starts Length Pipe_220x10_	test_nest_8_5 G1 X-1568.802 Y0.000 Z0.000 A23.536 B360.000 C-56.771	
	Cutting 2 2 m 67.157 mm	M90 D5.000	
	Detection 2	GT X-1303.802 Y0.000 Z0.000 A23.338 B0.000 C-30.7/3	
		moo kity Elocidoo (recipower.acc-1.000, 100.00)	
	Total 4 2 m 67,157 mm	M90 D2.000	
	Total 4 2 m 67.157 mm	M90 D2.000 G1 X-1561.802 Y0.000 Z0.000 A23.534 B0.000 C-56.769	
$\langle \rangle \rangle$	Total         4         2 m 67.157 mm           Value         2	M90 D2.000 G1 X-1561.802 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D140.981	
$\leq 2$	Total         4         2 m 67.157 mm           Value         Count         8	M90 D2.000 G1 X-1561.802 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D140.981 G1 X-1420.821 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M00 D0 550	
	Total         4         2 m 67.157 mm           Value         Value           Count         8           Size         L: 416.03 mm	M90 D2.000 G1 X-1561.802 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D140.981 G1 X-1420.821 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D0.580 G1 X-1420.815 Y0.000 Z0.000 A22.657 B0.000 C-56.467	
$\$	Total         4         2 m 67.157 mm           Value         Value           Count         8           Size         L: 416.03 mm	M90 D2.000 G1 X-1561.802 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D14.0.981 G1 X-1420.821 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D0.580 G1 X-1420.815 Y0.000 Z0.000 A22.657 B0.000 C-56.467 M90 K159 U32.440 (rel.speed.act=0.929, 2003.36)	
	Total         4         2 m 67.157 mm           Value         Value         Size         Count         8         Size         L: 416.03 mm           Starts         Lenoth         Pine 220x10         Pine 20x10         Pine 20x10         Pine 20x10         Pine 20x10         Pine 20x10         Pine 20x10         Pine 20x10 <t< td=""><td>M90 D2.000 G1 X-1561 802 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D140.981 G1 X-1420.821 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D0.580 G1 X-1420.815 Y0.000 Z0.000 A22.657 B0.000 C-56.467 M90 K159 L93.440 (reLspeed.act=0.929, 2003.36) M90 D2.000</td><td></td></t<>	M90 D2.000 G1 X-1561 802 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D140.981 G1 X-1420.821 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D0.580 G1 X-1420.815 Y0.000 Z0.000 A22.657 B0.000 C-56.467 M90 K159 L93.440 (reLspeed.act=0.929, 2003.36) M90 D2.000	
	Total         4         2 m 67.157 mm           Value         Value           Count         8           Size         L: 416.03 mm           Starts         Length         Pipe_220x10_           Cutting         2         2 m 766 572 mm	M90 D2.000 G1 X-1561.802 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D14.0.981 G1 X-1420.821 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D0.580 G1 X-1420.815 Y0.000 Z0.000 A22.657 B0.000 C-56.467 M90 K159 IJ32.440 (rel.speed.act=0.929; 2003.36) M90 D2.000 G1 X-1420.813 Y0.000 Z0.000 A21.040 B0.000 C-55.425 M00 D2.000	
	Total         4         2 m 67.157 mm           Value         Value           Count         8           Size         L: 416.03 mm           Starts         Length         Pipe_220x10_           Cutting         2         2 m 786.572 mm           Dutting         2         2 m 786.572 mm	M90 D2.000 G1 X-1561.802 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D140.981 G1 X-1420.821 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D0.580 G1 X-1420.813 Y0.000 Z0.000 A22.557 B0.000 C-56.467 M90 DX159 IJ34.40 (rel.speed.act=0.929; 2003.36) M90 D2.000 G1 X-1420.813 Y0.000 Z0.000 A21.040 B0.000 C-55.425 M90 D2.000 G1 X-1420.813 Y0.000 Z0.000 A21.040 B0.000 C-55.425 M90 D2.000	
	Total         4         2 m 67.157 mm           Value         Value           Count         8           Size         L: 416.03 mm           Starts         Length         Pipe_220x10_           Cutting         2         2 m 786.572 mm           Detection         2	M90 D2.000           G1 X-1561.802 Y0.000 Z0.000 A23.534 B0.000 C-56.769           M90 D140.981           G1 X-142.021 Y0.000 Z0.000 A23.534 B0.000 C-56.769           M90 D0.580           G1 X-1420.81 Y0.000 Z0.000 A22.657 B0.000 C-56.467           M90 D159 U92.440 (rel.speed.act=0.929; 2003.6)           M90 D2.000           G1 X-1420.813 Y0.000 Z0.000 A21.040 B0.000 C-55.425           M90 D2.000           G1 X-1420.813 Y0.000 Z0.000 A9.422 B0.000 C-55.434           M90 D2.000           G1 X-1420.814 Y0.000 Z0.000 A19.422 B0.000 C-54.384           M90 D2.000	
	Total         4         2 m 67.157 mm           Value         Value           Count         8           Size         L: 416.03 mm           Starts         Length         Pipe_220x10_           Cutting         2         2 m 786.572 mm           Detection         2         Total         4         2 m 786.572 mm	M90 D2.000           G1 X-1420.812 Y0.000 Z0.000 A23.534 B0.000 C-56.769           M90 D140.981           G1 X-1420.821 Y0.000 Z0.000 A23.534 B0.000 C-56.769           M90 D0.580           G1 X-1420.817 Y0.000 Z0.000 A22.657 B0.000 C-56.467           M90 D140.981           G1 X-1420.815 Y0.000 Z0.000 A22.657 B0.000 C-56.467           M90 D2.000           G1 X-1420.813 Y0.000 Z0.000 A21.040 B0.000 C-55.425           M90 D2.000           G1 X-1420.814 Y0.000 Z0.000 A21.040 B0.000 C-55.434           M90 D2.000           G1 X-1420.812 Y0.000 Z0.000 A17.804 B0.000 C-53.342	
	Total         4         2 m 67.157 mm           Value         Value           Count         8           Size         L: 416.03 mm           Starts         Length         Pipe_220x10_           Cutting         2         2 m 786.572 mm         Pipe_210x10_           Detection         2         Total         4         2 m 786.572 mm           Value         Value         Value         Value	M90 D2.000 G1 X-1561.802 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D140.981 G1 X-1420.821 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D0.580 G1 X-1420.821 Y0.000 Z0.000 A23.557 B0.000 C-56.467 M90 D159 IQ3.440 (rel.speed.act=0.929; 2003.36) M90 D2.000 G1 X-1420.813 Y0.000 Z0.000 A21.040 B0.000 C-55.425 M90 D2.000 G1 X-1420.813 Y0.000 Z0.000 A21.040 B0.000 C-55.425 M90 D2.000 G1 X-1420.813 Y0.000 Z0.000 A19.422 B0.000 C-54.384 M90 D2.000 G1 X-1420.812 Y0.000 Z0.000 A17.804 B0.000 C-53.342 M90 X199 IJ97.740 (rel.speed.act=0.959; 2095.54)	
	Total         4         2 m 67.157 mm           Value         Value           Count         8           Size         L: 416.03 mm           Starts         Length         Pipe_220x10_           Cutting         2         2 m 786.572 mm           Detection         2         Total         4         2 m 786.572 mm           Value         Count         1	M90 D2.000 G1 X-1561.802 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D140.981 G1 X-1420.812 Y0.000 Z0.000 A23.534 B0.000 C-56.769 M90 D0.580 G1 X-1420.815 Y0.000 Z0.000 A22.657 B0.000 C-56.467 M90 K159 U32.440 (rel.speed.act=0.929; 2003.36) M90 D2.000 G1 X-1420.813 Y0.000 Z0.000 A21.040 B0.000 C-55.425 M90 D2.000 G1 X-1420.813 Y0.000 Z0.000 A19.422 B0.000 C-54.384 M90 D2.000 G1 X-1420.814 Y0.000 Z0.000 A17.804 B0.000 C-53.342 M90 K159 U37.A0 (rel.speed.act=0.959; 2095.54) M90 D2.000	

Fig. 288: HTML cutting report

3D 2D Report Computation 9999 11 XPR300-MST- 10 000- 130-02+Air-3 Bevel	~	(mcam.info3 cut mode=Z_CONST B_CONST HORIZONTAL) (mcam.info3b no lead=Z_CONST B_CONST HORIZONTAL)
Cut path         Machine limits         Tool operations         Nesting / supports         Lead in/out	Measure Generate Intensity	<ul> <li>(mcam.info4 main-GENERAL mode=PLANE adapt=DISABLED head=2 (mcam.tech path_cut_data kerf:ON limitA= 76.0 AV=VM_AM HW= 4 (PART 'Pipe_220x10_test_nest_8_5' 4 2155254)</li> </ul>
Technology limits		(SIZE 1; 10 220; 416.028) (SIZE: CircleDine Thickness=10 Diameter=220: Length=/16.028)
Maximum angle between torch and material normal while cutting	76.0 deg	(mcam.expert.tool Operation 3. thickness= 10.00 speed= 2144.00
Angle limitation mode	Grinding will be required on A and	M108 X-2601.771 (1200) M6 T311 (CUT BEVEL A 3)
Maximum angle between torch and material normal while piercing	45.0 deg	G0 C-56.839
Beam lagging angle limitation		M94 D7 X-1492.994 M38 L-27.593 L26.433 (Corr A from B 30.0. Add=1.0)
Maximum angle between torch and material normal while cutting with beam lagging	g 20.0 deg	G0 X-1573.802 Y0.000 Z0.000 A0.669 B0.000 C-56.839 (setB=0.000)
Maximum weld preparation angle (torch axis material normal)	46.0 deg	M20 D2 M3
Cut path		M90 K159 L97.740 (rel.speed.act=0.977; 2095.54)
Additional kerf for holes (delta value) 0.00 mm		→ G1 X-1571.302 Y0.000 Z0.000 A11.454 B0.000 C-56.826
Inner angle limit for kerf compensation 30.0 deg		M90 K159 L90.295 (rel.speed.act=0.903; 1935.92)
Path generation mode	~	M90 D2.502
Planarchifting to normal (smooth sut)	-	G1 X-1568.802 Y0.000 Z0.000 A23.536 B360.000 C-56.771 M90 D5 000
Planar shirting to normal (smooth-cut) 20.00 mm	Line to normal (smooth-cut) 20.00 mm	
Planar shifting to normal per degree (automatic) 1.20 mm		M90 K147 L100.000 (rel.power.act=1.000; 130.00) M90 D2.000
Ignore YK edges		G1 X-1561.802 Y0.000 Z0.000 A23.534 B0.000 C-56.769
		G1 X-1420.821 Y0.000 Z0.000 A23.534 B0.000 C-56.769
Divide cut path		M90 D0.580
Limit angle for automatic cut path division 50.0 dog	M90 K159 L93.440 (rel.speed.act=0.929; 2003.36)	
Solit paths on II and Lorofiles		M90 D2.000
Tilting		M90 D2.000
Pre-tilting in corners of profiles		G1 X-1420.814 Y0.000 Z0.000 A19.422 B0.000 C-54.384 M90 D2 000
aximum change of angle per mm for pre-tilting 7 deg/mm		G1 X-1420.812 Y0.000 Z0.000 A17.804 B0.000 C-53.342
Post-processing on planar tilting None	~	M90 K159 L97.740 (rel.speed.act=0.959; 2095.54) M90 D2.000
		<
		Line: 5174 Q Search
<	>	

Fig. 289: Program configuration – used for CNC generation

## Simulation graphs

The watch panel includes the following tabs:

- Plot A-/B-/C-axes The tab displays information distilled from the generated CNC plan, namely angular coordinates of A-axis and B-axis (rotator axes) and C-axis (R-axis rotary positioner) to reveal unexpected and unwanted defects/mistakes in NC code by excessive, sudden deviation or changes of the coordinates. The angular positions of A and B axes are expressed in degrees with respect to path tangential distance in [mm]. Limitations of A-axis, B axis and C axis (R axis) are set in *machine limits* for each *machine* and *technology* (for more detailed information see section Machine limits on page 197).
- Plot speed / angle The tab provides graphical plot of percentage feed and the angle of normal to the material surface with respect to current location of the tool in terms of path tangential distance in [mm].
- Plot thickness Plot of effective material thickness [mm] versus path tangential distance [mm].
- Plot XYZ axis The tab displays information distilled from the generated CNC plan, namely coordinates of X-axis, Y-axis and Z-axis to reveal unexpected and unwanted defects/mistakes in NC code by excessive, sudden deviation or changes of the coordinates. The coordinates of X, Y and Z axes are expressed in millimeters.
- Plot delta axis first derivation, analogy of speed according to the distance
- Plot delta2 axis second derivation, analogy of acceleration according to the distance
- Plot XYZ axes (s) shows changes in X, Y and Z axes in time during cutting
- Plot A/B/C axes (s) shows changes in A, B and C axes in time during cutting
- Info This tab displays information about stock part, type of used rotator and source of shape type.
- Line context More detailed description of action performed within the current block.
- **Transformations** Auxiliary information about geometric transformations applied in the current block.
- **Debug info** Additional information useful for verification and debugging of the CNC program.
- **CSV** summary of all data from simulation in one table that can be copied and exported to excel for further analysis
- Errors

Ranges of horizontal and vertical axes in graphical plots are adjusted automatically. The cross-hair in the plot area displays coordinates assigned to the horizontal and left vertical axis. It is also possible to zoom—in a rectangular area of the plot by selection of the area by using the left mouse button. Zooming—out is performed by <Esc> key.

Keyboard arrows controls cutting simulation manually by setting the cursor on a selected location in the NC code. Use buttons below the CNC code and Blocks panel to move through the CNC code.

11	Pauses the simulation
	Moves automatically forward through simulation
	Moves through individual blocks (cuts) of simulation. Same as pressing the "-" key
▼	Moves through individual blocks (cuts) of simulation. Same as pressing the "+" key



Fig. 290: Cutting simulation features and functions

### **Blocks panel**

On the right side of the screen in Simulation is a new overview panel that displays individual blocks of cutting process. Each row in the table represents one cut from the cutting plan. For each cut, there are several columns, number of which changes in different simulations, depending on the properties of the cut and shape type. The columns depict useful summary about some CNC instructions and general information for each cut in the whole cutting plan. If the instruction is the same for every cut, this column will remain hidden.
List of possible columns in blocks panel:

- Id cut ID
- **Item** if there are more parts nested in the cutting plan, the number in this column represents to which part (in cutting order) the cut belongs to
- Item name if there are different kinds of parts nested, it shows the name of the part the cut belongs to
- **M94 D** shows the type of the instruction M94 (first number) used and number of measuring points (second number) e.g. 7:2 would mean M94 D7 was used with 2 measuring points
- **M94 K** further specifies measuring mode and shape type that has been determined by laser measuring
- Alignment (M94 D14) shows how are the holes aligned when the actual part has different dimension than CAD model
- M117 shows the type of the cut begin (first cut), hole (cut will not shorten the stock) or end (final part will fall off)
- M20 shows which type of M20 instruction is used
- M21 shows type of parking mode
- M6 shows which tool is used for each cut
- Cut off shows if the cut off is a waste or the final item
- **Supports** displays the position of supports (instruction M108)
- Remove (cut off part) shows if cut-off part needs to be removed manually (instruction M97)



Fig. 291: Blocks panel

# Settings

All settings that can be set up individually according to the machine configuration, user requirements, material and tools properties, and other production facilities can be found in: *File* – *Settings*.

The settings screen includes these subsections organised in tabs:

- Application
- Cut path
- Machine limits
- Tool operations
- Nesting / supports
- Lead-in/out
- Measure
- Generate
- Intensity
- Transformations
- Expert table
- Internal

### Settings controls and visual cues

Following section explains controls and visual cues used for better overview of changes done by user. mCAM settings work on different levels based on selected machine, technology or tool. There are some parameters in mCAM that are not linked to a specific machine but most of them are linked to machine, technology or tool based on their properties. It is best to change them according to their respective relevant level (e.g. machine limits are relevant to change for machine or specific technology, but can't be changed for individual tools).

Each machine connected to mCAM has its own set of parameters that can be adapted according to user requirements with respect to machine/technology/tool properties.

Settings screen is divided into three sections:

- 1. **Technology setup** technology setup level needs to be specified for settings that are linked to particular machine, technology or tool. Selected level affects availability of parameters that can be changed.
- 2. Configuration level is divided into several levels:

- *Default* read only, can't be changed. Contains default settings values set by mCAM. They are hard–coded in the source code of the program.
- *Machine* read only. Contains settings values loaded from the machine according to parameters selected in technology setup.
- Application on this level, individual parameters can be changed. Changes are applicable for whole application
- *Imports and Jobs* individual parameters can be changed. Changes are applicable only for selected import or job.
- 3. Actual settings is divided into 12 groups of parameters (<u>Application, Cut path,</u> <u>Machine limits, Tool operations, Nesting</u>
- 4. \_\_\_\_\_Subsection Nesting defines parameters regarding nesting of parts.
- **Nesting gap** represents the distance between individual parts. Nesting gap ignores lead-ins during the nesting so the gap must be larger than lead ins for parts.
- Use lead -ins/-outs and bottom contours in 2D nesting this parameter is used to prevent overlapping of adjacent parts caused by lead–in s/–outs or the bottom contours of these parts.
- Limited positioner Defines if machine has a limitation for range of rotation (usually set from -398° to 39°)
- Enable 1D envelope nesting allows to use simplified nesting process of parts that are enclosed by theoretical solid (i.e. pipes are enveloped by simple cylinders, H beam by simple cuboid, etc.)
- Enable common cut is a special feature that enables to employ cutting between two adjacent edges that can be cut simultaneously by a single cut. The method is applicable only for cutting technologies that provide equal cutting quality independent on the side of the tool. Common cut can be used only on circular pipes.
- Enable profile rotations and flipping if enabled, program will rotate and/or flip the material in the best position for cutting of the part.
- **Nesting time** sets maximum time that nesting will run to prevent the algorithm running indefinitely when searching for best solution.
- Precision of common cut detection specifies the value of precision of common cut.

Application	Cut path	Machine limits	Tool operations	Nesting	Supports and rests	Lead in/o			
Nesting									
• • 👢	Nesting ga	р	5.0	5.00 mm					
• • 👢	Use lead-ir	ns/-outs and botto	om contours in 2D	nesting 오					
• • 👢	Limited po	sitioner		Ο					
• • 👢	Enable 1D	envelope nesting		Ο					
• • 👢	Enable con	nmon cut		Ο					
• • 🕺	Enable pro	file rotations and	flipping	•					
• • 🐺	Nesting tin	ne		10	s				

#### Fig. 312: Nesting settings

5. Supports, *Lead in/out, Measure, Generate, Intensity, Transformations, Expert table,* <u>Internal</u>) that are described in respective chapters.

To help user track the changes in settings, mCAM uses **bold font** to easily see which settings differs from value loaded from previous configuration level.

Settings		Imported 1 🗵									
Application	Cut path	Machine limits	Tool operations	Nesting / suppor	Lead in/out	Measure	Generate	Intensity	Transformations	Expert table	Internal
Generate											
\$ \$ <del>\</del>	CNC usage	e		Cnc will be cut		$\sim$					
¢ ¢ 🛼	💠 💠 🐺 Supports positioning by CNC Yes (automatic verification) 🗸										
\$ \$ <del>]</del> .	🗧 🔄 🖳 Automatic material/lunette positioning by CNC 🛛 No material/lunette positioning 🛛 🗸										
\$ \$ <b>D</b>	Use M121			Use on mesh		$\sim$					
\$ \$ N	Collision	limitations on dom	es								
C axis move	ments										
\$ \$ <del>0</del>	Default m	ode for cutting circ	le pipe	[	Moving in XYZC a	(es	~				
\$ \$ >\<	Default m	ode for cutting bea	ms	[	Static cutting (on	supports/r	ollers) 🗸 🗸				
\$ \$ <del>\</del>	Linearize	C-axis movements	on profile corners v	vithout rotator [							
\$ \$ <del>\</del>	Prefer to	use the same C-axis	constant value for	cuts on one hole	2						
Straight cutting											
\$ \$ <del>\</del>	Max angle	e between torch an	d material normal f	or straight cut 6.0	deg						
\$ \$ <del>0</del>	Max A to i	gnore B		4.0	deg						
Ordering											
<b>\$</b>	Marking-o	utting changeover	Pause after n	narking	$\sim$						
<b>\$</b>	Item finis	hing mode	Finish whole	plan (mark all part	) ~						
\$ \$ <u>&gt;</u> <	Thermal r	node	No thermal s	orting	$\sim$						
\$ \$	Start poir	nt of plate CNC prog	ram At X min and	Y min	$\sim$						
\$ \$	Movemen	t at program end	No movemen	t	$\sim$						
Parking mod	de										
\$ \$	Global pa	rking mode	Full park	ing	$\sim$						
\$ \$ <del>0</del>	Global pa	rking mode in mar	king text No parki	ng	$\sim$						
Short distar	nce parking	g mode									
💿 🔄 🐺 Maximum distance of two sequential cuts 50.00 mm											
\$ \$ <del>\</del>	Parking m	node	Full	parking	~						
						_					

Fig. 292: Settings displayed with bold font were changed by user

Changes can be easily reverted to original value by using buttons to the left of each parameter:

Button	Description
÷	Use inherited value – uses the value from previous higher configuration level
<b>¢</b>	Revert all changes to start editing value – uses value that was set at the start of application
*	If this button is <u>not</u> greyed out, it indicates, that on some lower technology setup level are more specific values (e.g if machine is selected, more specific values can be on technology or tool level).

## Application

Subsection *Application* includes information used in user reporting such as report destination URL (sending location), user mail address, customer name.

- All files open dialogs share one current directory enables to open all files, reports, CNC codes, jobs, libraries, etc. from the same directory which increases efficiency and reduces the time of cutting plan preparation. This directory path is saved after every positive opening/loading/saving of file/job/CNC code.
- Plan save folder default folder for saving generated plans
- **Make a file preview** enables a preview of listed parts in folder Directories in *Master panel* which can be inefficient when working with hundreds of parts.
- Open simulation on CNC file

Subsection *Application restart required* contains settings that require program restart to be applied (Language, Inverse mouse wheel zoom, etc.)

- Web Service defined the connection to machine via *WebService* application. *WebService* code is defined by machine number: msnc500wxxxx, where xxxx is number of machine. Machine *WebService* connection is described in more details in section WebService or Virtual machine on page 194.
- Keep Import opened after the restart the function automatically recovers opened *Import* with all imported files in case that program needs to be restart after program freeze or crash.
- **Inverse mouse wheel zoom** is used to define behaviour (direction) of mouse wheel for zooming–in and zooming–out.
- Enable access to MPM enables/disables connectivity to MPM.
- Enable access to Machine WebService enables/disable connectivity to machine via *WebService* application.

- Shared configuration folder defines a directory in company network for sharing all application configurations. Directory of shared folder has to be accessible and writeable (all rights/permissions need to be allowed for all users).
- **Simulation animation level** depending on the performance level of a computer it is possible to adjust detail of simulation generation:
  - $\rightarrow$  *No animation* colors of cut path are not changing
  - $\rightarrow$  Cut path animation colors are changing for whole cut path at once
  - $\rightarrow$  Cut point animation colors of cut pat in simulation are changing for each individual cut point.

Subsection Virtual machine type contains settings that define type of the Virtual machine, technology number and number of tools. Virtual machine settings are described in more details in section mCAM setup for virtual machine.

Settings		Imported 1 🗵									
Application	Cut pat	h Machine limits	Tool operations	Nesting / supports	Lead in/out	Measure	Generate	Intensity	Transformations	Expert table	Internal
Application											
Target U	JRL for re	port									
User e-i	mail addr	ess									
Custom	er name										
All file of	open dialo	ogs share one curre	nt directory 🗌								
🔶 Plan sa	ve folder										
Aake fil	e preview		$\checkmark$								
Application	restart re	quired									
Web servic	e										
Machine	number	Computer name	Web service	EkoInfo	MPM						÷
		msnc500ww64	Enabled	Disabled	Disabled						-
			E I'- h								
Cangua	ge		English		~						
< Keep in	iport ope	ned after applicatio	on restart 🗹								
<ul> <li>Inverse</li> <li>Enable</li> </ul>	mouse w	neel zoom									
Crable	access to	MPM	. 0								
Change	access to	Machine web servic	e 🗹								
Shared	configura	tion folder	Cut point	animation							
Simulat	tion anim	ation level	cut point	ammation	~						
-Virtual mac	hine type		Nono								
< Virtual	macrime i	ype fan sústand som skisse	1			~					
<ul> <li>Number</li> <li>Anachine</li> </ul>	r or tools	or virtual machine	1								
A Techard	e technol										
<ul> <li>Technol</li> <li>Technol</li> </ul>	logy for d	ritt (15,0)									
Iechno	logy for A	SCII Writer (18,0)	U								

Fig. 293: Application settings

#### EkoInfo

EkoInfo stands for economical information and when enabled, the user can access the Ekoinfo service on machine directly from mCAM. EkoInfo is activated or deactivated for each machine in mCAM separately by manually rewriting the corresponding cell in Web Service table in Settings->Application to enabled/disabled. Alternatively, the corresponding number can be written in the cell – 0 for disabled and 1 port for enabled. Default port is 80.

Settings		Imported 1 🗵									
Application	Cut pa	th Machine limits	Tool operations	Nesting / supports	Lead in/out	Measure	Generate	Intensity	Transformations	Expert table	Internal
Application Target U User e-n Custome All file o Plan sav Make file Application	IRL for re nail add er name pen dial ve folder e previev restart r	port ress ogs share one curre v equired	nt directory								
Machine	number	Computer name msnc500ww64	Web service Enabled	Ekolnfo Enabled	MPM Disabled						4

Fig. 294: Ekoinfo enabled

Ekolnfo reports are accessed via Simulation menu in Simulation screen. The list contains all machines that have Ekolnfo enabled in Settings. If none machine has Ekolnfo enabled, the list will be empty.



Fig. 295: List of machines with enabled EkoInfo to access EkoInfo reports

Clicking on a particular machine opens a browser and EkoInfo page with reports containing information about used technology, cutting time, prices for cutting, material, waste and other information that user can download and inspect.

Ekolnfo	Preview				
Economic evaluation	<del>17-</del>				
Upload					
Preview	Pipe_220x10_t	est_nest_8_8 + 7.cnc			
Standard report	Material:		Specification:	*	Thickness: 0 mm
Detailed report	Use CNC s	izes (0 x 0 mm)			
Preview report	Use minimu	um sizes (2940 x 0 mm)			
Parameters	🔍 Use user de	efined sizes	X: 2940.45: Y: 0		
Machine	Technology	HD plasma		<b>.</b>	
Technology	T11	поразна			
Technology parameters		H130-MST- 10.000- 13	0-O2+Air-13 Bevel	•	
Materials	Fixed price	0	EUR		
Materials Technology Parameters	Park type	Full 🔻			
Application					
Password change	Selection fr	rom group			

Fig. 296: EkoInfo page with reports

### **Cut path**

Subsection *Technology limits* defines maximum angles used for cutting and marking:

 Maximum angle between torch and material normal while cutting [°] – upper limit of the normal angle of a material surface with respect to the vertical imposed to respect angular restrictions of bevel cutting following from applied technology (applied plasma torch tip, laser nozzle or water–jet nozzle).



Fig. 297: Maximum angle between torch and material normal while cutting

• **Angle limitation mode** – defines the type of the angle limitation mode that is applied on paths that are limited by *mCAM* due to angle limitation of the machine and the



technology (default value is set approximately to 45 degrees which is the limit value of the angle between torch axis and material normal in the process of plasma cutting.

Fig. 298: Angle limitation modes

• Maximum angle between torch and material normal while piercing [°] – the parameter defines maximum possible angle between the tool and a material normal where it is allowed to perform piercing.



Fig. 299: Maximum piercing angle between material normal and torch

• **Beam lagging angle limitation** – this option should be checked when cutting with laser in certain direction (shown in red zone in). It activates angle limitation to ensure that the whole material is cut through



Fig. 300: Direction of cutting (red zone) requires angle limitation due to the beam lagging

- Maximum angle between torch and material normal while cutting with beam lagging defines the maximum angle between torch and material normal where the limitation is not necessary.
- Maximum weld preparation angle (torch axis/material normal)

Subsection *Cut path* contains parameters that defines cutting path settings and properties:

 Additional kerf for holes (delta value) [mm] – this parameter defines total value of diametral difference of cutting beam (kerf width – defined in expert system) while cutting inner and outer contours. It is commonly used to compensate the difference between kerf width of all inner and outer contours.



Fig. 301: Delta kerf width for inner contours

- Inner angle limit for kerf compensation [°] defines the limit angle of an inner contour that ensures precise generation of kerf compensation. Limit angle can be set on much lower values (e.g. 0°) but this may cause a significant extension of generation time.
- Path generation mode defines the default path generation mode that is applied on all newly imported parts. Path generation mode can be set on every cut-path individually. Characterization of all path generation modes is described in the section Path generation mode on page 144.
- Planar shifting to normal (smooth-cut) [mm] defines the length of the upper cutpath contour of straight cutting edge at which the tool moves from bevel position to the position of the material normal (if possible) and continues with straightened tool. Parameter is applied only when using *Smooth-cut path generation mode*.



Fig. 302: Minimal length for torch shifting to material normal on planar surface

- Planar shifting to normal per degree (automatic) [mm] defines the length of the upper cut-path contour at which the tool moves from bevel position to the position of the material normal (per 1 degree) and continues with straightened tool. Parameter is applied only when using *Automatic path generation mode*.
- **Ignore Y, K edges** the option is used to ignore unwanted edges (mostly Y and K edges but also X edges) identified by *mCAM* but not intended for cutting.
- K-factor (location of neutral line) K-factor is a term used for bending in metal industry and refers to the ratio of location of the neutral line to the material thickness as defined by t/T where t = location of the neutral line and T = material thickness (http://www.wikipedia.org). The neutral line is a theoretical line in the metal sheet profile that does not change its length even after the forming process or the unfolding process. The value is from the interval <0,1>, where value= 0 represents radius of the neutral line on the inner surface and value= 1 represents the radius at the outer surface. This parameter is important in cases, where the work–pieces (round pipes with large dimensions, e.g. with radius + 1 m) need to be unwrapped and cut as the sheet work–piece. The value of the parameter can be find from empiric experience and in general it is specific for each material and thickness. It includes the impact of factors affecting the location of neutral line.



Fig. 303: Definition of K-factor for bending (http://www.wikipedia.org)

Subsection *Divide cut path* contains parameters that defines presets of cut path dividing and used cutting mode on U–beams:

- **Divide cut paths on non–linear edges** enables/disables automatic division of cutting paths on non–linear edges according to set limit angle.
- Limit angle for automatic cut path division [°] defines the limit angle of outer contour (outer edge) for automatic cut path division.



#### Fig. 304: Split cutting path

• Split paths on U-profile – enables/disables automatic advanced cutting path splitting on U-profiles to provide better detailed quality on complicated features near the beam edge (profile radius). This function allows to avoid overburnt of the material by the plasma beam.



#### Fig. 305: Split paths on U-beam

Subsection *Tilting* contains parameters that define pre-tilting speed limit in advanced type of pre-tilting in corners of profiles (rectangular shaped pipes):

- **Pre-tilting in corners of profiles** enables/disables pre-tilting in corners of profiles.
- Maximal change of angle per mm for pre-tilting defines the maximal angle speed limit applied by pre-tilting. This function allows to avoid overburning the material by plasma or laser beam in profile corners by linear pre-tilting of cutting contour.
- Post-processing on planar tilting
  - $\rightarrow$  None
  - $\rightarrow$  Linear
  - $\rightarrow$  Cubic



Fig. 306: Cutting path – without pre-tilting in corners



Fig. 307: Cutting path – with pre-tilting in corners

Settings		Imported 1 🗵									
Application	Cut path	Machine limits	Tool operations	Nesting / supports	Lead in/out	Measure	Generate	Intensity	Transformations	Expert table	Internal
Technology	limits										
¢ ¢ 봊	Maximum a	angle between tor	ch and material noi	mal while cutting		45.0 deg					
\$ \$ <u></u>	🕫 💿 🧏 Angle limitation mode Grinding will be required on A and V cuts 🗸										
\$ \$ <del>.</del> .	Maximum a	angle between tor	ch and material noi	mal while piercing		45.0 deg					
\$ \$ <del>.</del> .	Beam laggi	ng angle limitatio	on								
\$ \$ <del>\</del>	Maximum a	angle between tor	ch and material noi	mal while cutting with	h beam lagging	20.0 deg					
\$ \$ <del>.</del>	Maximum	veld preparation a	angle (torch axis ma	aterial normal)		46.0 deg					
Cut path											
\$ \$ <u></u>	Additional	kerf for holes (de	lta value)	0.00 mm							
\$ \$ \$	Inner angle	e limit for kerf con	npensation	30.0 deg							
\$ \$ \$	Path gener	ation mode		Automatic		$\sim$					
\$ \$ \$	Planar shif	ting to normal (sn	nooth-cut)	20.00 mm							
\$ \$ \$	Planar shif	ting to normal pe	r degree (automatio	:) 1.20 mm							
\$ \$ \$	Ignore YK e	edges									
\$ \$ <b></b>	K-factor (lo	ocation of neutral	line)	0.500							
Divide cut p	ath										
\$ \$ <u>&gt;</u>	Divide cut	paths on non-line	ar edges 🛛 🗹								
\$ \$ <del>\</del>	Limit angle	for automatic cu	t path division 50.0	deg							
\$ \$	Split paths	on U and L profile	es 🗌								
Tilting											
\$ \$ <del>\</del>	Pre-tilting	in corners of prof	iles								
🔄 🔄 🗏 Maximum change of angle per mm for pre-tilting 7 deg/mm											
\$ \$ <del>\</del>	Post-proce	essing on planar ti	ilting	None		$\sim$					

Fig. 308: Cut path settings

### **Machine limits**

This tab contains parameters that impose limits of motion on operating range of the machine motion axes. Machine motion limits are intended to prevent collisions between a tool and any part of the machine and define the operating range of the machine, or to impose practical limitations following from the machine control system.

Subsection Machine limits contains these parameters:

- **Minimum Z [mm]** motion limits of Z-axis are usually defined in the servo parameters. The limits define overall range of the axis travel. In case of bevel cutting, depending on the machine kinematics, movement of Z-axis can also be used. The minimum limit can be used to override the setting.
- Minimum A for cutting [°] (tilting axis) defines the minimum value of A-axis bevel angle for cutting.
- Maximum A for cutting [°] (tilting axis) defines the maximum value of A-axis bevel angle for cutting.
- Minimum A for marking [°] (tilting axis) defines the minimum value of A-axis bevel angle for marking.
- Maximum A for marking [°] (tilting axis) defines the maximum value of A-axis bevel angle for marking.



Fig. 309: Maximum A axis angle for cutting and marking

- Minimum B [°] (azimuth axis),
- Maximum B [°] (azimuth axis),

- Minimum R [°] (rotary positioner),
- Maximum R [°] (rotary positioner).
- B axis speed limit the parameter defines the limitation of B-axis speed in degrees per 1 millimeter (°.mm<sup>-1</sup>) that is used for backward rotation of rotator B-axis. Backward rotation of B axis is used to reduce cumulative rotation of B axis at low degree of A-axis (this limitation value of A-axis is defined in parameter Max A to ignore B. This function is useful especially in cutting paths where cumulative values of B-axis could reach the limit values (which is defined approximately on 400°– depends on type of the CNC machine).

Subsection Machine layout defines the parameter:

- **Chuck location (X-min/ X-max)** defines position and orientation of clamping device for the work–piece with respect to the machine coordinate system.
- **Rest type** specifies the machine type in order to define whether machine has rest or it uses standard rotary positioner.
- **Rotator geometry** defines the geometry of particular rotator that is applied in limitation processing and generation of *CNC program*.

Settings		Imported 1	×					
Application	Cut path	Machine lin	nits	Tool operations	Nesting / supports	Lead in/out	Measure	Generate
-Machine lim	its							
\$ \$ <del>\</del>	Minimum Z -1000.00 mm							
¢ ¢ 봊	Minimum A	for cutting	-45.0	0 deg				
¢ ¢ 봊	Maximum /	A for cutting	45.0	deg				
¢ ¢ 🐺	Minimum A	ofor marking	-45.0	0 deg				
¢ ¢ 봊	Maximum A for marking 45.0 deg							
\$ \$ <del>\</del>	Minimum E	3	-720	.0 deg				
\$ \$ \$	Maximum B	3	720.	0 deg				
\$ \$ \$	Minimum F	R	-400	).0 deg				
\$ \$ \$	Maximum I	र	400.	0 deg				
\$ \$ \$	🗇 🐺 B axis speed limit 🛛 18 deg/mm							
Machine lay	out							
🗢 🔄 🕂 Chuck location 🛛 At X min								
\$ \$	Rotator ge	ometry Plas	ma ro	otator 45 degrees (t	ype R5)		~	

Fig. 310: Machine limits

### **Tools operations**

This subsection contains definitions of tool operation codes used for specific operation (*straight cutting, bevel cutting, marking, etc.* or quality-oriented cutting as *Large contours, Medium contours, Q1, Q2,* etc.). One row in *tool operation type* table represents one column in *iMSNC table of cutting parameters*.

Each tool number consists of two numbers. First number  $(T\underline{x}11)$  of each tool code represents the operation (row of cutting parameters in iMSNC), known also as group of technological parameters. Second number of each tool  $(T1\underline{xx})$  code represents technology number (plasma – 11, laser – 17, waterjet – 14, oxy–fuel – 12, etc.). Tool operations are described in more details in section Tool operations)

Settings	Importe	ed 1 🗵												
Application Cut	path Machi	ne limits	Tool operations	Nesting / sup	oport	s	Lead	l in/out	Measure	Generate	Intensity	Transformations		
Tool operations type							Tool operations quality							
🔶 💠 某 Ope	eration 1 type	Straight c	ut	$\sim$	$\langle \Rightarrow$	$\diamond$	ֿ	Operatio	on 1 quality	Undefined		~		
🗢 🗢 💻 Ope	eration 2 type	Bevel cut	top (V-cut)	$\sim$	$\Leftrightarrow$	$\Leftrightarrow$	ֿ	Operatio	on 2 quality	Undefined		~		
🔶 🔶 💻 Ope	eration 3 type	Bevel cut	bottom (A-cut)	~	$\Leftrightarrow$	$\Leftrightarrow$	*	Operatio	on 3 quality	Undefined		~		
🔶 🔶 💻 Ope	eration 4 type	Marking +	Text marking	~	$\Leftrightarrow$	$\Leftrightarrow$	罞	Operatio	on 4 quality	Undefined		~		
🔶 🔶 💻 Ope	eration 5 type	Punching		~	$\Leftrightarrow$	$\Leftrightarrow$	≚	Operatio	on 5 quality	Undefined		~		
🔶 🔶 💻 Ope	eration 6 type	Quality h	ole cutting (THT/CC)	~	$\Leftrightarrow$	$\Leftrightarrow$	≚	Operatio	on 6 quality	Undefined		~		
🔶 🔶 💻 Ope	eration 7 type	Undefine	d	~	$\Leftrightarrow$	$\Leftrightarrow$	≚	Operatio	on 7 quality	Undefined		~		
🔶 🔶 💻 Ope	eration 8 type	Undefine	d	~	$\Leftrightarrow$	$\Leftrightarrow$	枼	Operatio	on 8 quality	Undefined		~		
🔶 💠 봊 Ope	eration 9 type	Undefine	d	~	$\langle : :$	$\Leftrightarrow$	¥	Operatio	on 9 quality	Undefined		~		

Fig. 311: Tool operation settings – tools

### Nesting

Subsection Nesting defines parameters regarding nesting of parts.

- **Nesting gap** represents the distance between individual parts. Nesting gap ignores lead-ins during the nesting so the gap must be larger than lead ins for parts.
- Use lead -ins/-outs and bottom contours in 2D nesting this parameter is used to prevent overlapping of adjacent parts caused by lead–in s/–outs or the bottom contours of these parts.
- Limited positioner Defines if machine has a limitation for range of rotation (usually set from -398° to 39°)
- Enable 1D envelope nesting allows to use simplified nesting process of parts that are enclosed by theoretical solid (i.e. pipes are enveloped by simple cylinders, H beam by simple cuboid, etc.)
- Enable common cut is a special feature that enables to employ cutting between two adjacent edges that can be cut simultaneously by a single cut. The method is

applicable only for cutting technologies that provide equal cutting quality independent on the side of the tool. Common cut can be used only on circular pipes.

- Enable profile rotations and flipping if enabled, program will rotate and/or flip the material in the best position for cutting of the part.
- **Nesting time** sets maximum time that nesting will run to prevent the algorithm running indefinitely when searching for best solution.
- Precision of common cut detection specifies the value of precision of common cut.

Application	Cut path	Machine limits	Tool operations	Nesting	Supports and rests	Lead in/out
Nesting						
* * 🐺	Nesting ga	р		5.0	00 mm	
• • 💺	Use lead-ir	ns/-outs and botto	om contours in 2D i	nesting 😒		
• • 👢	Limited po	sitioner		0		
• • 😾	Enable 1D	envelope nesting		0		
• • 💺	Enable con	nmon cut		$\Box$		
• • 💺	Enable pro	file rotations and	flipping	•		
• • 🐺	Nesting tin	ne		10	S	
Common cu	t					
• • •	Precision o	of common cut det	ection 3.00 mm			

Fig. 312: Nesting settings

### Supports and rests

Subsection Supports and rests defines parameters of clamping system and system of supports. It was optimized in mCAM 1.5 to make the utilization of supports more effective. Supports are used on long profiles to prevent bending of the material, to maintain precision of cutting and to ensure that the cut-off parts that can't drop freely to the ground will be removed safely. The minimal length of profiles when supports have to be used varies depending on the characteristics of the material (dimensions, mechanical properties). Generation of supports is activated in <u>Settings->Generate->Supports positioning by CNC</u>.

Described below are various settings available in mCAM that specify the usage of supports. They are located in Settings -> Nesting/Supports.

- **Support placement** to increase the stability it is possible to support hanging parts of the stock material.
  - $\rightarrow$  Support only cut area only the area around cut is supported
  - → Support cut area and outer part this option is for machines that have special supports (props) that supports inner part of the semiproduct

- → Support cut area, outer and inner part if only two supports are available and one is used to support cut area, the other one supports the free end of the pipe (outer part) preferably
- **Support cut-off part** tells whether cut-off part should be supported with two supports or not at all.
- **Chuck length [mm]** defines the length of semi–product that is clamped in the chuck.



#### Fig. 313: Chuck length

- Number of all supports defines the number of all supports used for generated CNC programs. (automatic and non-motorized). Since there are different kinds of supports for pipes and for profiles and it is possible to have different quantity of supports for pipes as for beams, it is necessary to adjust the number each time based on a shape that is being cut.
- **Number of motorized supports** how many supports from all supports are motorized. Motorized supports have its own motor and reposition themselves automatically.
- Support rails min minimal length of support rails
- Support rails max maximal length of support rails
- Support cylinder width length of support cylinder
- Support blocked area for cutting X+ [mm] distance from a cut in the direction of X+ where cutting is not possible due to the danger of collision between support and cutting head.

• Support blocked area for cutting X- [mm] – distance from a cut in the direction of Xwhere cutting is not possible due to the danger of collision between support and cutting head.



#### Fig. 314: Blocked areas for cutting X+ and X-

- Has deflector tells if machine has deflector
- Length of gripped part
- Length of support base [mm] defines the length of the base of each support (length of support placed on rails). This value is important to prevent collision between two supports.
- Offset of support base
- Length of support up [mm] defines length of the support
- Offset of support up



length of support base

Fig. 315: Length of support and support base

- Maximum support-support distance [mm] defines maximum distance between two consecutive supports. This value should respect mechanical properties of manufactured materials (compressive strength and elasticity).
- **Maximum support-cut distance** defines maximum distance between cut and support to ensure the best precision of cutting. This value should respect mechanical properties of manufactured materials (compressive strength and elasticity) to prevent bending of the material.



Fig. 316: Maximum support-cut distance

- Min length of the cut-off part to be supported with two supports defines minimum length of cut-off section that has to be steadily supported with two supports so it does not fall-off
- Min length of the cut-off part that must be manually removed defines the shortest length of a part that should not drop freely to the ground. Any cut-off part that is longer that this value will be supported with support/s so it can be safely removed.
- **Support-End of profile distance [mm]** defines maximum distance between end of the profile and closest support while cutting.
- Sort cuts in groups for compact support positioning enables/disables sorting of all cuts to groups in order to reduce number of repositioning the supports while cutting.



Fig. 317: Min length of the cut-off part to be supported with two supports



#### Fig. 318: Support-End of profile distance

Settings	🔋 Imported 1 🛛								
Application Cut	path Machine limits	Tool operations	Nesting / suppo	orts	Lead in/out	Measure	Generate	Intensity	
Nesting									
🔶 🔄 🖳 Nest	ing gap 5.00 mm							]	
-Supports and rest	ts								
🔄 🔄 🖳 Supp	ort placement			Supp	port only cut a	area	~		
🔶 🔄 🖳 Supp	ort cut-off part			Do n	ot support cu	t-off part	~	]	
💠 💠 🖳 Chuc	k length			330.0	)0 mm			]	
🔶 🔄 💆 Num	ber of all supports			2				]	
🔶 🔄 💆 Num	ber of motorized suppo	orts		0				]	
💠 🔄 🖳 Supp	ort blocked area for cu	tting X+		600.0	00 mm			]	
💠 🔄 🖳 Supp	ort blocked area for cu	tting X-		600.0	00 mm			]	
🔶 🔶 🖳 Leng	th of support base			500.0	00 mm			]	
🔶 🔄 🖳 Leng	th of support			70.00	) mm			]	
🔶 🔄 🖳 Maxi	mum support-support (	distance		3000	.00 mm			]	
🔶 🔄 🖳 Maxi	mum support-cut dista	nce		1100	.00 mm			]	
🔄 🔄 🖳 Min l	ength of the cut-off par	t to be supported w	ith one support	1200	.00 mm			]	
🔶 🔶 🖳 Min l	ength of the cut-off par	t to be supported w	ith two supports	1200	.00 mm			]	
💠 🔶 🐺 Min l	🔄 🔄 🐺 Min length of the cut-off part that must be manually removed 🛛 1000.00 mm								
	cuts in groups for comp	act support positio	ning						

Fig. 319: Nesting/supports settings

# Lead in/out

Lead-in/out tab contains definition of default parameters of lead ins and lead outs that are applied during import of parts. The parameters are defined separately for different situations identified according to machining requirements.

Lead-ins/-outs are set according to type of particular cut. *mCAM* recognizes different types of cuts and automatically apply predefined lead – in/–out:

- **Convex corner** defines the type of lead-in/-out based on location of the lead-in/out on the contour in this case on the convex corner of the cut
- **Contour** defines the type of lead-in/-out based on location of the lead-in/out on the contour in this case on the contour besides the convex corner.
- **General contour** cutting a generally opened contour with possibly different starting and ending points (non-cyclical cut)
- Slot narrow gap that is cut by one single cut
- Flange cut this type of contour represents cut (e.g. H-beam trim cut), where ignition needs to be performed near the flange edge. Flange cut on beams (H/ U/ L-beam) requires a special type of lead-in to cutting contour (slide edge) that begins and ends on the edge and its lead-in /-out needs to be performed by slide edge (cross-section of I-beams, U-beams, H profiles).
- Web cut this type of contour represents cuts, where ignition needs to be performed on web near the flange from inner side. Web cut of beam (H/ U/ L-beam) requires a special type of lead-in to cutting contour (web lead) that begins in the material normal position, continuously bevels to limit position and ends in the limited position of cutting contour.
- Welding represents welding cutting contours

Convex corner	Contour	General contour
Slot	Flange cut	Web cut
Welding		

Each section contains several parameters for setting the lead in/out:

- Type based on the selected type, other parameters are active or not
- Base length set by user
- Thickness multiplier multiplies the material thickness by set number
- **Tangential angle** the angle between a lead-in /-out and a tangent vector (applies for all types of linear lead-ins/outs)
- Section angle the angle between the sections for linear type with two identical sections (applies for linear lead-in/out with 2 sections)
- Tool orientation

The final length of lead-ins/out is calculated as <u>base length plus (thickness multiplier times</u> <u>thickness of the material.</u>) Thickness of the material is base thickness not effective cutting thickness.

For small holes or cases when the lead in/out does not fit inside of the hole, the lead in will begin in the middle of the hole, regardless of what is set as default in settings.



Fig. 320: Lead-ins on small holes begin in the center of the hole

There are several types of lead-ins/-outs in mCAM:

- none
- path conforming
- path conforming & linear
- linear (1 section)
- linear (2 sections)
- arc (90 deg)
- arc (180 deg)
- in profile axis this method is used when lead-in/-out needs to be performed in X axis of profile, especially on H-beams while cutting Web section
- Slide edge this method is used in cases of cross-section cuts of I-beams, H-beams, Uprofiles, etc. where lead-in s/-outs have to be performed on the edge of the part (slide on the edge)
- **Web** this method is used in all Web-cuts on H-beams where ignition near the flange from inner side is required. A tool starts in the straight position (in normal to material) followed by continuous bevelling to limit position near flange

✓ Tool path #5			
Path generation mode	Automatic	$\sim$	
Kerf compensation			
Marking			
Cutting			1 m m
Transformations			
Layer	Automatic transformation	$\sim$	
Laser operations	Large contours	$\sim$	
Waterjet operations	Q5	$\sim$	
🗌 Stop (M0) before cuttin	ng		
User order			
Normal limit			
Y Technology modification:	s		
User speed	100%		
Microjoints			
∨ Lead-in			
Туре	None	$\sim$	
✓ Lead-out			
Туре	None	~	

Fig. 321: Lead-in none, lead-out none on gap cutting contour



Fig. 322: Lead-in path conforming, lead-out path conforming



Fig. 323: Lead-in path conforming & linear, Lead-out path conforming & linear

<ul> <li>Tool path #5</li> <li>Path generation mode</li> <li>✓ Kerf compensation</li> <li>Marking</li> <li>✓ Transformations</li> <li>Layer</li> <li>✓ Cutting</li> <li>Laser operations</li> <li>Waterjet operations</li> <li>User order</li> <li>Microjoints</li> </ul>	automatic   automatic transformation   Large contours   Q5	11111
Start position  4 Lead-in Shape Length	286 pick reset	
Tangential angle Tool orientation	0.0 deg bevel •	
Shape Length Tangential angle	linear (1 section)	
Tool orientation	bevel •	
		Z Y X

Fig. 324: Lead-in linear (1 section), Lead-out linear (1 section)



Fig. 325: Lead-in linear (2 section), Lead-out linear (2 section)



Fig. 326: Lead-in arc (90 deg), Lead-out arc (90 deg)



Fig. 327: Lead-in arc (180 deg), Lead-out arc (180 deg)



Fig. 328: Lead-in edge slide, Lead-out in profile axis

Tool path #15			
Path generation mode	automatic 🔹		
Path alignment	stretch 🝷		
<ul> <li>Kerf compensation</li> </ul>			1
Marking			ć.
✓ Transformations			
Layer	automatic transformatio 🔻		
Cutting			
Laser operations	Large contours 🔹		
Waterjet operations	Q5 🗸		
User order			
Microjoints			
Start position	0		
▲Lead-in	reset		
Shape	web lead 🔻		
Length	15.00 mm		
▲Lead-out			
Shape	in profile axis •		
Length	15.00 mm		
Tool orientation	bevel 🔻		
Reversed			
1			
		Y	
			4

Fig. 329: Lead-in Web lead, Lead-out in profile axis

Depending on tool orientation, the lead-in s/-outs can be performed in four different ways:

- **Bevel** a tool is maintained in a bevelled position and enters/leaves a contour with corresponding tilt angle
- **Straight** –a tool is kept in the straight position and bevelling is performed only at the points of entry and departure of a contour suitable only for straight cutting heads
- Straight to bevel 1 a tool starts / finishes in the straight position (in normal to material) followed / preceded by continuous bevelling, bevelling takes place in the middle of lead–in /–out path
- Straight to bevel 2 a tool starts / finishes in the straight position followed / preceded by continuous bevelling, bevelling takes place in the last third of lead–in /first third of lead–out path



Fig. 330: Tool orientation – bevel

Tool path #5 Path generation mode ♥ Kerf compensation Marking ♥ Transformations Layer ♥ Cutting Laser operations Waterjet operations	automatic automatic transformation Large contours QS	•	1111111
Microjoints	-	_	
Start position	286 Di	CK ot	
Shape Length	linear (1 section) 10.00 mm	•	
Tool orientation	o.u deg		
Lead-out			
Shape	none	•	
			z

*Fig. 331:Tool orientation – straight (not suitable on bevel cuts)* 



Fig. 332:Tool orientation – straight to bevel 2

corner						
	Lead-in		Lead	l-out		
	o o J Type	Linear (1 section)	6	6 .	Type	Linear (1 section)
	A A I longth	0.00 mm	6		Longth	0.00 mm
		4.000		× 2		
	C C K Length multiplie	r 1.000	4	Q >	Length multiplie	r 1.000
	🔄 🔄 🕺 Tangential angle	0.0 deg	$\langle : $	\$	🖳 Tangential angle	0.0 deg
	💠 🄄 🧏 Check collision			\$	👢 Check collision	
	👌 🔄 🐣 Section angle		\$	¢ .	Section angle	
		Ctraight to house 2	4	4		Daviel
	C C K Iool orientation	Straight to bevel 2	Ģ	0	lool orientation	Bevei
ır						
	Lead-in		Lead	l-out		
	🗢 🗢 🐺 Type	Arc (90 deg) v	4	\$	Type	Path conforming
	A A I Longth	0.00 mm	15	A	Longth	6 00 mm
	ve ve sig tength			A. 5	e cengen	4.00 mm
	Length multiplie	r 1.000	¢	\$	Length multiplie	r 0.000
	🔄 🔄 🖳 Tangential angle		$\langle \diamond \rangle$	\$	🖳 Tangential angle	
	🗢 🔄 🐺 Check collision		4	4	Check collision	
	C C Sortion and a		6	Δ.	Section angle	
	Je Section angle			V- 2	Section angle	
	Colorientation	Straight to bevel 2 🗸	4	¢ ;	Tool orientation	
contour						
	Lead-in		Lead	l-out		
	🔄 🤄 🖉 Type	None	4	<b>4</b>	Type	Linear (1 section)
	A A PK Hype			• •		
	Contraction Contraction Contraction		4	\$ ×	👯 Length	3.00 mm
	🔄 🤄 🖳 Length multiplie	r	$\langle \Rightarrow$	\$	🖳 Length multiplie	r 0.000
	🗢 🔄 🐺 Tangential angle		4	\$	🐰 Tangential angle	0.0 deg
	Chock collision		6	Δ.	Check collision	
				Y* 2		
	🗢 🔄 🔆 Section angle		¢	\$	Kection angle	
	🔄 🔄 🖳 Tool orientation		¢	\$	Tool orientation	Bevel
	Lead-in		Lead	l-out		
	G G J Type	None	6	6 .	Type	None
	C C Strain		\$	\$	Kength	
	🔶 🔄 🖳 Length multiplie	r	$\langle \diamond \rangle$	\$	🖳 Length multiplie	r
	🔶 🔄 🐺 Tangential angle		4	4	👢 Tangential angle	
	G G J Check collision		6	6	Check collision	
				* >		
	Section angle		4	Q >	Section angle	
	🔄 🔄 🖳 Tool orientation		\$	\$	Tool orientation	
t						
	Lead-in		Lead	l-out		
	🔄 🔄 🖑 Type	Slide edge 🗸 🗸	4	¢ ;	Type	None
		0.00 mm			I Langth	
	C C St Length	0.00 mm	4	4 2	- Length	
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	🗢 🔄 🐣 Check collision		\$	4	Check collision	
	PIN PIN				11. 11.	
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	수 후 곳 Section angle	90.0 deg	¢	¢ >	Section angle	
	Image: Section angle	90.0 deg Straight to bevel 2 v	$\hat{\Phi}$	4 4	Section angle	
t.	Image: Section angle	90.0 deg Straight to bevel 2 ~	Ŷ	\$ \$	Section angle Tool orientation	
	C C C C C C C C C C C C C C C C C C C	90.0 deg Straight to bevel 2 ~	¢ ¢	4 ,	<ul> <li>Section angle</li> <li>Tool orientation</li> </ul>	
t	C C I Section angle C C I Tool orientation	90.0 deg Straight to bevel 2 ~	¢ ¢ Lead	4 x	Section angle	None
	Contraction angle	90.0 deg Straight to bevel 2 ~	¢ Lead	4 5 1-out	Section angle Tool orientation	None
	Contraction angle Contraction Cead-in Contraction Cont	90.0 deg Straight to bevel 2 ~ Web lead ~ 10.00 mm	¢ Lead ¢		Section angle Tool orientation	None
	Image: Section angle       Image: Section angle         Image: Sectio	90.0 deg Straight to bevel 2 ~ ~ Web lead ~ ~ 10.00 mm r 0.000	¢ <b>Lead</b> ¢ ¢		Tool orientation Tool orientation	None
	Image: Section angle	90.0 deg Straight to bevel 2 ~ ~ Web lead ~ ~ 10.00 mm 0.000	¢ <b>Lead</b> ¢ ¢		Tool orientation	None
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	Lead-in C C T Tool orientation	90.0 deg Straight to bevel 2 ~ Web lead ~ 10.00 mm 0.000	<ul> <li>Lead</li> <li></li> <li< td=""><td>中 中 中 中 中 中</td><td>Tool orientation Tope Length Length multiplie Tangential angle Check collision</td><td>None</td></li<></ul>	中 中 中 中 中 中	Tool orientation Tope Length Length multiplie Tangential angle Check collision	None
-1	Image: Section angle	90.0 deg Straight to bevel 2 ~ Web lead ~ 10.00 mm 0.000	•           •           •           •           •           •           •           •           •           •           •           •           •           •           •	ゆ ゆ ゆ ゆ ゆ ゆ ゆ ゆ ゆ ゆ ゆ ゆ ゆ ゆ ゆ ゆ ゆ ゆ ゆ	Tool orientation Tope Length Length multiplie Tangential angle Check collision Section angle	None
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	Image: Section angle	90.0 deg Straight to bevel 2 ~ Web lead ~ 10.00 mm 0.000	Φ           Φ           Φ           Φ           Φ           Φ           Φ           Φ           Φ           Φ           Φ           Φ           Φ           Φ		<ul> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> <li>Length multiplie</li> <li>Tangential angle</li> <li>Check collision</li> <li>Section angle</li> <li>Tool orientation</li> </ul>	None
4 	Lead-in Control of the section angle Control orientation Lead-in Control of the section Control o	90.0 deg Straight to bevel 2 ~ Web lead ~ 10.00 mm 0 0.000	0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0           0		<ul> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> <li>Length multiplie</li> <li>Tangential angle</li> <li>Check collision</li> <li>Section angle</li> <li>Tool orientation</li> </ul>	None
5	Lead-in Check collision Check collision	90.0 deg Straight to bevel 2  Web lead 10.00 mm 0.000	Cead Co Co Co Co Co Co Co Co Co Co Co Co Co		<ul> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> <li>Length multiplie</li> <li>Tangential angle</li> <li>Check collision</li> <li>Section angle</li> <li>Tool orientation</li> </ul>	None
	Image: Section angle	90.0 deg Straight to bevel 2 ~ Web lead ~ 10.00 mm 0.000 ~ Linear (1 section) ~			<ul> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> <li>Length multiplie</li> <li>Tangential angle</li> <li>Check collision</li> <li>Section angle</li> <li>Tool orientation</li> </ul>	None
	Image: Section angle	90.0 deg Straight to bevel 2 ~ Web lead ~ 10.00 mm 0.000 Linear (1 section) ~			<ul> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> <li>Length multiplie</li> <li>Tangential angle</li> <li>Check collision</li> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> </ul>	None Linear (1 section) 5.00 mm
	Lead-in Check collision Check collisio	90.0 deg Straight to bevel 2 ~ Web lead ~ 10.00 mm 0.000 Linear (1 section) ~	C C C C C C C C C C C C C C C C C C C		<ul> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> <li>Length multiplie</li> <li>Check collision</li> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> <li>Length</li> <li>Length</li> <li>Length</li> <li>Length</li> </ul>	None Linear (1 section) 5.00 mm 0.000
	Lead-in Constraints of the section angle Constraints of the section angl	90.0 deg       Straight to bevel 2       Web lead       10.00 mm       0.000			<ul> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> <li>Length multiplie</li> <li>Check collision</li> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> <li>Length</li> <li>Length</li> <li>Length</li> <li>Length andle</li> <li>Tangential andle</li> </ul>	None Linear (1 section) 5.00 mm 0.000 0.0 der
	Cad-in       Tool orientation         Cad-in       Cad-in         Cad-in       Cool orientation         Cad-in       Cool orientation         Cad-in       Cad-in         Cad-in       Cad-in <td>90.0 deg Straight to bevel 2 ~ Web lead ~ 10.00 mm 0.000 ~ Linear (1 section) ~ 0.0 deg</td> <td>Lead C C C C C C C C C C C C C C C C C C C</td> <td></td> <td><ul> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> <li>Length multiplie</li> <li>Tangential angle</li> <li>Check collision</li> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> <li>Length</li> <li>Length</li> <li>Length</li> <li>Tangential angle</li> <li>Tangential angle</li> <li>Tangential angle</li> <li>Tangential angle</li> </ul></td> <td>None Linear (1 section) 5.00 mm 0.000 0.0 deg</td>	90.0 deg Straight to bevel 2 ~ Web lead ~ 10.00 mm 0.000 ~ Linear (1 section) ~ 0.0 deg	Lead C C C C C C C C C C C C C C C C C C C		<ul> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> <li>Length multiplie</li> <li>Tangential angle</li> <li>Check collision</li> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> <li>Length</li> <li>Length</li> <li>Length</li> <li>Tangential angle</li> <li>Tangential angle</li> <li>Tangential angle</li> <li>Tangential angle</li> </ul>	None Linear (1 section) 5.00 mm 0.000 0.0 deg
	Cad-in       Tool orientation         Cad-in       Ength         Cad-in       Caderin         Caderin       Caderin         Caderin       Caderin         Caderin       Caderin         Caderin       Caderin         Caderin       Caderin         Caderin       Colorientation         Caderin       Colorientation         Caderin       Caderin         Caderin       Calerin         Calerin       Calerin         Caderin       Calerin         Calerin       Calerin         Calerin       Calerin         Calerin       Calerin         Calerin       Calerin         Calerin       Calerin         Calerin       Calerin	90.0 deg       Straight to bevel 2       Web lead       10.00 mm       0.000			Section angle Tool orientation Type Length Length multiplie Check collision Section angle Tool orientation Type Length Length multiplie Tangential angle Check collision Check collision Check collision Check collision Check collision	None Linear (1 section) 5.00 mm 0.000 0.0 deg
	Image: Constraint of the section angle       Image: Constraint of the section angle         Image: Constraint of the section angle       Image: Constraint of the section angle         Image: Constraint of the section angle       Image: Constraint of the section angle         Image: Constraint of the section angle       Image: Constraint of the section angle         Image: Constraint of the section angle       Image: Constraint of the section angle         Image: Constraint of the section angle       Image: Constraint of the section angle         Image: Constraint of the section angle       Image: Constraint of the section angle	90.0 deg       Straight to bevel 2       Web lead       10.00 mm       0.000			<ul> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> <li>Length multiplie</li> <li>Tangential angle</li> <li>Check collision</li> <li>Section angle</li> <li>Tool orientation</li> </ul>	None  Linear (1 section)  5.00 mm  0.000  0.0 deg
4 	Lead-in Control of the section angle Control of the section angle	90.0 deg       Straight to bevel 2       Web lead       10.00 mm       0.000			<ul> <li>Section angle</li> <li>Tool orientation</li> <li>Type</li> <li>Length</li> <li>Length multiplie</li> <li>Tangential angle</li> <li>Check collision</li> <li>Section angle</li> <li>Tool orientation</li> </ul>	None Linear (1 section) S.00 mm O.000 O.0 deg Bevel Bevel

*Fig. 333: Lead in/out settings – presets*
# Measure

All settings in this tab are applicable to surface detection for pipes as well as to laser scanner detection for profiles.

Regardless if Scanner surface detection or Default surface detection mode is selected as main surface detection mode, the settings in this section apply. The following settings apply for these instructions:

- → M94 D7 measuring pipes only new machines support measuring on two Xpositions
- → M94 D12/D13 measuring beams laser scanner measuring always supports measuring on two X-positions

Subsection Measurements defines parameters of surface detection:

- Main surface detection mode beam surface detection is a method of coarse scanning of a material by defined measurement procedure. This function is used to determine surface detection method.
  - → **Default surface detection mode** (performs standard IHS surface detection). It is further specified by Default surface detection mode options
  - → Laser scanner surface detection (machines equipped by laser scanner for beam measurement H/ U/ L-beams and rectangular shaped pipes).
  - → Model based cutting (without any measurement)
- Adaptivity mode Adaptive mode defines the way how the tool is moved above the material surface. From tool stand-off control point of view, there are two types of cutting:
  - → Do not use adaptivity, so-called robotic mode (non-adaptive cutting) used in bevel cutting, and cutting of curved surfaces, pipes, domes, etc. In case of nonadaptive cutting (curved surfaces, pipes, domes, etc.), activation of the option Prefer surface detection is recommended.
  - → Use adaptivity whenever possible adaptive control of tool height is preferably used for straight cutting, a common method for plasma cutting is arc voltage based adaptive control
  - → Always use adaptivity adaptivity is turned on each cut regardless it is straight or bevel contour (recommended to use only water–jet machines equipped by adaptive measurement unit that detects material surface continuously while cutting all contours).
- Default surface detection mode surface detection is a method of coarse scanning of a material surface by measurement of tool height in several points. This setting defines detection method for plates, domes, sphere–caps and circular pipes. Available options are:
  - → **No measurement** (water-jet machines without measurement unit),

- → Measure only one point (laser cutting machines),
- → Measure plane if possible (plasma cutting machines).

Whenever possible, it is recommended to use surface detection using three points (plane measurement) to achieve the highest possible accuracy. In specific situations, the number of detection points is reduced to two or even to one. Usually, the restrictions follow from limited space available for the detection.

Subsection Points detection:

Maximum angle between material normal and up direction while surface detection
 [°] – the parameter defines maximum possible angle of the tool with respect to the
 normal to a material surface where it is allowed to perform measurement for surface
 detection. In fact, the parameter limits the area of material surface by means of
 maximum curvature where surface detection or IHS (initial height sensing) can be
 applied to prevent without a damage of a measuring tool.



# *Fig. 334: Maximum angle between material normal and up direction while surface detection*

• **Minimum distance of detection points [mm]** – the parameter imposes limits for minimum distance between all surface detection points.

Subsections *Profile, beam and pipe shape detection:* 

- Measure mode
  - → Measure every cut separately for each cut separate measurement is made

- → Use one measurement for more cuts one measurement is made for cut paths that are grouped according to set length in Maximum length for one/two X-position measurements
- Can use two measure points for machines, that can execute the surface detection on two X positions for one group of cuts.
  - → New machines (only for circular pipes) mCAM gets the information if it is possible to measure pipes on two X-positions from machine via webservice and automatically checks/unchecks this setting based on this information.
  - → Old machines (for profiles) it is necessary to manually check/uncheck this setting, if the machine is capable to perform measurement for profiles on two X-position or not or if the 2 position measurement should/shouldn't be used
- Maximum length for one X-position measurement (mm) one measurement is sufficient for group of holes and cuts that don't exceed set width in X-axis
- Maximum length for two X-position measurement (mm) for group of holes and cuts that exceeds the width in X-axis for one measurement, two measurements are necessary
  - → When the length of cut path exceed the set length in X-axis for two X position measurements, it is recommended to split the cut path
- Length of cut off material when new measurement is necessary (mm) when the length of cut-off material exceeds the entered value, new laser measurement is necessary

The measurement cannot be done on X positions where some holes were already cut. If it is the case, it uses the closest possible position for measurement.



Fig. 335: Measuring on two X positions for group of cuts on pipe

Settings		Imported 1 🗵									
Application	Cut path	Machine limits	Tool operations	Nesting / supp	orts	Lead in/out	Measure	Generate	Intensity		
Measuremer	nt										
\$ \$ <del>\</del>	A strain surface detection mode Scanner surface detection					`	1				
\$ \$ <b>\$</b>	🔶 🔄 🐺 Adaptivity mode Use adaptivity whenever po					$\sim$					
\$ \$ \$K	Default su	rface detection mo	de Measure plane	with 3 points (pl	asma,	/water-jet mad	:hines) 🗸				
Points detec	tion										
\$ \$ <del>\</del>	Maximum	angle between ma	terial normal and u	p direction while	e surfa	ace detection [	35.0 deg				
\$ \$ <del>\</del>	Minimum	distance of detecti	ion points			[	35.00 mm				
Profile, bear	n and pipe	shape detection									
\$ \$ <del>\</del>	Measure m	ode		l	Use one measurement for more cuts $~~{\sim}~$						
\$ \$ <b></b>	Can use tw	o measure points									
\$ \$ <del>\</del>	🗧 🔄 🖳 Maximum length for one X-position measurement					200.00 mm					
\$ \$ <del>]</del>	🔄 💠 🖳 Maximum length for two X-positions measurements					1500.00 mm					
\$ \$ <del>0</del>	Enght of cut off material when new measurement is necessary 200.00 mm										

Fig. 336: Measure settings

# Generate

Subsection *Generate* defines functions and parameters used during the plan generation:

- CNC usage
  - → CNC will be cut mode without applying mesh
  - → Before cut, mesh will be applied when preparing cutting plan for parts that will be scanned and mesh will be used for adjusting cutting paths
- **Supports positioning by CNC** this function enables to generate *CNC program* with instructions of supports positions. The *mCAM* is able to generate instructions of supports positioning that are automatically recalculated to absolute machine coordinates by machine control system or relative coordinates of support positions in comments of *NC code* for manual positioning without recalculating.
- Automatic material/lunette positioning by CNC
  - → No material/lunette positioning this option is for machines without material/lunette positioning
  - ightarrow Positioning of every cut for machines with standard IHS measuring
  - → **Positioning of group of cuts** for laser measuring, for machines that use laser scanner for pipes and beams measurement
- Use M121 when applying mesh to adjust cut paths to real shape of a material, CNC code M121 moves the center of the dome to 0,0 coordinates
- Collision limitations on domes if it's necessary to cut near the bottom edge of the dome, the collision limitations can be turned off by unchecking the checkbox beside this setting. It has to be used with great caution and turned off only for specific cases because if the dome was placed on the ground, without the limitations of the cut path, the whole cutting head would collide with the ground and break. The dome has to be placed on some kind of supports and there has to be enough space around/below it that the cutting head will not collide with the ground.

Subsection *C axis movements* defines these settings:

- **Default mode for cutting circle pipe** the parameter forces behaviour of the machine in case of cutting round pipes. Circle pipe cutting modes are described in more details in section Cutting mode.
  - → Moving in XY axes (Y is rotation) setting means that relative movement of a tool with respect to the material surface in Y direction is performed by rotation of the pipe.
  - $\rightarrow$  Moving in XYZC axes both the pipe and cutting head can be moved

- $\rightarrow$  Moving in XC axes the cutting head is in straight position the Z axis is fixed
- → **Moving in XYZC axes (fixed in B)** cutting head can move only in direction of the pipe
- **Default mode for cutting beams** the parameter defines used mode of beam cutting. Mode *Plane cutting* is used for *ProfileCut* machines equipped by 120°pantographic rotator where beams are cut on static supports. Mode *Moving in XYZ* is used for other machines equipped by standard 45° rotator where beams are clamped in rotary positioner and placed in supports while rotating the beam during the cutting.
- Linearize C-axis movements on profile corners without rotator the function linearizes the movements of C-axis while cutting profiles corners (rectangular shaped pipes) without using rotator (used only for straight cutting heads)
- Prefer to use the same C-axis constant value for cuts on one hole If checked, the C axis value will be the same for all cuts in complex Y, K and X cuts (if it is possible)

Subsection *Straight cutting* defines maximum A-axis angle for straight cutting and limitations used for backward rotation of B axis during cutting:

- Max angle between torch and material normal for straight cut [°] a threshold for tilting angle of A-axis. If the angle is smaller than the parameter value, the mCAM considers it as straight cutting (T111). This specifies usability of the tool for straight cutting with the advantage of adaptive tool height control despite the low non-zero angle of A-axis, following from exact computations.
- Max A to ignore B [°] a threshold defined for tilting angle of A-axis that enables to ignore B-axis and thus to prevent excessive rotation of B-axis in single point that possibly causes damaged contour by concentrating energy of the tool in one location.



Fig. 337: Maximum A axis angle for straight cut and for B-axis repositioning

Subsection *Ordering* defines all ordering parameters:

- Marking-cutting changeover the parameter is used to determine machine behaviour after marking is completed and prior to cutting. There are two possible settings: Immediately start cutting and Pause after marking.
- **Item finishing mode** this function defines an ordering mode. Every mode has its own significant feature and utilisation. There are four *Item finishing modes*:
  - → Program ordering (nearest contour) cutting order is based on the principle of the nearest cut. This mode also uses the principle Mark all which means mCAM generates all marking instructions and then all instructions for cutting (Marking – Cutting).
  - → Finish whole plan (mark all parts) all parts in whole cutting plan are marked first and then cut
  - → Finish part (mark all -> cut all) cutting order is based on the principle Mark all parts at once which means mCAM generates marking instructions for all parts first and then all cutting instructions. All these instructions are generated according to the principle Part at once which means that each part (including its holes or inner contours) must be completely finished with particular technology. After system finishes this process on one part it can move to the next position (part).
  - → Finish part (mark+cut) cutting order is based on the principles Part at once, Mark at once and which means mCAM generates all marking instructions and all cutting instructions for each part separately. All these instructions are generated according to the principle Part at once which means that each part (including its holes or inner contours) must be completely finished (marked and then cut) first. After system finishes marking and cutting on whole part it can move to the next part.
- Thermal mode
- Start point of plate CNC program defines the start point position of CNC program on sheet. Start point can be set to four positions: Xmin/Ymin, Xmin/Ymax, X max/Ymin, Xmax/Ymax. This setting can be useful especially when working with sheet cutting (2D cutting).
- **Movement at program end** the parameter expresses machine behavior after cutting is completed. Available options are:
  - $\rightarrow~$  No movement at program end
  - $\rightarrow$  At program end return to begin position
  - $\rightarrow~$  At program end move to next free position

#### Subsection *Parking mode* defines global parking mode and parking mode for text marking:

• **Global parking mode** – this function defines the type of global parking mode used for all technological operations except text marking operation and sections controlled by Short distance parking mode. Available options are:

- $\rightarrow$  Full parking
- $\rightarrow$  Limited parking
- **Global parking mode in text marking** this function enables to define parking mode used during the text marking. Available options are:
  - $\rightarrow$  Full parking
  - $\rightarrow$  Limited parking
  - $\rightarrow$  No parking.

Subsection <u>Short distance parking mode</u> defines individual parking mode for short distance sections between two separate cuts:

- **Maximum distance of two subsequent cuts** the parameter defines the maximum distance between end and start of two subsequent cuts.
- **Parking mode** the function defines the parking mode used between two subsequent cuts with defined distance in previous parameter.

Settings	🔋 Imported 1 🗵							
oplication Cut	path Machine limits	Tool operations	Nesting / suppo	rts Lead	in/out	Measure	Generate	In
Generate						•		-
♦ ♦ <sup>1</sup> / <sub>2</sub> CNC	usage		Cnc will be cut			$\sim$		
🗧 💠 🗏 Sup	ports positioning by CNC		No (support posi	tions igno	red)	$\sim$		
a 🗢 🗏 Aut	omatic material/lunette p	ositioning by CNC	No material/lune	ette positio	oning	$\sim$		
🗢 🔄 🖳 Use	M121		Use on mesh			$\sim$		
🗢 💠 🐺 Coll	ision limitations on dome	s						
axis movement	s							
🔄 🔄 🗏 Defa	ault mode for cutting circle	pipe		Moving in	XYZC ax	es	~	
🗧 🔄 🐺 Default mode for cutting beams Static cutting (on supports/rollers) 🗸								
🗢 🗢 🖳 Linearize C-axis movements on profile corners without rotator								
🔄 🔄 🛼 Pre	fer to use the same C-axis o	onstant value for	r cuts on one hole	$\checkmark$				
Straight cutting								
🔶 🔶 🖳 Max	angle between torch and	material normal f	for straight cut 6.0	deg				
🔶 🔶 🖳 Max	A to ignore B		4.0	deg				
Ordering								
🔶 🔄 🛼 Mar	king-cutting changeover	Start cutting	immediately	~				
🔄 🔄 🛼 Iten	n finishing mode	Finish part (n	nark all → cut all)	$\sim$				
🔄 🔄 🐺 The	rmal mode	No thermal se	orting	~				
🔶 🔄 🐺 Star	t point of plate CNC progra	am At X min and	Y min	$\sim$				
🔶 🔶 💑 Mov	ement at program end	No movemen	t	~				
Parking mode								
🔄 🔄 🕂 Global parking mode 🛛 Full parking 🗸								
🔶 🔄 🛼 Glo	bal parking mode in marki	ng text No parkir	ng		$\sim$			
Short distance p	arking mode							
🔶 🔄 🛼 Max	imum distance of two sequ	uential cuts 50.00	) mm					
🕹 🔄 🖳 Par	king mode	Full	parking		~			

Fig. 338: Generate settings

# Intensity

Cutting intensity modifiers affects the quality of cutting especially in complicated areas on plates, pipes or profiles. Cutting modifiers contain functions for slowing down in sharp corners of cutting contour, slowing down at the end of cutting contour, controlling the cutting speed according to effective cutting thickness or reduction of cutting power according to the cut area. All cutting modifiers are applied during generation of CNC program.

Subsection <u>Slow in corners</u> defines parameters of slowing-down on sharp edges on cutting contour:

• Slow in corners – this function enables to use relative speed on edges that meet minimum edge angle limitation.

- Minimum angle of corner [°] the parameter defines minimum angle of the corner to be cut by relative speed.
- **Relative speed [%]** the parameter defines relative cutting speed used in corners that meet minimum edge angle condition.
- **Distance [mm]** the parameter defines the length of cutting path from the corner of material cut by defined relative speed.



Fig. 339: Minimum angle of contour to use relative cutting speed (WaterJet cutting)

Subsection <u>Slow at end</u> defines parameters of slowing–down before each lead–out in cutting contour:

- Slow at end this function enables to use relative speed at end of each cutting contour.
- Relative speed [%] defines relative cutting speed used at end of cutting contour.
- **Distance [mm]** defines the length of cutting path from the last point of cutting contour cut by defined relative speed.

Subsection <u>Adjust intensity control according to effective cutting thickness</u> enables/disables automatic control of cutting speed according to real effective thickness.

Subsection <u>*Cutting are based intensity control*</u> defines parameters for power reduction on edges:



Fig. 340: Affected area by reduced laser power

• **Cutting area based intensity control** – this function enables to use relative power according to current cut area in profile radius.

🕸 Settings		Imported 1 🗵						
Application	Cut path	Machine limits	Tool operations	Nesting / supports	Lead in/out	Measure	Generate	Intensity
-Slow in corn	ers							
💠 💠 🐙 Slow in corners								
\$ \$ <del>\</del>	Minimum a	ingle of corner 45	i.0 deg			]		
\$ \$ <b></b>	Relative sp	eed 70	.000 %			]		
\$ \$	Distance	20	.00 mm			]		
-Slow at end								
\$ \$ <u>*</u>	Slow at end	L L						
\$ \$ <b></b>	Relative sp	eed 70.000 %				]		
\$ \$ <b>\</b>	Distance	20.00 mm						
Adjust inten	sity control	according to effe	ctive cutting thickn	ess				
\$ \$ <del>\</del>	🗢 🗢 🖳 Adjust intensity control according to effective cutting thickness 🗹							
Cutting area based intensity control								
\$ \$	Cutting are	a based intensity	control 🗹					

Fig. 341: Intensity settings – cutting intensity modifiers

# Transformations

This section contains list of *Transformations* (rules, conditions and tasks) that can be applied on cutting paths. *Transformations* are used for *Quality hole* applications (*True hole/Contour cut*), *Drilling* and *Punching*.

Ø Settings		Imported 1									
Application	Cut path	Machine limits	Tool operations	Nesting / supports	Lead in/out	Measure	Generate	Intensity	Transformations	Expert table	Internal
Transformat	tions										
Nam	e				Enal	bled					Ŷ
quality hole											J.
											4-
											-
											D
Enable											
Name qua	lity hole										
					onditions						
Circle hole											0
											87
											~
											-
Circle hole											~
Diameter 10	0.00 mm										
Epsilon 0.	.01 mm										
					Tasks						Ŷ
Quality hole	cutting (TH	IT/CC)									÷
											÷
											-
Quality hol	e cutting (	THT/CC)									~

Fig. 342: Transformations settings

#### Setup transformations

Transformations are set for whole application (not for particular machine or technology), therefore it is not necessary to select any machine, technology or tool. All transformations can be edited in program configuration level.

Transformations are processed during generation of CNC program, therefore user is able to see whether transformations were applied as expected only in cutting simulation.

#### **Transformation rule**

Transformation rule contains set of transformations that should be performed on particular cuts (drill + tapping; punch + marking, etc.) that meet the conditions set for each transformation rule. One transformation rule may contain as many transformation conditions and as many transformation tasks as needed. It is possible to add, delete or copy transformation rules by buttons on the right side of the screen.

🕼 Settings	×										
Application	Cut path	Machine limits	Tool operations	Nesting / supports	Lead in/out	Measure	Generate	Intensity	Transformations	Expert table	Internal
Transformati	ions										
Nam	ne				Ena	bled					Ŷ
Drilling +	tapp										J.
											-
											-0-
											D
Enable											
Name Dhilin	ig + capping										
					Conditions						Ŷ
Hole											- €
Circle noie	e										4
Hole Minimal Diam	eter Thickness	a mitia 1 200									•
Maximum Dia	meter: Thickness	ess ratio 2 000									
	in contractor	2.000									
D.111. (0					Tasks						Ŷ
Drilling (G	381) 684)										♣
Tapping (	004)										4
											•
											IJ
Drilling (G81	.)										-
Z 1	10.00 mm										
Z full deep											

Fig. 343: Transformation rule, its conditions and tasks

#### **Disabling transformation rules**

Transformation rule can be completely disabled (for whole application) in settings of particular transformation rule by unchecking the checkbox Transformation rule enabled. Transformation then won't be performed even if some feature fulfils criteria set by disabled transformation.

🔯 Settings 🗵										
Application Cut path	Machine limits	Tool operations	Nesting / supports	Lead in/out	Measure	Generate	Intensity	Transformations	Expert table	Internal
Transformations										
Name					Enabled					Ŷ
Drilling + tapping										2
										$\square$
Enable 🗹										
Name Drilling + tapping										

Fig. 344: Global disabling of transformation rule

#### **Transformation condition**

Transformation condition defines a condition or set of conditions (in version 1.3 only circle diameter, size of any closed hole) where transformation task should be used.

Specified transformation task is applied to features (cutting contours) that match at least one of transformation conditions defined within particular transformation rule (unless transformation rule is disabled).

Transformation conditions available in version 1.5:

- **Circle hole**; defined by:
  - 1) Diameter of hole [mm]
  - 2) Epsilon [mm] (tolerance)

Set transformation task or tasks are applied on all circle holes that match at least one of the transformation condition (hole diameter + tolerance).

- Hole (any closed hole); defined by:
  - 1) Minimum diameter: thickness ratio
  - 2) Maximum diameter: thickness ratio

Transformation task is applied on holes where distance of two points of contour (two points with maximum distance) is smaller than multiple of thickness of the material and thickness multiplier (d < t. coef).

- **Constant thickness** transformation task is applied only when the condition of constant thickness is met (defined by epsilon = tolerance)
- Path in plane transformation task is applied only when whole path is in plane

 Always false – alternative way to disable transformation task, but it still remains accessible in dropdown menu in properties area for selected cut path (Tool path -> Layer) and can be manually applied

#### **Transformation task**

Transformation task defines the operation (e.g. drilling or punching) or set of operations (e.g. drilling + tapping) that should be performed on matching feature (cutting contour) defined by transformation condition.

Transformation of any contour automatically disables standard cutting (unless cutting is also included in transformation task) and applies set of transformation tasks.

Transformation tasks available in version 1.5:

- **Drilling cycles** (G81, G82, G83, G84, G85, G86, G89) (all drilling cycles are described in more details in section Drilling)
- Cutting
- Punching
- Quality hole cutting (THT/CC)
- Quality hole cutting in axis (THT/CC)

#### **Drilling cycles**

A *drilling cycle* is an elementary drilling operation represented by a dedicated instruction in CNC code. Arguments of *drilling cycles* include *depth*, direction of rotation, *time dwell*. The *mCAM* supports the following drilling cycles: "*G81*", "*G82*", "*G83*", "*G84*", "*G85*", "*G86*", and "*G89*". All *drilling cycles* are defined and used in *Transformations* (*Settings – Transformations*). *Transformations* are described in more details in section Transformations.

## G81 – Drilling

G81 – Drilling	G81 – Drilling									
Parameters	Z	Drilling depth [mm]	F, S -FF, S							
Comment	Feed F	Feed F [mm/rev] and spindle rotation speed S [rpm] are set in tool parameters								
Example	G81 Z30	G81 Z30 (Simple drill cycle with 30 mm depth)								

## G82 – Drilling with dwell

G82 – Drilling	g with dv	vell					
Parameters	Z	Drilling depth [mm]					
	РТ	Dwell time in the hole [s]	F, S -FF, S PT				
Comment	Feed F	Feed F [mm/rev] and spindle rotation speed S [rpm] are set in tool parameters					
Example	G82 Z3	G82 Z30 PT5 (Drilling cycle with 30 mm depth and 5 s dwell after drilling)					

## G83 – Deep drilling

G83 – Deep d	G83 – Deep drilling (peck drilling)							
Parameters	Z	Drilling depth [mm]						
	PZ	Drill step [mm]		<u>-</u>				
			F, S -FF, S FF/F, S <b>G83</b>					
Comment	Feed F	[mm/rev] and spindle ro	otation speed S [rpm] are set in tool paramete	ers.				
	Correct	Correction for retract step H [mm] is set in servo in parameter KorekStep						
Example	G82 Z3	0 PZ5 ( <i>Drilling with dept</i>	th 30 mm performed in 5 mm steps)					

## G84 – Tapping

G84 – Tappin	G84 – Tapping (making threads)							
Parameters	Z	Drilling depth [mm]	F, S -F, -S					
Comment	Feed F	Feed F [mm/rev] and spindle rotation speed S [rpm] are set in tool parameters						
Example	G84 Z30	G84 Z30 (Tapping with depth 30 mm)						

## G85 – Boring with feed retract

G85 – Boring	G85 – Boring with feed retract							
Parameters	Z	Drilling depth [mm]	F, S -F, S					
Comment	Feed F	Feed F [mm/rev] and spindle rotation speed S [rpm] are set in tool parameters						
Example	G85 Z3	G85 Z30 (Boring depth 30 mm with slow return)						

### G86 – Boring with spindle stop

G86 – Boring	G86 – Boring with spindle stop							
Parameters	Z	Drilling depth [mm]	F, S -FF, S=0					
Comment	Feed F	Feed F [mm/rev] and spindle rotation speed S [rpm] are set in tool parameters						
Example	G86 Z3	G86 Z30 (Boring depth 30 mm with spindle turning switched off when returning)						

G89 – Boring	with dw	ell and feed retract	
Parameters	Z	Drilling depth [mm]	Z G89
	РТ	Time dwell in the hole [s]	F, S -F, S PT
Comment	Feed F	[mm/rev] and spindle ro	otation speed S [rpm] are set in tool parameters
Example	G89 Z3	0 PT5 ( <i>Boring depth 30</i> i	mm with spindle kept turning and 5 s dwell)

#### G89 – Boring with dwell and feed retract

# **Expert table**

This section is used for *Expert tables* generation and editing. *Expert tables* contain cutting parameters (*thickness – cutting speed – kerf width*) used for kerf width compensation and cutting speed control. *Expert tables* initial setup as well as subsequent editing is described in section Expert tables.



Fig. 345: Expert table settings

# Internal

Parameters in the folder are intended to be set by MicroStep staff. Correctness of the values is a necessary condition for trouble–free performance of the machine. The parameters define fundamental conditions for generation of cutting plans and due to the internal nature they are not explained in this document.

Settings		Imported 1	×								
Application	Cut path	Machine lim	its Tool operations	Nesting / supports	Lead in/out	Measure	Generate	Intensity	Transformations	Expert table	Internal
[Editing is per Machine lay	rmitted onl	y for MicroSte	o technical support]								
\$ \$ <del>\</del>	Coeff A->B		30.0 deg								
\$ \$	A state of the sta										
\$ \$	Coeff A->Z		210.00 mm								
¢ ¢ 👱	Radial acc	eleration	200 mm/s^2								
¢ ¢ 봊	💠 🔄 📜 Tangential acceleration 250 mm/s^2										
Discretisatio	n										
\$ \$	Check for a	angle 🗹									
\$ \$ <u>*</u>	🔄 🔄 👯 Discretise min length 0.10 mm										
\$ \$ <u>*</u>	Discretise	max length 2.	00 mm								
\$ \$ ×	Discretise	max angle 6.	0 deg								
Generate	60 colit m	ode	None		~						
6 6 J	Relative s	need CNC mod	Percentage M9	D Kxx Lvv	~						
	Relative p	ower CNC mod	e Percentage M9	D Kxx Lvv	~						
\$ \$ \$	Linear filte	ering									
\$ \$ \$	Smooth fil	tration AB	0.0 deg								
\$ \$ <b></b>	Compensa	tion mode	Compensation	is on	~						
\$ \$	Maximum	kerf value	6.00 mm								
\$ \$ <del>\</del>	Limit for n	o K102 measur	ement 180.0 deg								
\$ \$ \$<	Position t	ype	Version 2 with	M122	$\sim$						
Heating											
\$ \$\vec{b}{v}_{i}<	Material te	emperature du	ring cutting 157	0 C							
\$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	Maximum	required temp	erature for cutting 300	C							
\$ \$ \$	Cooling co	pefficient in 1[r	nin] 0.8	00							
\$ 2	Maximum	distance for h	eating up (1%) 500	).00 mm							
Quality hole	Quality ho	le extensions	Extended Quality hole	expert ~							

Fig. 346: Internal settings

# Troubleshooting

This section contains several troubleshooting options, reporting system and basic information about the program (version, used libraries, etc.), view help (manual guide), console, tips and keyboard shortcuts.

# Help

This subsection contains basic information about program manuals, console usage, useful paths, tips and keyboard shortcuts.

#### About

This option displays the basic information about program, version of the executable file and version of dllcore file, and about used libraries: Qt, Open Cascade, etc.



Fig. 347: About program

#### View new features

This function opens the PDF version of user manual – upgrade to version 2.0.

## View help

This function opens the PDF version of user manual, keyboard shortcut: <F1>.

#### Console

This section contains commonly used options, commands and directions (keyboard shortcut: <F1>). Two main subsections of console are switch and paths+strings. Almost all sections included in the console are hard–coded, so it is not possible to change them. The most important and useful settings are presented below.

#### Paths and strings

This section displays paths and strings to important files, configurations, and other data that could be modified. It contains directories for these useful data:

- common program user data
- configurations and libraries
- MPM local databases
- temporary directories for traces
- temporary directory application
- import libraries
- reports
- executable file name
- documentation path
- files for all languages
- crash report directories

							mCAM appl	ication	console	#115			*		×
ge	neral sv	vitch	decorati	ion	info	arg	paths+strings	profile	msg	shapes	jobs	SQL	notif	colors & const	
	n	ame					h	}	pati	h	-				^
1	app path		C	\msnc\	mcam	21.10									
2	user path	cfa	C:	\msnc\	mcam	21.10	config								
3	shared pa	th cfg	C:	\msnc\	mcam	21.10	config								
4	mpm dtb	cache	C	\msnc\	mcam	21.10	config\mpm								
5	tempUser		C	C:\msnc\mcam21.10\temp											
6	tempApp		C:	C:\msnc\mcam21.10\config\temp											
7	customer	Cfg	C:	:\msnc\mcam21.10\mcam_cfg											
8	MPM exce	eption	C:	C:\msnc\mcam21.10\exceptions											
9	MPM bin	path	C:	C:\msnc\mcam21.10											
10	examples		C:	\msnc\	mcam	21.10	examples								
11	plugin-pa	th	C:	\msnc\	mcam	21.10	plugins								
12	machine p	params	C:	\msnc\	mcam	21.10	config\ws								
13	console o	ut file	C:	C:\msnc\mcam21.10\config\console.txt											
14	exe GUI		C:	C:\msnc\mcam21.10\mcam.exe											
15	cmd exe		C:	\msnc\	mcam	21.10	mcamcmd.exe								
16	app name	9	m	cam											
17	startPath		C:\	\msnc\	mcam	21.10\(	doc								
18	wd		C:\	\msnc\	mcam	21.10\(	doc								
19	doc path		C:	\msnc\	mcam	21.10	doc								
20	doc PDF		C:	\msnc\	mcam	21.10	doc\mcam_Engl	ish.pdf							
21	doc PDF		C:	\msnc\	mcam	21.10	doc\mcam_Engl	ish_new_fe	eatures_1	_3.pdf					
22	test dir		C:	\msnc\	mcam	21.10\	\data								
23	crash repo	ort dir	C:	\msnc\	mcam	21.10	crash\								
24	crash repo	ort file	C:	\msnc\	mcam	21.10	crash\mcam_201	5_11_11_	12_57_500	08_gui.md	mp				
25	gd mask		C:	\msnc\	mcam	21.10	config\gd_cfg.*.	*							
26	gd cfg de	fault	C:	\msnc\	mcam	21.10	config\gd_cfg.01	I.def.cfg							
27	gd cfg de	fault	C:	\msnc\	mcam	21.10	config\gd_cfg.02	2.machine	.cfg						
28	gd cfg pr	ogramr	m C:	\msnc\	mcam	21.10	config\gd_cfg.0	3.app.cfg							
29	lang base		C:	\msnc\	mcam	121.10	Texts\mcam								
30	lang path		C:	\msnc\	mcam	121.10	Texts\mcam\Eng	lish							
31	language		Er	nglish											
32	défault la	nguage	e Er	nglish											
33	language	.0	\$ <u>0</u>	general	_mcar	n.langi	uage_name								
34	language	:1 .a	Ce	esky											
35	language	.2	En	igiish											
30	ianguage		De	eutsch											× .

Fig. 348: Paths and strings

# Shape geometry data

In order to understand process of shape type recognition, several functions need to be specified. Next sections describe several functions for rescanning shape type/ cutting faces or tool paths that are used when user deals with some problem or wants to apply changed presets. The *mCAM* also contains functions that helps user (or MicroStep technician/support) to determine possible problem.

#### Shape data rescanning

In–depth analysis of raw geometrical data *mCAM* is able to recognize shape type and process cutting faces automatically.

#### **Rescan shape type**

If the detection procedure fails or in cases of ambiguity, several possibilities of shape interpretation are offered for manual selection, i.e. ring shape can be created from a round pipe or as an annulus from a flat sheet.



Fig. 349: Rescan shape type to Circle pipe



Fig. 350: Rescan shape type to Plane

## Geometrical inspection

3D geometrical inspections allows to display a 3D CAD drawing with all geometry data of processed/unprocessed 3D solid. This function allows user to view tree structure of shape geometry, including recognized cutting faces and cutting paths (in *Full view*). Depending on function *mCAM* is able to view raw data of solid geometry in *Raw view* or processed solid geometry in *Full view*.

#### **Full view**

This option allows to display a detailed specification of selected part. Detailed specification includes shape information that have been processed by mCAM during the import of particular part. The function can be found in the list that is displayed by using right-

click on the part in the list of parts within any shape in *Import task* or in the list of parts in the *Job task*.



#### Fig. 351: Full view function

Full view displays detailed shape data processed by *mCAM*. All geometry data are structured by the definition of *B-rep model structure*. Shape data are displayed in tree structure that describes whole part. A solid is divided into five elements:

- shell
- faces
- wires
- edges
- vertexes

Settings Imported 1 Full view - Tube70 S		
😭 3D 📑 YZ 🕋 XY 🕋 XZ	Name	Value
	Tube70	Circle pipe D: 70.00 mm T: 4.00 mm; L: 400.00 mm
	Shape type CIRCLE ✓ SOLD 6 ✓ SHELD 7 > FACE 8 R > FACE 40 R > FACE 17 R > FACE 17 R > FACE 23 R > FACE 17 R > FACE 23 R = FACE 23 R	SOLD: volume-18719 surface-162671           SHELL:           CUT BSPline surface           CUT BSPline surface           CUT SSPline surface           CUT Sylinder R= 1000000 point-pnt[ 24.67675, -0.00000, 35.00000] axis           CUT Qrinder R= 500000 point-pnt[ 30.67675, -0.00000, 35.00000] axis           CUT Grinder R= 500000 point-pnt[ -0.0000, -0.0000, -0.00000, -0.00000] axis           UTR Qrinder R= 500000 point-pnt[ -0.0000, -0.00000, -0.00000] axis           CUTR Qrinder R= 500000 point-pnt[ -0.0000, -0.00000, -0.00000] axis           UTT Qrinder R= 500000 point-pnt[ -0.0000, -0.00000, -0.00000] axis           UT Qrinder R= 500000 point-pnt[ 30.67675, -0.00000, -0.00000] axis           UT Qrinder R= 500000 point-pnt[ 30.6775, -0.00000, -0.00000] axis           UT Qrinder R= 500000 point-pnt[ 30.6775, -0.00000, -0.00000] axis           UT Qrinder R= 500000 point-pnt[ 30.6775, -0.00000, -0.00000] axis           UT Qrinder R= 10.00000 point-pnt[ 27.6775, -0.00000, -0.000000] axis           UT Qrinder R= 10.00000 point-pnt[ 27.6775, -0.00000, -0.00000] axis           UT Qrinder R= 10.00000 point-pnt[ 27.6775, -0.00000, -0.00000] axis           UT Qrinder R= 10.00000 point-pnt[ 27.6775, -0.00000, -0.00000] axis
	<pre>&lt;006&gt; EStatus::S_USED SOLID: volume=318719 s value=318719 mm3 location: loc[gp_TrsfCompoundT -0.00000, 0.00000, 1.000000, 0.00000, 0.00000, -1.00000,</pre>	wrface+162671  rsfscale: 1.00000 -1.00000, -0.00000 -0.00000, -0.00000 -0.00000, -0.00000 -0.0000 -0.00000 -0.00000 -0.00000 -0.0000 -0.00000 -0.
2	Min angle	Min angle
A state of the	Max angle	Max angle
×	Discretization distance	
[] ⊘	Show arrows	

Fig. 352: Geometrical structure of 3D solid (B-rep model)

More information about the listed elements can be found in section Boundary representation. Full view displays shape data information divided to few groups according to their type:

- faces: inner, outer or cut faces
- edges: smooth (also known as auxiliary edges) or outer
- edges cut
- faces cut
- cutting paths

Face-cut recognition directly affects the way and quality of cutting path processing. It is important especially in features and cuts with weld – edge preparation where complex cuts (Y, K, X-cuts) have to be automatically recognized. Therefore, it is important to have those cut – faces identified and processed correctly. For debugging those kind of problems face-cuts need to be visually analysed.

It is important to check whether cutting edges were processed correctly:

- top edge of cutting contour (line on the top of the material) has to be highlighted by yellow color
- bottom edge of cutting contour (line on the bottom of the material) has to be highlighted by light blue color
- starting edge of cutting contour has to be highlighted by green color
- ending edge of cutting contour has to be highlighted by purple color



Fig. 353: Face – cut recognition and processing

Note: In case that some cut is not recognized correctly (i.e. cutting – points do not copy the face – cut) or not recognized at all (complex cuts like Y, K or X – cut) the only way to find out the problem is to go through geometry inspection.

#### **Raw view**

This option displays a raw view i.e. unprocessed CAD drawing of *mCAM* file. All info and data that are defined in the imported file (STEP, IGES) with all geometrical data are displayed in a tree structure of the file (on the right side of the screen). *Raw view* of any 3D shape can be displayed by using function in *File* – *Raw* and selection of particular part (key shortcut <Ctrl + S>).

The raw view is useful in cases when the file was not processed correctly and a user wants to check whether the model, complete info, geometry, dimensions, and data from the file are properly and correctly defined.



Fig. 354: Raw geometrical shape data – Raw view

# Reporting

This option displays the dialogue where user can describe any issue or problem with *mCAM*, that he encounters. There is also possibility to add user's email address, error description, problematic shapes, select data that could be useful for the solving of the problem (see) or add any files that are considered to be helpful for software development. It is possible to load or save the report. The report has to be sent directly to the *mCAM* support team who will try to solve the problem as soon as possible.



Fig. 355: Open Reporting dialogue window

,
1

Fig. 356: Saving of .zip report with attached job task and generated CNC program

# Working with MPM

Integration the *mCAM* with the *MPM module* that manages parts, semi–products and orders, afford to create cutting plans, manage production requirements and monitor the status of orders effectively in real–time.

*MicroStep Production Management module (MPM)* is an application of a SQL database with an intranet interface that allows to access to data to all authorized users of a company network via any internet browser. This *module* serves to manage all materials, stock material, parts, products, orders, cutting plans, and reports data.

To activate MPM module within mCAM, it has to be first enabled in Settings -> Application by checking the checkbox beside *"Enable access to MPM"* which will provide access to MPM globally for mCAM. mCAM has to be restarted afterwards. MPM is then activated or deactivated for each machine in mCAM separately by manually rewriting the corresponding cell in Web Service table in Settings->Application to enabled/disabled. Alternatively, the corresponding number can be written in the cell – 0 for disabled and 1 for enabled.

Application Cut path Machine limits To	ol operations Nesting / support	ts Lead in/out Measure	Generate Intensity Transformations Expert table Internal	
Application				
🔄 🔮 🖳 Target URL for report				
🔄 🖓 🧏 User e-mail address				
🔶 🕔 🧏 Customer name				
🔄 💿 🐺 All file open dialogs share one current o	directory			
💠 🔗 🐺 Plan save folder				
💠 🕓 🐺 Make file preview	$\checkmark$			
Application restart required				
Web service			_	
Computer URL adress	Web service	EkoInfo	MPM	4
msnc500ww64	enabled	disabled	enabled	
🗢 🗸 🕹 Language	English	•		
🔄 🔍 🐺 Keep import opened after application r	estart 🗸			
O J Inverse mouse wheel zoom				
♦ ♣ Enable access to MPM				
6 0 Enable access to Machine web service				
Charad configuration folder				
	Out a sint asimutian	_		
	cut point animation	•		
Virtual machine type		_		
Virtual machine type	ne			
Number of tools for virtual machine 1				
△ ◇ 💥 Machine technology (11,12,) 11				
Central Control Contro				
🔄 🕑 🚆 Technology for ASCII writer (18,0) 0				
Found problems				
level			description	

Fig. 357: MPM

# Standard working procedure

The procedure of working with *mCAM* integrated with *MPM module* can be defined in several steps:

- 1. Load parts into mCAM
- 2. Import loaded parts to MPM through mCAM
- 3. Create semi-product in MPM
- 4. Create MPM job in mCAM
- 5. Add semi-product into job task from MPM
- 6. Add parts into job task from MPM
- 7. Assign parts to semi-product and nest them
- 8. Generate cutting plan

#### Loading parts into mCAM

Loading 3D or su rface parts into *mCAM* while working with *MPM module* is exactly the same as without *MPM module*. Loading parts into *mCAM* is performed by the function *Import* or *Import surface*. Importing procedure is described in more details in section Importing.

## Importing of loaded parts into MPM

Importing of loaded parts into *MPM* is executed by the function Import all to *MPM* or by dragging the selected parts into the *MPM* folder in *Master panel* (function Drag and drop).



Fig. 358: Import of selected parts in the MPM database

Parts that have been imported in the *MPM* database are displayed in *Master panel* in *MPM* folder. Imported parts also appear in *MPM* intranet database where they can be displayed using the filter.

8°	ROD	UCT	NON M	AN	066		EN	т	F		
Min.	his Stat	Amprotec	the Party Process	a Dadera	Cathol	kan Rep	-	a	Series go	10.	ne later
/* Rider											
MINIM	INCHINE .										
humbi		- Steele	wie 🖂 🖂	1							
Samipter	last properties										
200	-	. N									
Reach											
SAL	heroine	(max)	Enrolander	Oracleche	Rosality St.	BORMAN	1	(they sel	Autorial	Sector and an	A COMMENTS )
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In	-	0 a 16.00							*84 Qard (972) 15	-	医多
							00 - O		(booked) )	Danisher a	7 adiabat
			-								



## Creation of semi-product in MPM

To create a cutting program with real semi–product, it has to be created in *MPM module*. Afterwards, the created semi–product can be used to nest the parts and for cutting.

The semi–product can be added into the *MPM database* using function *Add* on the bottom of the window. Parameters that define the semi–product are as follows:

- name (material)
- thickness
- size
- specification (optional)

Materials	Semiproducts	Parts	Products	Orders	Cutting Plans	Reports	
ert Pipe Iaterial			_	Size			
lame 'hickness Specification	Mild Steel		•	X: 1400 R: 65			
tock item	T(neme)						
Template	C Stock item						

Fig. 360: Creation of the semi-product with specified size and material

#### Creation of MPM job in mCAM

A new *MPM* job can be created using the function Open *MPM* job. In next dialogue window user defines the type of semi–product (circular pipe, rectangular pipe, etc.) and its name.

Ø			
File	Settings Windows	Help	
	Load library		Ctrl+O
	Load job		
	Import		Ctrl+I
	Import surface		
	Raw view		Ctrl+S
	Refresh MPM data		
	Refresh data from ma	achine web service	
	Settings		Ctrl+T
	Simulation		
	Open MPM job		
	Exit		Alt+X

Fig. 361: Create MPM job task

8	CadCamMZM.SaveProject	- • ×
Properties		
Name	mpin_jab	
Machine	MicroLws3001.15L(1050)	Select
Project type	CirclePipe	
Status		
Description	Part of the bridge	
	OK Cancel	

Fig. 362: Creation of MPM job

### Adding semi-products from MPM database

The next step is to add defined semi–product from *MPM* database into Job task in *mCAM*. To add a semi–product with defined dimensions and material type from *MPM* database, use the function Add stock from *MPM* in Job task that appears by using right–click in the *Working tree*.

Name	Value	mpm_	job #883 - jo	
4 3D viewer		Job	Shapes	Plan generation
Tool path		Nan	ne	
Job - job_mp Machine ID:	1069 MicroLas3001.	15L <b>v</b>		Open Favorites Generate plan Remove plan
				Add stock from MPM
				Copy name to clipboard

Fig. 363: Add stock from MPM function

The function opens the *MPM* database with all semi–products and by using the filter it is possible to find specified semi–product. Specified semi–product can be added to the *MPM* job by simple selection and the button OK.

•				Se	elect Semiproduct	- 🗆 🗙
Semiproduct CadCamMZ	//.Stock Select	ed				
□ Filter						
Material required by pro	duction	_				
Name	<ul> <li>Spec</li> </ul>	ification			•	
Type CirclePipe	Thickness	10	to 10	CadCamMZM	M. 110 to 110 CadCamMZM. 1350 to 1450	
Material	Specification	Part count	Туре	Preview	Dimensions	
Mild Steel (37.2) 10mm		70	CadCam		Ø110mm L=3400mm	
Mild Steel (37.2) 10mm		70	CadCam		Ø110mm L=6000mm	
Mild Steel (37.2) 10mm		70	CadCam		Ø110mm L=2000mm	
Mild Steel (37.2) 10mm		70	CadCam		Ø110mm L=1400mm	
Stainless Steel 10mm		0	CadCam		Ø110mm L=6000mm	
Add to selected	Edit material	P	roduction info			Ŷ
🖉 OK 🛛 🚫 Cancel						Items: 1

Fig. 364:Adding semi-product from MPM database to mCAM

### Adding parts to mCAM from MPM database

To add specified parts to *MPM* job in *mCAM* the particular parts from *MPM* database should be selected by using the function Add part from *MPM*. The function is displayed by right–click on the semi–product (stock) which have been added to the job in previous step. To add parts that have not been added into some Order in the *MPM module*, the tab Template should be opened. In case of parts that have been included in some orders, the Production tab should be opened. Both tabs, Template and Production, contain the filter for more effective searching of specific parts.

Name	Value	mpm_	job #883 - jol			
✓ 3D viewer ✓ Stock mat		Job	Shapes	Plan	generation	
Tool path		Nar	ne			
Job - job_mp		4.	🕤 Circle pi	pe D: 2	20.000 mm T: 10.000	
Machine ID:	1069 MicroLas3001.15L 🔹				Nest this	
Virtual sto		11 1	9.9	-	Move rest parts to stock	
Unlimited					Generate plan	
Length	1 1400.00 mm				Remove plan	
Generation					Add stock from MPM	
Name: Output format:	cnc 🔻				Add part from MPM	
Rotator mode:	moving in XYZ 🔹				Return stock to MPM	
Chuck locati Marking	at X min 🔻			_		
Punching						
<ul> <li>Text marki</li> <li>Cutting</li> </ul>						
L. Louing						

Fig. 365: Add parts from MPM database
e	Sel	1 ect Parts				-	- 🗆 🗙
CadCamMZM.MATERIAL_FOR_NEST	TING Mild Steel (37.2)						•
🖙 File 💆 Template 📻 Producti	on Selected						
B'Filter	0						
Name Mild Steel (37.2)	Specification						-
Type							
Quick search: Q  mpm							
Products	Name	Preview	Count	Material	CadCamMZM	Source	CadCamM2
All	mpm_1		1	Mild Steel (	L=526.784691	Circle	Ø 110 mm
	mpm_2		1	Mild Steel (	L=600.412502	Circle	Ø 110 mm
	Add Select all						
OK 🚫 Cancel							Items: 2

Fig. 366: Adding selected parts to MPM job task

#### Generating a cutting plan

A cutting plan within the work with *MPM module* can be generated in exactly the same way as the cutting plan that is generated without the connection to the *MPM module*. That means that the cutting plan can be generated for whole template (including all stocks in its structure) or for particular stocks (semi–products). The process of cutting plan generation is described in more details in section Simulation of CNC program and graphical visualization.

After generating the cutting plan (CNC code), a report is displayed in the visualization screen. The report contains basic information about particular cutting plan such as: name, date, time of generation, type and size of semi–product, chuck location and information about all parts that are included in the cutting plan.



Fig. 367:Report of generated cutting plan

Note: After generation of cutting plan, it is automatically sent to *MRP module* (module of cutting plans). This module works as a local database of all generated cutting plans. Cutting machines are directly connected to this database, so the *MRP* works as a kind of a source. In case that particular CNC code (cutting plan) has not been used for cutting (no machine has taken it) yet, the cutting plan can be modified in *mCAM* and regenerated. Otherwise, if CNC has been already taken by some CNC machine, CNC code (cutting plan) cannot be modified and therefore it cannot be re-generated. If a cutting plan has been already taken from MRP to some machine and a user tries to edit that particular cutting plan in *mCAM*, *mCAM* displays the report that permission to modify the cutting plan is denied.

# Supporting documents

## Petal cutting workflow in mCAM

### Introduction

MicroStep machines have all the means for precise cutting of dome petals from semiproduct. Dome petals are prefabricated from pressed sheets of material and cut into their final form, with the use of a petal cutting process on a MicroStep machine. This document represents the recommendations during the mLIVE program preparation.

### **Dome petals shapes**

conical petals

Dome petals are divided into 3 categories based on their shape and geometrical parts:

- <u>spherical petals</u> (single radius -> spherical surface)
  - torispherical petals (dual radius -> spherical, toroidal, cylindrical surface)
    - type 1 cylindrical surface + radius + spherical surface
      - type 2 conical surface
      - type 3 conical surface + radius + cylindrical surface

**type 4** - cylindrical surface + radius + conical surface + radius + cylindrical surface



Fig. 368: Spherical dome petal



Fig. 369: Torispherical dome petal



Fig. 370: Conical dome petal type 1



Fig. 371: Conical dome petal type 2



Fig. 372: Conical dome petal type 3



Fig. 373: Conical dome petal type 4

### Importing dome petals in the mCAM program

#### Import shape in mCAM

To import the desired petal shape in a suitable format (\*.step / \*.stp) it is possible to use the Import shape button on the left side of the main mCAM screen. Pressing the button will allow you to browse computer files and choose, which should be loaded in mCAM.

Alternatively, the user can choose File -> Import shape or press the shortcut key Ctrl + I.

Imported 1 - TS	- mCAM		
<u>File</u> Import <u>W</u> i	ndows <u>H</u> elp		
Import shape		Ctrl+I	
Import 2D surfa	ace		
Create shape			
Create/load job	)		
Raw view		Ctrl+S	
Refresh MPM c	lata		
Refresh data from machine web service			
Settings		Ctrl+T	
Simulation			
Open MPM job		•	
E <u>x</u> it		Alt+X	



Fig. 374: Import shape in mCAM

### **Cutting paths of the dome petal**

Cutting of the petal itself can be done either by:

- using a single cut (lead in -> cut -> lead out)
- split the cutting path into multiple paths, which is a recommended option

To split the cutting path simply click the Tool path area on the petal (displayed on the edge of the material) and in the **Split cut paths** box choose **Standard.** After splitting the cut paths user is able to highlight each path separately.



Fig. 375: Cut paths before splitting in mCAM



Fig. 376: Cut paths after splitting in mCAM

For each cut paths, it is recommended to set lead in and lead out. It is even desired to set larger lead-ins/outs (relative to the size of the material) to ensure that the cutting path is complete.



Fig. 377: Setting the lead ins and lead outs for each cutting path in mCAM

MicroStep recommends choosing "Linear (1 section)" or "Path conforming" for leadin and lead-out types.

#### **Order of cuts**

Side cuts are usually performed first. To set the order, click on the specific cutting path and enter a number in the **User order box** in the Tool path category (for example numbers 1-4 in case the path will be split into 4 different cutting paths).

✓ Tool path #1		
Split cut paths	Standard	$\sim$
Path generation mode	Automatic	$\sim$
Kerf compensation		
Marking		
Cutting		
Transformations		
Layer	Automatic transformation	$\sim$
Laser operations	Large contours	$\sim$
Waterjet operations	Q5	$\sim$
Stop (M0) before cutting		
No piercing		
Shift points on surface	In hole axis	$\sim$
Adaptivity mode	From measure settings	$\sim$
Technology operation	Default	$\sim$
User order	3	
Normal limit		
Technology modifications		
Cut thickness computation	Full material thickness	$\sim$
User speed	100%	

Fig. 378: Setting the cutting order for each cutting path in mCAM

In case when the cutting of a specific side is not required and should be skipped, simply highlight that path by mouse-click and delete it by clicking the trash bin located in the panel on the right side of the mCAM screen.



Fig. 379: Deleting the selected cutting path in mCAM

#### Marking

If user wants to take advantage of the marking function before cutting, it can be done by checking the box **Marking** in Tool path settings for each cutting path separately.

✓ Tool path #1		
Split cut paths	Standard	$\sim$
Path generation mode	Automatic	~
Kerf compensation		
🗹 Marking		
🗹 Cutting		
Transformations		
Layer	Automatic transformation	$\sim$
Laser operations	Large contours	$\sim$
Waterjet operations	Q5	$\sim$
Stop (M0) before cutting		
No piercing		

#### Fig. 380: Marking checkbox in mCAM

To ensure that the machine will stop before cutting, after the marking has been done, check "**Stop before cutting**" box in the Tool path options. Otherwise, the machine will perform the cut right after the marking.

✓ Tool path #1		
Split cut paths	Standard	$\sim$
Path generation mode	Automatic	$\sim$
Kerf compensation		
🗹 Marking		
Cutting		
Transformations		
Layer	Automatic transformation	$\sim$
Laser operations	Large contours	$\sim$
Waterjet operations	Q5	$\sim$
Stop (M0) before cutting		
No piercing		
Shift points on surface	In hole axis	$\sim$
Adaptivity mode	From measure settings	~
Technology operation	Default	

Fig. 381: Stop before cutting the checkbox in mCAM

There is a possibility to select more than one cutting path for the settings of cutting paths purposes (e.g., settings of lead-ins and lead-outs, marking, stop after marking function, etc.). To choose multiple cutting paths hold SHIFT and select all desired cutting paths. Performed settings will apply to all the selected paths.

### Path generation mode

For Path generation mode settings MicroStep recommends:

- In case of a single cutting path ->
- In case of multiple cutting paths ->
- Linear partial mapping Min distance



#### Fig. 382: Single cutting path



Fig. 383: Multiple split cutting paths

### Shift points on the surface

Due to the precise projection of the cutting path on the surface of the scanned semiproduct, the user is prompted to choose the method for "Shift points on surface". This means the way how is the direction of the cutting path shifted on the scanned material. MicroStep recommends using one of these options:

#### • In hole axis

In hole axis method means, that each one of the cutting points shifts in the exact same direction depending on the hole axis.



Fig. 384: Shift points on surface – in hole axis type

To select this method, click on the desired path and choose "In hole axis" in Shift points on surface area in the Tool path options.



Fig. 385: Shift points on surface – in hole axis type in mCAM

#### • In cutting direction

In this method each one of the cutting points shifts in a defined direction -> perpendicular to the material.



Fig. 386: Shift points on surface – in cutting direction type

To select this method, click on the desired path and choose "In cutting direction" in Shift points on surface area in the Tool path options.



Fig. 387: Shift points on surface – in cutting direction type in mCAM

Finally, to generate the CNC, simply create a Job by dragging the desired shapes in the Jobs area and press the diskette icon to choose a folder for placing generated CNC file.

Imports Import shape	✓ ▲ Dome segment CD: 4670.00 mm RS  ✓ ▲ CH: 100.00 mm  ✓ ✓ Stock part  ✓ 4670x642_petal_smaller.
~ Recent imports / Folders	
Jobs	
Drop shapes here to create new job	
Temporary job 4	
₹ tx	

Fig. 388: Generating CNC from created Job

## Pipe nesting in mCAM

### Introduction

Pipe nesting process is a complex task of nesting individual parts on a stock in all forms of pipe and profile shapes. This document introduces settings, possibilities and recommendations during Pipe nesting process in mCAM.

For customer based production

- Import shapes
- Place them to temporary job
- Cut result
- Discard all data

For own production:

- Import shapes
- Place them to permanent job
- Cut result and check result
- Store job for later usage

### Importing pipe shapes in the mCAM program

#### Import shape in mCAM

To import the desired pipe shapes in a suitable format (\*.step / \*.stp) it is possible to use the **Import shape** button on the left side of the main mCAM screen. Pressing the button will allow to browse computer files and choose those, that should be loaded in mCAM.

Alternatively, the user can choose File -> Import shape or press the shortcut key Ctrl + I

For import whole directory use – right icon <sup>Ca</sup>.



Fig. 389: Import shape in mCAM



Fig. 390: Imported pipe shapes in mCAM

 $\bigcirc$  Import shape

### Creating a Job in mCAM

To create Job in mCAM simply drag and drop your selected shapes into the Jobs area in the left part of the mCAM screen. Shapes can be imported to a newly created Job or in already existing Job. Job can be saved to disk as a single file. This job can easily be transferred to different mCAM.



Fig. 391: Drag shapes to create a new job in mCAM



Fig. 392: Drag shapes into already created Job in mCAM



Fig. 393: Example of imported job in mCAM

After creation of job, mCAM automatically sets a template and stock with default length. User can run simulation and save CNC using the corresponding icons. Template is a single size of stock pipe or profiles.



Fig. 394: Template

### Stock settings in mCAM

**Stock part** is a specific piece of material where the parts have been nested. To add stock with specific dimension, use right mouse click and choose "**Add stock**". In the Job stock area set desired length. The number of stocks can be multiple.

1
6000.00 mm
0.00 mm

Fig. 395: Job stock properties in mCAM

The objects with grey contours in the list (for example "**sq\_60\_40\_1\_500\_7**") are parts that have already been placed on the stock.



#### Fig. 396: Part that has been placed on stock

The objects with red contours (for example "**sq\_60\_40\_1\_500\_6**") are the parts that have not been placed on the stock yet.



#### Fig. 397: Part that is waiting to be placed on stock

mCAM allows to multiply number of parts. If you want to create multiple parts with the same shape and dimensions navigate to Job part area and set a desired number of parts. Take into consideration that change of the cutting paths that has been done on the original part will apply for all of the copies as well. To avoid this, it is necessary to drag & drop the part multiple times.

∨ Job part		
Count	2	

Fig. 398: Setting number of Job parts

#### Nesting of parts in mCAM

Icons for nesting of the parts are shown on the right side from the template as orange or grey "puzzle pieces" as shown below.



Fig. 399: Nesting icons

Grey icon represents the (original) full nesting. The way it works, is that it takes all the parts and stacks them according to its own consideration (randomly). Nesting is a complicated task; by using this method, the results might not always be optimal. The drag and drop function will order the parts according to the requirements within the job.

- 💮 Rectangular profile 🕅 💿 🛟 🖗 L: 1200.00 mm W a Stock part 984.44 mm sq\_60\_40\_1\_500\_7 sq\_60\_40\_1\_500\_6 Stock part 983.78 mm sq\_60\_40\_1\_500\_3 sq\_60\_40\_1\_500\_5 L: 1300.00 mm W @ Stock part 984.44 mm sq\_60\_40\_1\_500\_4 sq\_60\_40\_1\_500\_7 Stock part 1011.69 mm sq\_60\_40\_1\_500

Fig. 400: Ordering the parts within the job

Orange icon represents the local (arranging nesting). It allows user to manually set the rotation and to optimize nesting manually. This way is considered optimal for using mainly for

these reasons:

- does not change the order of the parts
- does not transfer the parts to other pipes
- if the part does not fit on the pipe, nesting will exclude this part

### Limited positioner in mCAM

Due to reasons of power supply wiring leading to the positioner and supports, the positioner has a usual limitation for range of rotation set from -398° to 39°. To take this matter into account, check button -> **Consider limited positioner** in Nesting settings for template.



Fig. 401: Consider Limited positioner option in Nesting settings in mCAM

Rotating the part might be a solution for cases when the positioner limitation can be an obstacle during the cutting process. To enable this feature check **Enable part rotation and flipping** in the Nesting settings for template. If it is possible program will rotate and/or flip the material in the best position for cutting of the part.



## Fig. 402: mCAM will alert the operator in case when the part can't be cut due to a limitation of the positioner

Another way how to solve the obstacle related to positioner limitation is to use microjoints, which will divide the whole cut to smaller sections.



Fig. 403: Microjoints applied to cut

For certain machines (in case there is a mechanical limitation on the machine), it is suitable to specify a small clearance at the beginning of the pipe. For these reasons there is a "**Start point X offset**" option, that can be found in nesting settings. To set the length of the offset start, enter the value specified in millimeters. "Start point X offset" and "Begin offset" represents the same entry.

Start point X offset is defined for template; i.e., all pipes specified in the given template (one type of shape). Begin offset is defined for a specific stock. The resulting offset is the sum of these two values.



Fig. 404: Start point X offset option in mCAM



Fig. 405: Start point X offset option applied on the material

#### Use part envelope only -

Using the function "**Use part envelope only**" in mCAM, will results in the parts being nested next to each other without the possibility to slide them into each other when bevel cuts are present. On the other hand, it allows the user to freely rotate the profile without the need to run the nesting again (i.e., the part is always considered as it does not have a diagonal cut on the edges).

Use part envelope only option can be enabled/disabled by using checkbox in Nesting settings in mCAM.



Fig. 406: Option "Use part envelope only" in mCAM



Fig. 407: Nesting results shown in a tooltip

#### Using the common-cut.

In cases when two parts are placed to each other and the cuts of these parts are identical (with given precision), they can be combined into a single common-cut; provided that this option is enabled in settings. To enable/disable common-cut and to set a precision of the common-cut, use checkbox "**Use common-cut**" in nesting settings.



Fig. 408: Common cut in mCAM

If the specified value of precision is too small (0,0001 mm), there is a risk that common cut cannot be created. If the specified value of precision is too big (3 mm), the common cut will be created, although the resulting precision of the cut might be insufficient.

### Nesting gap in mCAM

After the initial nesting and after all the necessary manual corrections, the field "Enable part rotations and flipping" can be unchecked. Nesting will automatically add the new parts one after another. To set the gap between each part, set "Nesting gap" value, which represents the distance between individual parts. Nesting gap ignores lead-ins during the nesting; therefore, the gap must be larger than lead in for each part.

Nesting gap

5.00 mm

Fig. 409: Nesting gap in mCAM

### Saving the CNC in mCAM

To **save** the desired CNC use one of the options below:

1. Using the diskette icon to save CNC

**Diskette icon** - save the CNC file to disk.

This option is suitable for machines that don't have the MRP feature turned on.





#### Fig. 410: Saving file to disk

2. Using the cloud icon to save CNC

Cloud icon - save CNC file to disk and also to MRP.

Using this option results to sending the CNC file directly to the machine and to the database.





Fig. 411: Saving file to disk and MRP

MRP must be supported by particular machine. In that case, user can select "use MRP" in mCAM settings, so mCAM can upload cutting programs directly to machine database – until the network to machine connection is available.

### Split stock in mCAM

In case when a single stock has multiple physical parts, it is possible to use "Split stock" function and separate individual stocks in the list of stocks in mCAM. Split stock function can be found in mCAM, after right click on the specific stock part.



Fig. 412: Before and after "Split stock" results in mCAM