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CAM
User's Guide

Cenon
The CAM User's Guide
Version 5.0

by Georg Fleischmann
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http://www.Cenon.com

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Contents

Chapter 1

General Information

1.1   About this Book

This documentation serves as a reference of the CAM functions of Cenon. It is meant as a reference guide as well as a working guide.

Depending on your computer system (Linux, Apple) or the applied Theme (skin), there are differences in the look of the user interface. The panels depicted in this book may differ in their look from the interface you are using, although the placement of the controls remain identical.

The various computer systems (Apple, Linux) also show some differences in the directory structure. This information is always given for all systems.

This book was created using LyX on Linux. The cover page was designed using Cenon.

All trade marks like PostScript, Adobe Illustrator, HPGL, DXF, Gerber, Excellon, Sieb&Meyer etc. belong to the respective owners.

1.2   The history of CAM with Cenon

Manufacturing is how Cenon started at the end of 1992 and is one of the major strength of Cenon. In the year 2000, restructuring of Cenon was started to bring Cenon to the new plattforms Apple and Linux. Cenon was also turned into a modular system.

Since version 3.6 of Cenon, the CAM functions reside in their own module. This gives Cenon a great flexibility and more users, especially in the area of vector design and Desktop Publishing. As a result, also the CAM functionality greatly improved.

Cenon CAM is very well prepared for the coming innovations in the sector of Computer Aided Manufacturing.

1.3 What can you do with Cenon CAM ?
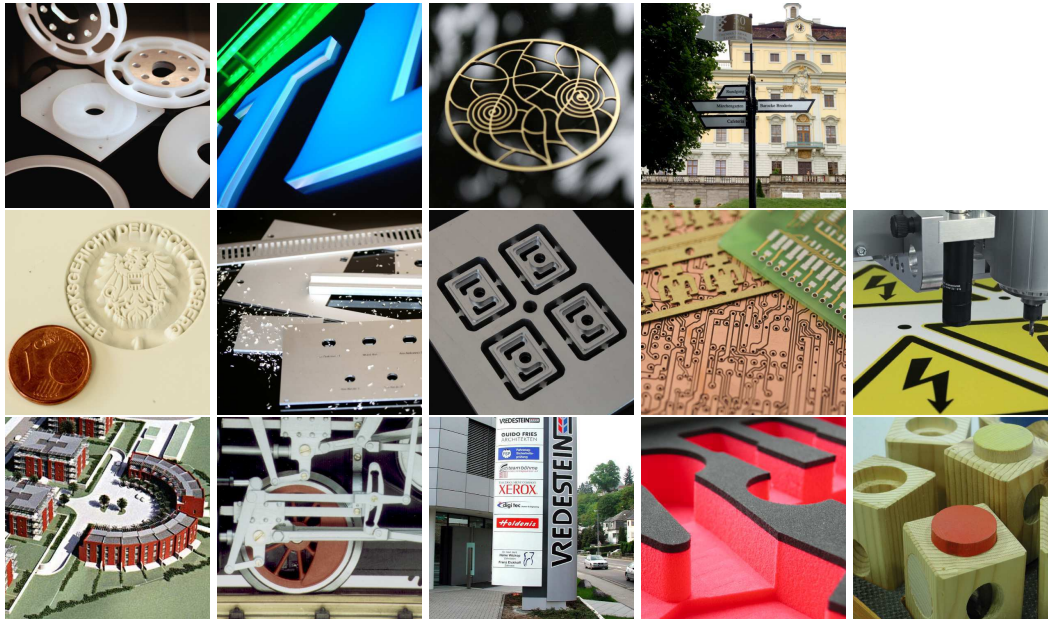
We thank our clients for their kind permission to use these pictures. You can find many more pictures on the Cenon web-site.

Manufacturing is the native application of Cenon. That is how Cenon started. Since 1993 this important application of Cenon has been continuously developed and improved. Today, Cenon is at home in almost all areas of manufacturing. The wealth of installations world wide ranges from Engraving of embossing plates, Model Making, and Sign-Making, to Industrial serial production.

Key Features

- Well structured and transparent work flow with short learning cycles

- transfer of data from almost any graphics- and CAD-application, as well as the internet, through Cenon's vast import capabilities.

- automatic tool radius compensation to inside, outside, right, or left

- Pocketing with standard- and Contour algorithm

- Pick Out (Carving) for high precision engraving, or raised items (logos, letters)

- Relief function on raster images and vector graphics to create 3-dimensional relief images

- Drills, threads, countersinks, counterbore, ...

- Stepwise machining in variable step widths

- Smoothing

- Angular Approach

- Webs (Bridges) to support parts during manufacturing

- Selective Manufacturing

- Precise interactive positioning of machine

- iPad App to control machine

- Teach-In

- Tool management

- Output to HPGL, ISO (G-Code/NC-Code), and DIN-66025 compatible devices

- Output Statistics with estimates

- Option: Camera-Positioning

- Option: Camera-Gauging

- Option: Prototyping of Printed Circuit Boards PCB

- Option: Multi Head Support

- Option: Flexible Automation, allows serial production with customized parametrization

Examples of application

- Sign Making

- Engraving (door signs, goblets, coining dies, ...)

- Wood Working, Furniture Making, Toys

- Reliefs (coins, embossing tools, furniture, etc.)

- Industrial engraving (type plates, labels, signs ...)

- Electronics (front panels, switch boards, prototypes of printed circuit boards, ...)

- Model Making (models of buildings, industrial appliances ...)

- Precision Mechanics

- Cutting, for example cutting of foils for polishing optical glasses, sandblast foils, leather

- Production of individual operation panels or dashboards

- you name it

1.4   Other products around Cenon CAM

This chapter introduces some products and services around Cenon CAM.

1.4.1   Additional Features

Cenon CAM can be extended by additional functionality. The following is a list of
add-on features:

- Cenon Control for iPad (free of charge)

- Camera-Positioning (included in Camera+Targeting)

- Camera+Targeting

- Prototyping of Printed Circuit Boards (PCB)

- Multi-Head Option to support more than one tool head (for example: spindle
  + knife)

- Flexible Automation

For more information visit our web site (http://www.Cenon.de) and the Cenon
CAM web site (http://www.Cenon.com).

1.4.2   Machining Systems

Selected Machining Systems for Cenon

To make it as easy as possible for you to find your Cenon machining system, we have
prepared a number of selected machining systems for a variety of applications. You
can configure each system online to your needs and request an offer.

Other Machines

Cenon CAM can drive most CNC-machines supporting a command set based on
HPGL or G-Codes (NC). Additionally some CNC-Controllers with special command
sets are supported by Cenon CAM. We can offer assitance to configure Cenon CAM

for your choice of machine.

Even if your machine's CNC controller is not compatible with Cenon CAM, you can still use Cenon CAM as a manufacturing software and export the NC data. This way, you can use any CNC terminal to output manufacturing data from Cenon. This is actually the standard way of most manufacturing software !

Retro Fits

On request, we also offer a bundle including Cenon CAM with a modern CNC controller. This enables you to convert almost any 2 or 3 axis mechanics into a state-of-the-art machining system.

For more information visit the Cenon CAM web site http://www.Cenon.com.

1.4.3 Tools and Tool Parameters

Tool Parameters

We offer an online calculation of tool parameters which gives a good idea of the tool parameters for a given tool and material. You can find the tool on the Cenon CAM web site:
http://www.Cenon.com

1.5 Installation

The installation process for Apple and Linux (GNUstep) differs. Please read the section for your System.

Here we describe the installation of the executable packages only. If you want (or need) to compile Cenon yourself, take a look at the file INSTALL inside the source tree.

1.5.1 Installation on Apple (Mac OS X)

1. Insert the installation medium and wait until the volume appears in the Finder. Then click on the volume and goto into the directory 'Apple'. If you downloaded Cenon, you can skip this step.

2. You will find a package with the name CenonCAM-x.x.x.pkg. Double click the package to start the installation.

3. The installer appears, where you have to authorize yourself as administrator.

4. Then you can start the installation process by confirming the various stages (Introduction, Read Me etc.).

   If you plan to install an alternate set of CNC configurations, you have to do this in the step "Installation Type" by pressing the button "Customize". See picture below.

5. If you have a previous version of Cenon already installed, the install program will notify you. Just continue the installation.

6. After the package is installed, you can start Cenon. To do this, go to the directory '/Applications' and start Cenon with a double click.

   If you have installed Cenon the first time, the license panel appears. Here you can license the program, or you can run Cenon in demo mode.

7. Your CNC controller may have a serial interface to be connected to the computer. Since newer Apple computers doesn't provide a serial interface, you need an USB adaptor - usually this is a adaptor from Keyspan:

   http://www.keyspan.com

   Install your Keyspan adapter and the driver software as given in the adaptor documentation. To be sure that everything works, you can use the 'Serial Assistant' coming with your Keyspan adaptor.

   If you have problems, you can check the device entry (#DEV) in the Cenon device configuration (Kapitel 4.2). The device entry must be equal to the device created by the USB adaptor (/dev/tty.USA...). The devices in the Cenon configuration provide a wildcard '*' to allow automatic device expansion.

   Tip: If it happens that the serial device hangs (e.g. no device is connected), than you can unplug the USB adaptor to regain access. You can use the cu device instead of the tty device to avoid the hanging of the device and Cenon in this case.

8. To come into the pleasure of importing PostScript or PDF files, you have to install GhostScript. You can get a version of GhostScript from the same place where you got Cenon, but any other version of GhostScript will do the job. Double click on the GhostScript package to start the installation.
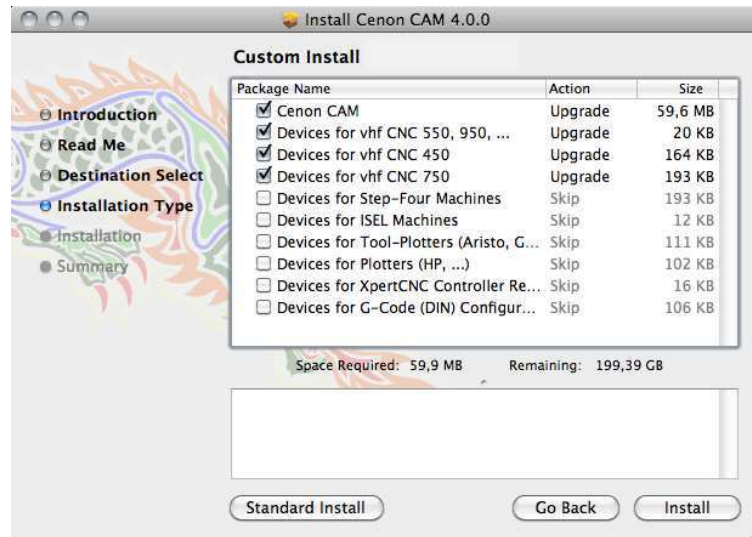
1.5.2 Installation on Linux

1. log in as user root

2. Insert the Cenon-CD and mount the CD. Then change to the directory 'Linux ▷ i386 ▷ CAM' or 'Linux ▷ ppc ▷ CAM', depending of your architecture. If you downloaded Cenon, you can skip this step.

3. You will find a RPM package. Install it with the installation tool of your Linux distribution, or enter the following command in a terminal shell:

```
rpm -Uhv Cenon*.rpm
```

4. To start Cenon go to the folder /usr/GNUstep/Local/Applications and start Cenon with a double click. If you don't have GWorkspace running you can start Cenon by typing 'openapp Cenon' from a shell.

   If this is your first installation, Cenon will ask you for a license key.

1.5.3   Installation on OpenStep (Deprecated)

1. Log in as user root

2. Insert the Cenon-CD and wait until the CD-Symbol appears in the File Viewer. Then click on the CD-Symbol and go into the directory 'Apple ▷ Packages ▷ CAM'. If you downloaded Cenon, you have to unarchive the downloaded file instead (usually a double click should work).

3. You will find three packages, which you have to double click one after the other. The names are:

    (a) Cenon.pkg

    (b) CenonLibrary.pkg

4. For each package a window will appear, where you have to click on Install.

5. Then another window appears. Just click on Install or press Enter. The files are now extracted from the file and copied to the hard disk. This takes a few moments.

    If you have an old version of Cenon already installed the install programm will notify you. Just continue the installation.

6. Wait until the first package has been finished before installing the next one.

7. After all packages are installed start Cenon as user root. To do this, go to the directory '/LocalApps' and start Cenon.app with a double click.

    If you have installed the CAM version of Cenon for the first time, the license panel appears. Here you can license the program (See the next section) or decide to run it in demo mode.

1.6 Licensing

In the Info menu of Cenon you can call the licensing panel (Info ▷ Licensing).. The first time you start Cenon CAM it will appear anyway.
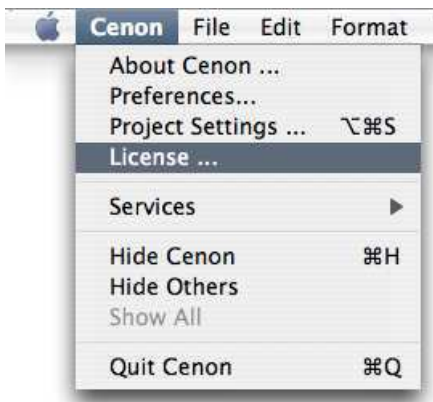
In the following panel you have to enter the Password for Cenon CAM. You should have received your license key with Cenon.

Please enter (or copy) the password into the password field. Then enter your name and address.

Finish the licensing process with a click on "Enter License".

The upper part of the Panel shows the active licenses. The lower part of the panel shows the features and their status of activation (Blue = activated).

1.7   Initial Operation

You will find Cenon in the application folder. Double click on Cenon.app to start Cenon.

In the library folder of Cenon you will find some examples: The folder *'CAM/Jobs'* provides some examples of Jobs.

The library of Cenon resides in slightly different places, depending on your system:

Apple: /Library/Application Support/Cenon

GNUstep: /usr/GNUstep/Local/Library/Cenon (or /opt/...)

OpenStep: /LocalLibrary/Cenon

1.8   Support

User Guide   We try to keep the user guide practical and full of information. The user guide should answer most of your question.

Tutorials   In the download area of Cenon, we have some tutorials available. Additionally, there are tutorials and examples in the Library folder of Cenon.

WWW   You can find information about new versions and an up-to-date FAQ (frequently asked questions) on our Cenon-CAM Website: http://www.cenon.biz.

Mailing list   In the mailing list of Cenon, you can ask questions and exchange yourself with other users of Cenon. To subscribe to the mailing list you can go to the Support page of the Cenon internet site.

eMail   The best support is certainly possible via eMail, as you can attach example files easily here.

Bugs   If you find a bug, we are thankful to receive your bug-report. We will try to fix serious bugs for the next release.

Chapter 2

CAM with Cenon

2.1 Methodology

In the following we will give you a short overview of the fundamental procedures for the output of a graphic. In the following sections you can find detailed information about all the (possible) operations.

- Import of a graphic

- Creation of layers for every necessary operation Distribution of the graphic to the right layers.

- Setting of the tools that you want to use.

- Allocating of the tools to the layers. Setting of the dip depth.

- Positioning of the machine. Start the output.

2.2   Output of a graphic

In the following we show you all the single operations to work with a graphic file on your milling and engraving machine. Our example is an imported graphic-file that is not edited.

Editing: The editing-functions of Cenon are described in the Cenon main book beschrieben.

2.2.1   Import of the graphic file

First you have to load the file. It can have Postscript (EPS, PS, or AI), HPGL, DXF, Gerber, SVG, or G-Code format. Cenon recognizes the format automatically by the file extension. You only have to choose the command "open" in the file-menu and select the right file from the graphic-file-window.

Menus: The description of the several menus you can find in section 3.3. and in the Cenon main book

For our example we want to load an Adobe-illustrator file. This file belongs to the delivery extent of your Cenon version. It is installed automatically in the library path. Go to path: /Library/../Cenon/Examples/ai and load the file "HighTension.ai" that looks as follows:
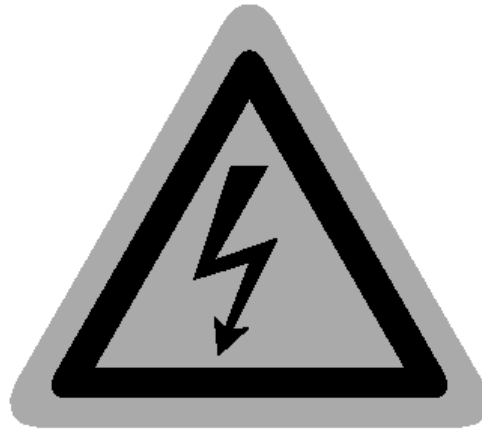
2.2.2 Creation of layers - partition in several production units

Several production steps are needed to work with such a graphic file on your machine. In this case there are at least two - the engraving of the flash and bordering, and cutting out the sign from the base material. These two operations will be handled in Cenon by two layers.

First you can choose another color for the grey graphic-file. Open the inspector. It offers you information about the selected graphic-file and you can alter it. You can find the inspector in the menu tools (entry inspector). When no element is selected the inspector shows the position of the crosshair. Click on the outer contour of the graphic. In the inspector a field appears that shows the color of the selected element (here light grey).
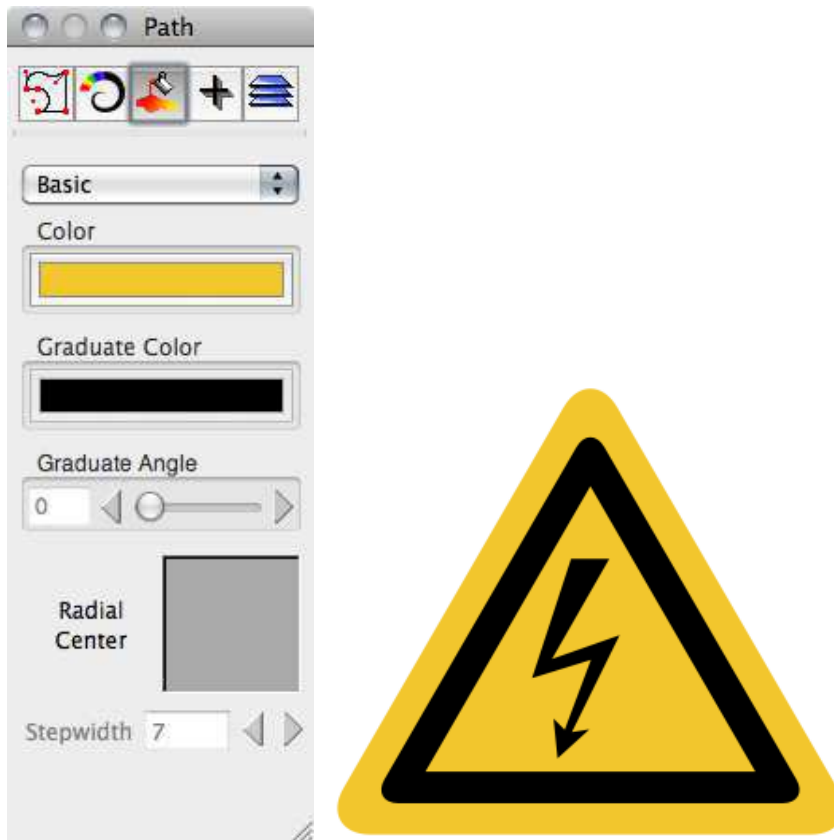
Inspectors: You can find further details about the inspector in the Cenon main book.

Click on the outer frame of this field. You get the Color-Panel with different options (you get the same window when you choose the entry colors in the menu tools). Here you can choose a shining yellow that suits for a warning signal.

Although black would be o. k. for the flash and the frame it's better to choose a brighter color because Cenon shows the ways of the tools also in black. To be able to see the difference it's better to choose grey.

After you have chosen the colors it's time for the CAM-Panel to separate the different operations. Open the CAM-Panel in the menu Tools (if it's not open already). The

CAM-Panel consists of "index cards". When you click on the name of one index card it is taken to the foreground and you can enter the settings.
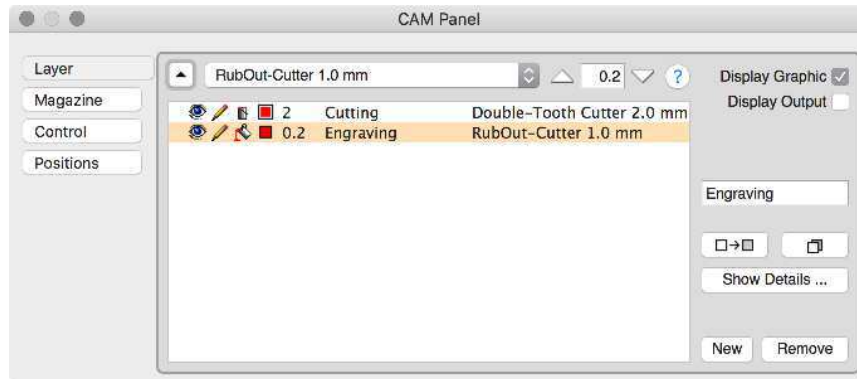
To separate the operations to the different layers you have to choose the index card Layer. With this panel you manage the layers, say the different operations of your graphic file. At first there is only one layer in the Layer Panel which is called "Non-ame". On the left of each line of layers are 4 different icons with which you can influence the design and the path calculation. The numerical value next to the icons indicates the dip depth or immersion depth of the tool, on the right you can see the name of the layer and on the right to the layer you can see the selected tool (in this case you cannot see a tool yet because none has been selected yet).

The name of the layer (here: Layer 1) should describe the respective operation. In this case you can enter e.g. "milling" for the layer that contains the outer contour (don't forget to confirm the input with "enter"). You can edit the name in the small field on the right of the window. Then you have to create a second layer that contains the engraving. Click on the button new and you get a further layer. You have to give this layer a new name, too, e. g. "engraving".

Now you can select the elements you want to engrave in the graphic window, the frame and the flash (by pressing the Shift-key during this selection you can choose more than one element (at the same time). Then you can select the second entry (engraving) in the layer-panel and click on Move to Layer. This will move the selected elements to the current layer. Now you have separated the two operations milling

and engraving successfully.

You can let Cenon carry out the operation for you (distribute the different elements with different colors on different layers. Therefore you have to switch on the button import colors on the layers in the window preliminary settings before you import the file (you get to the entry preliminary settings from the menu information.)- So you can spare a lot of effort later.

Now you can set some further parameters; therefore you can use the icons.

The eye on the left shows if the layers are displayed/shown. When the eye is closed the layer is not shown. Especially for control purposes we recommend to fade out some of the layers to be able to check whether the single elements are on the right layer.

With the small pencil you can decide whether a layer is editable or not. When you break the pencil you cannot change/transform/alter the layer any longer. So it is also protected from unintentional actions.

With the color-pot you can decide whether the output of the layer should be filled or not. In our case the engraving layer has to be filled (poured-out pot) and the milling layer (outer contour) is not filled.

You can set the radius-correction with the last of the four icons. For the milling layer you have to carry out an outward correction and for the engraving layer an inward correction. It's important that you choose the same diameter for the tool as for the operation later because the radius correction and the calculation of the filling alogarithm goes by the diameter of the chosen tool.

Some of the setting possibilities (and other special settings) that you can carry out with the icons you can also find in the window layer-details (you get there with the details button). When you click on layer in the layer-details-panel you get back to the layer-panel. But first you should set or check the needed tools.

Details: You can find further details about the Layer-Panel in section 3.6.1.

2.2.3 Preparing of the Tools
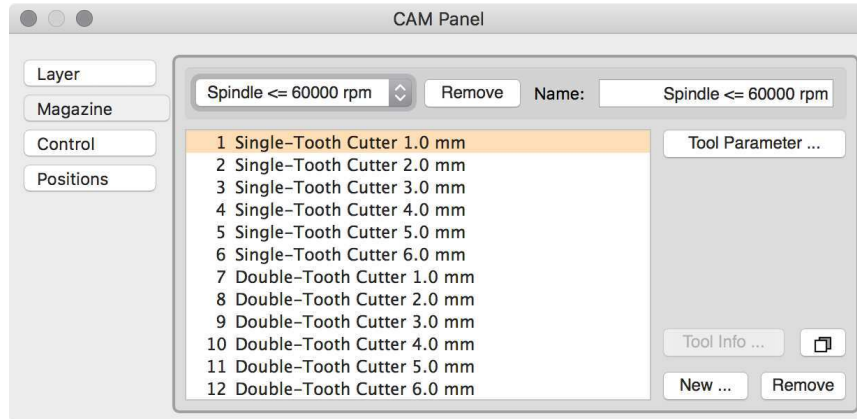
This panel shows the content of the current tool-magazine. Here you can delete existing tools and add new tools. With the pop-up-menu you can choose a different tool-magazine and from there you can select a tool for the next operation. The tools go by the ability to carry out a tool-change automatically (see plot-magazine).

When you click on parameter you can see the characteristics of the selected tool and you can adapt them if you want. In any case you have to check if our set parameters correspond to the actual values of your tools. If not change it according to the instructions.

When you use different tools you should also mind that all the tools must be chucked in the same height. Otherwise you have to set the z-position newly after every tool-change because you define the scratch-height with the z-contact value in the disposition-control-panel. Use only tools with stopping ring that are assembled in the same height if possible. If this is not the case with every tool you have to do the following:

Click on the button parameter in the Magazine-Panel. The following panel will show up:
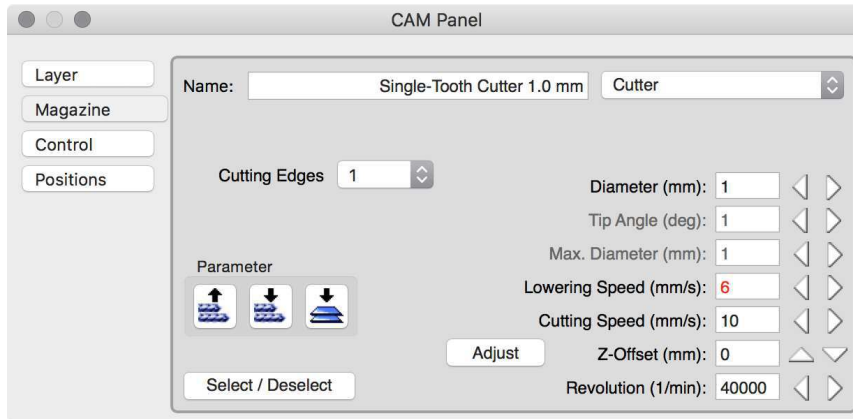
Here you can find the entry z-offset (among other entries). With this entry you can enter the difference of the height to the biggest tool (the value z-contact has to be fixed with this tool). If the longest tool is 38mm from the stopping-ring to the top and the actual tool is only 30 mm you have to enter 8 to the z-offset. You can use the adjustment button to determine the scratch depth by trying out.

Details: You can find further details to the tool-panel in section 3.6.4.

Tools: Interesting information about the tools, the selection, the calculation of the rotary frequency, forward feed you can find in section 5.1.

2.2.4   Assigning tools to layers

After the adjustment of the tool parameter you have to assign a tool to every layer and adjust its dip depth into the material. Therefore click on the Layer-Panel again.
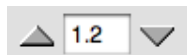
On the right next to the red icon for the radius-correction is a numerical value (presently:0). This value indicates the dip depth directly from the surface into the workpiece. For the engraving some tenth of a mm is enough to get through the topmost layer of the material. You can adjust the dip depth either with the help of the two arrow buttons

or you can enter the numerical values directly in the field between the two arrows. For the layer that is milled you have to enter the thickness of the material so that it is completely cut during the milling operation.

```
 1  Single Tooth Cutter 1.0 mm
 2  Single Tooth Cutter 2.0 mm
 3  Single Tooth Cutter 3.0 mm
 4  vhf Rub – Out 0.5 mm
 5  vhf Rub – Out 1 mm
 6  vhf Iso Cutter 0.2
 7  Drill 0.8mm
 8  Drill 3 mm
 9  Drill 5 mm
10  Zweischneider 4.0 mm
11  Zweischneider 5.0 mm
```
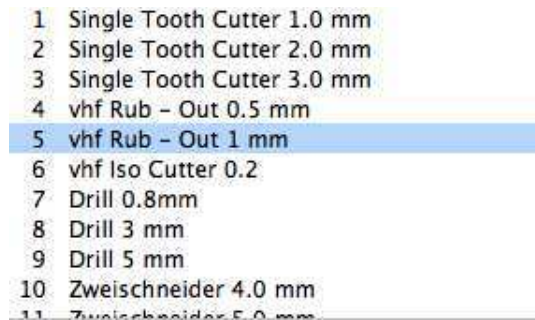
With the pop-up-menu next to it you can select the tool with which the next operation should be carried out on your engraving machine. Mind that you enter the right tool diameter because it is needed for all the calculations. All the tools that are in the actual magazine are shown.

```
Display Graphic ☑
 Display Output ☐
```

When you finally click on "Display Output" in the Layer-Panel you can see the drive-ways that were calculated by Cenon. They lay black over the original graphic. If it's hard to see the drive-ways it might be better to enlarge the display. Therefore you can find a pop-up-menu on the lower border of your graphic window with which you can choose the zoom-factor. The best way might be to click on the magnifying glass. Then you can drag up an area of the graphic window that is enlarged to the whole size of the graphic window.
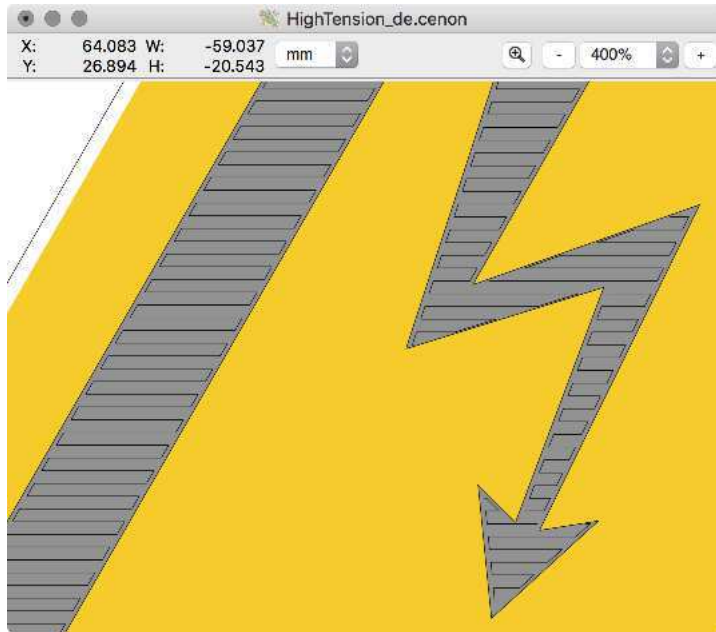
Graphic window: Further details about the graphic window you can find in the Cenon main book.

Your Layer-Panel should look almost like this when everything is correct:
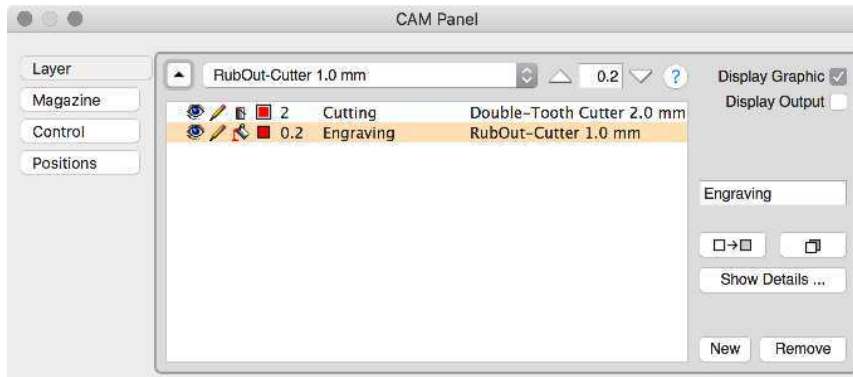
2.2.5   Positioning of the machine

Now the preparation is finished and we can now start to go into production of our graphic: take an appropriate multilayer plastic board (we recommend to take one with a yellow top layer and a black basic layer). Now you can chuck the board onto the engraving machine.

Now we come to the third part of the panel namely the machine Control. Click on the appropriate index card and your window looks like that:
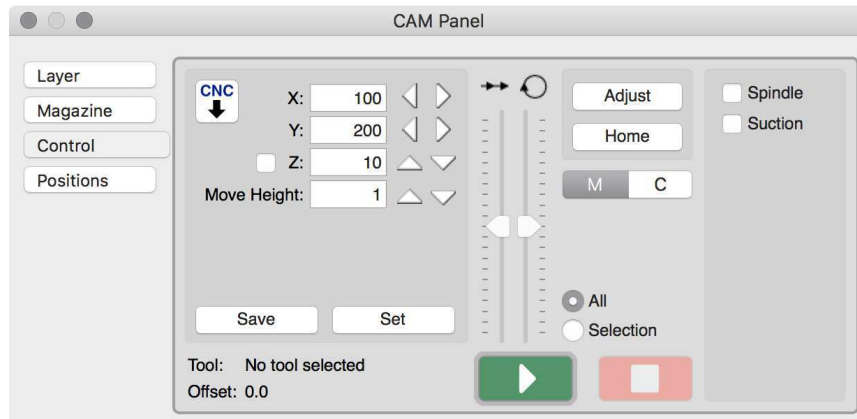
In the machine control you set the starting point where the machine is supposed to start the operation on your workpiece. You can move the machine directly when you click on the appropriate arrow buttons. If you want to enter the positions manually don't forget to press the Enter-button to drive towards the position. But Attention: as soon as you press Enter or click on Set Position the machine moves to the given position. If you give a wrong position (especially for z) this could lead to damage of the spindle or the workpiece.
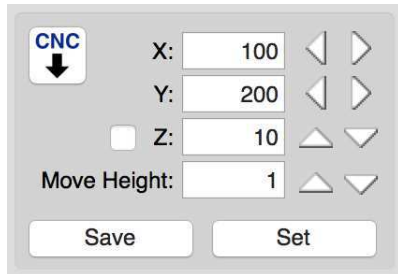
That means it's better to set the starting position with the arrow buttons for X, Y, and Z. Move X, and Y to the lower left of your working piece, then lower Z down to the surface, so the surface is almost scratched but isn't. When you click on the arrows and press the Ctrl-key at the same time the machine is positioned in 1 mm steps.

The move height (or flight level) should be set to a secure value. This is the height the tool will move above the surface of the working piece.

Use the memory for the positioning! Especially when you have a lot of workpieces of the same size we recommend to justify the workpieces at the side stop and take the saved starting position when you work with a workpiece of the same size.

To save a position move to the starting position in the machine Control-Panel. Then choose the index card Positions. Now you are in the position-memory management.

Click on the pop-up-menu and choose the last entry New Position. Cenon takes over the current position from the Control-Panel and calls it: UNTITLED. You can edit this field and give it a proper name. Later you can recall the saved position, watch it and finally move the machine directly there by clicking on *Move to Position*.
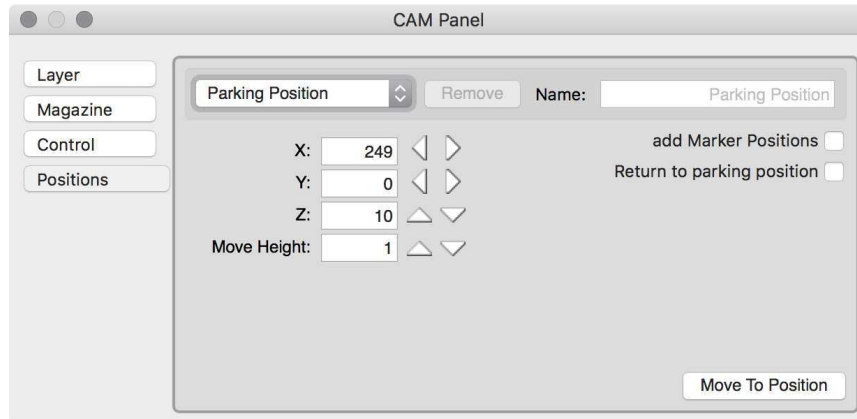
As we already mentioned please mind that the Z-position is not too low when you move to saved positions (e.g. when you use another pad). After you have clicked on "move to the position" you get back to the Control-Panel automatically.

Details: Further details about the Control-Panel and the position memory you can find in section 3.6.5.

2.2.6   Starting the output

Finally you can start machining your workpiece. By pressing the start-button the output begins. Before the output actually starts, you may be asked to insert a tool. For this the z-axis moves to the zero position.

Depending on how your system is equipped, Cenon can select the tool automatically and also start the spindle automatically. If not, you have to turn on the spindle manually before you press OK in the dialogue box!

The machine starts to work on the workpiece. The machine starts to work according to the sequence of the layers you have set in the layer-panel. that means in this case the machine starts with the outer contour.

If you want to change the sequence you can do this as follows: the machine only works on layers with open eyes. When you want to start the output with the layer "outline", shut the eye of the milling-layer and start the output. In a second operation you can open the eye again and shut the eye of the engraving-layer.

A second possibility to output certain elements only, is to select the desired elements in the graphic window. In the Layer-Panel, select the radio button "Selection". If you press start only the selected element will be given out.

When the machine is ready after an operation the z-axis moves back to zero-position and asks you to change the tool until all the layers are ready.

2.3   Pick Out (Carving)

The function Pick-Out (Carving) has been developed for the manufacturing of stamps. Therefore you have to keep a few things in mind.

2.3.1 Preparation of the graphic

The pick-out will clear the black fields of the graphic. That means you have to create a negative picture of your graphic. Your graphic appears then in white color on a black background. The black background is cleared while the graphic is filled. The outline of the stamp must lay within the negative graphic so that only the original graphic remains raised.

You can also calculate the drive-ways for **raster images** (e.g. TIFFs) during the pick-out. To get a good result you have to scan the graphic bigger than how it should appear later. In the Cenon program you can reduce the size to the original size again. You should scan the graphic at least 4 times bigger than the original size so that Cenon is able to work with it. After you have dragged your graphic into the graphic

window you can start scaling the graphic in the transformation panel (menu work, entry transform).

The bigger you scan your graphic the more exact is your result but also the longer is the calculation-time. You need a negative picture of your graphic here, too.

2.3.2   Selection of the tools

The Pick Out corresponds mainly to the inward tool-radius-correction. Additionally the tool is raised in the edges and in parts that are too small to create an exact picture of the graphic on the material best as possible.

The right choice of the tool plays a very important role because the Pick Out can only be carried out with conical tools. Four values are decisive for the choice of the tools:

- maximum diameter

- diameter

- acute angle

- wanted dip depth

d2	maximum diameter
d1	diameter
a	acute angle
h	dip depth
d3	calculated angle
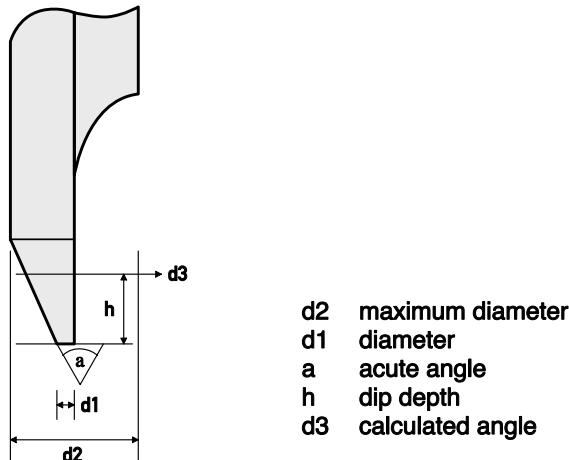
Cenon calculates the effective diameter (d3) of the tool from the dip depth (h). The drive-way is calculated with the effective diameter (d3). When we come close to an edge the way to the edge is searched and the diameter (d3) is reduced as necessary by lifting the tool. The maximum accuracy in edges is determined by the diameter (d1). The same goes for passages that are too small for the maximum diameter (d2); the diameter is reduced until it is small enough to go through this passage.

The tool is supposed to get through every passage with the effective diameter (d3) (calculated with the dip depth) so that the tool has only to be lifted in the edges. Too small parts on the graphic should be avoided if possible.

2.3.3   Example

The example of a stamp will show a practical example. The stamp has an original width of 34 mm and a text height of approximately 4 mm.
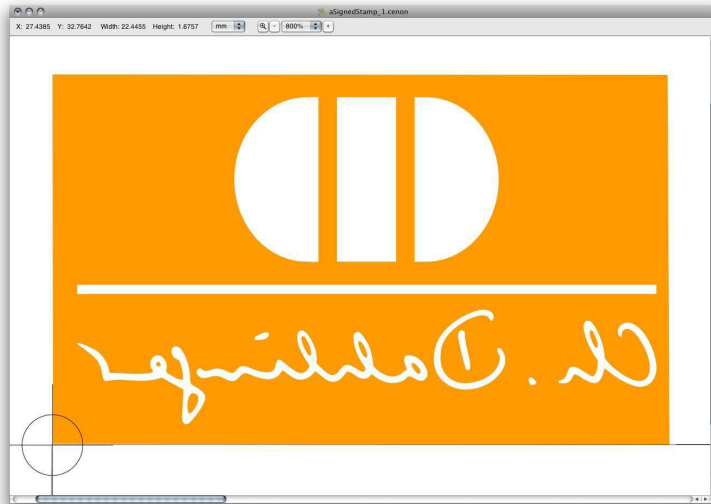
As we want to make a stamp, the motive is mirrored. The orange areas in the example will be removed, the white text will remain.

Layers and Tools
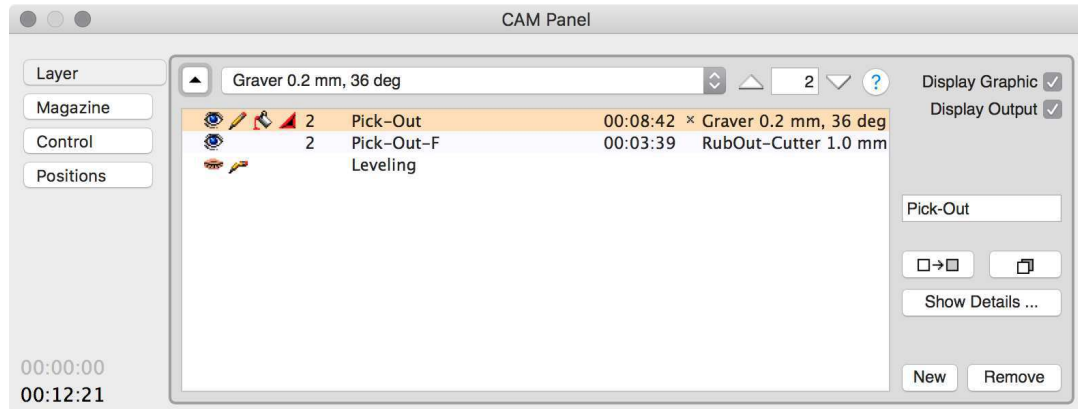
The PickOut offers two layers. The first layer is responsible for the actual pick out process. The second layer is filled and makes the rubout.

In the example a conical tool is used with 0.2 mm tip diameter and a tip angle of 36 degree. The first tool must be conical!

For the filling, the example uses a conical tool too. It has a tip diameter of 1.0 mm and 36 degree tip angle. The tool for filling may be cylindrical.
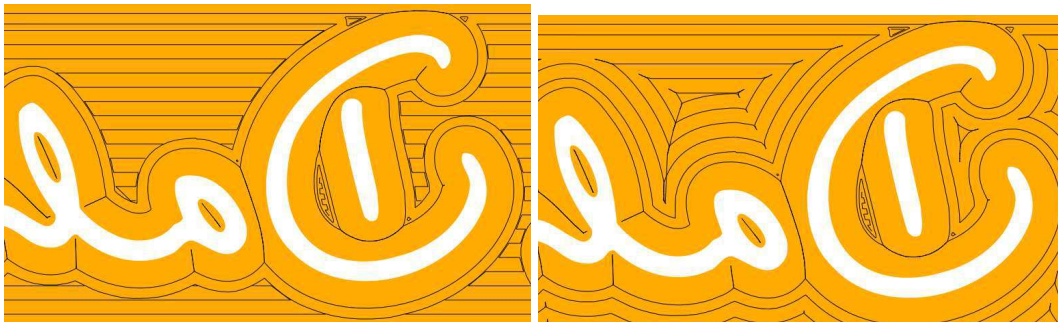
The result is a complex fill pattern. The images show the engraving tracks of an enlarged part of the screen. The first Image shows the Standard-Filling, while the second image shows the Contour-Filling.

The three processing steps are clearly visible:

1. rough filling using the filling tool

2. fine filling using the pick-out tool

3. pick out

Tip: The Contour-Fill can be activated in the Project-Settings (see section 3.2.1).

Tip: Cenon offers Vector- and Raster-Algorithms. In case the Pick-Out shows a critical spot with problems, you can change to the Raster-Algorithm (see section 3.2.1).

2.3.4   Carving from Outside (>= v5.0)

To achieve a more three dimensional appearance of cut shapes, you can carve individual letters or logos from Outside.

The first step is to go to the Layer-Details Panel and choose "Pick-Out Outside" from the algorithm Pop-Up (see section 3.6.2).

Cenon will create an additional passive layer, having the same name as your original layer, with a suffix "-C" for "Contour". This is a contour layer, used for cutting the shape.

			Carving Outside-C	Single-Tooth Cutter 3.0 mm
		10	Carving Outside	Graver 0.5 mm, 36 deg

1. Carving Layer: "Carving Outside", 2. Contour Layer: "Carving Outside-C"

1. Carving Outside

The graphics to be carved is placed on the layer you created, in the example it has the name "Carving Outside".

For carving outside, you will need a conical tool, just like for Pick-Out (Carving Inside), which you have to assign to this layer.

Especially for complex layers, you should turn on "Pocketing" (flipped bucket). Only the conical tool on the carving layer is used for pocketing, and only as much as necessary to clear the area.

This first machining step with conical tool will take care of the slanted edges.

2. Carving Outside-C

The other layer, which has been created by Cenon (-C) can have it's own settings, for example: output direction, depth, approach angle, step-wise cutting, tool settings. This layer is processed after the carving and will cut out the path (here the letter A) from the material.

2.4 Creating Reliefs

Using the Accessory Inspector you can enable the Relief function for graphic objects (Image, Path, Rectangle, Arc, PolyLine). The Relief function allows turning Grayscale shading into 3-D output.

Examples are Reliefs in furniture making. Also processing steps like Chamfering or Slanting can be achieved.

If you set the relief switch, the output is calculated as a relief with Z representing the grayscale.
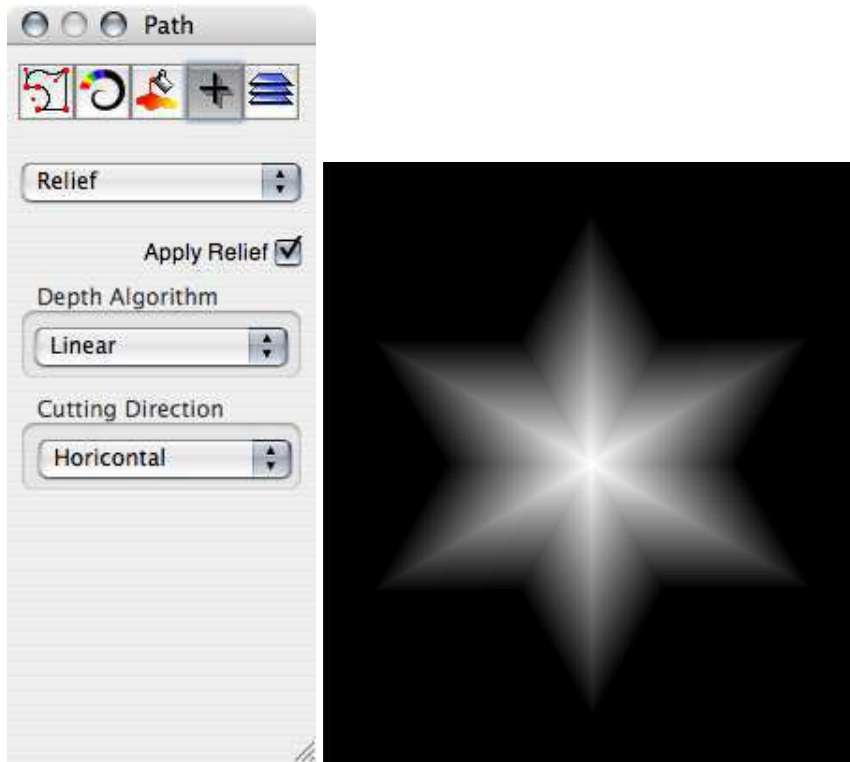
The colors of the image now represent a Z-level. Black color is rubbed out using the dip depth assigned to the layer (see section 3.6.1). For white color the material is not touched - the cutter moves at surface level.

The gray shades in between black and white are handled in three possible ways, depending on the settings in the Inspector:
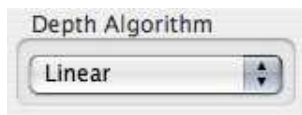
Here you can select the kind of graduated processing of the image:

Linear   The gray levels are processed in a linear way

Circular   The gray levels are processed in a way that a linear graduation
                          results in a circular cutting of the material.

Logarithmic   The gray levels are processed logarithmic.
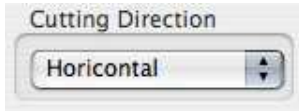
Here you can set the cutting direction (Horicontal, Vertical, or both):

- If the Filling is activated for the Layer (see section 3.6.1), the graphics will be
  processed applying the selected Depth-Algorithm in the given direction.

- If the Filling is disabled, then only the contour of the graphics will be cut,
  applying the Depth-Algorithm to the contour.
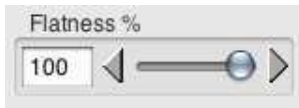
The Flatness can be set in percent between 10 and 100. At 100% the length of the
output-lines are equal to the tool diameter. At 10% the lines are only 10% of the tool
diameter, which takes more time but gives much smoother results on curved surfaces.

If the shape is convex or concave (curved) and the tool diameter is large, then the flat-
ness must be less than 100% to achieve a smooth surface. But also a too large cutter
may have negative effects on the results, when the tool radius doesn't fit the gradient-
changes. Good results are achieved by carefully chosing the right tool diameter for a
given curvedness.

The Fill-Overlap (Layer-Details) should be set to 0 for a Relief.

Tip: To cut out a relief from the material, you should create a separate layer with the
contour of the cut.
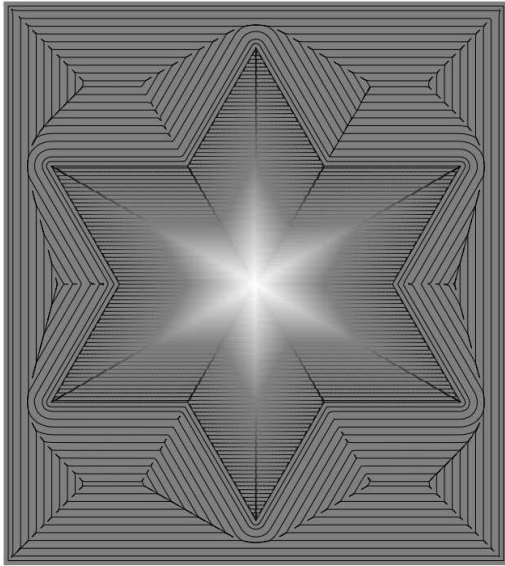
2.4.1   Relief with Vectorgraphics (Path, Rectangle, etc.)

The contour of the graphic objects is always applied.
The filling is processed only, when the Graphic Object is filled and the Layer in the Layer-Panel is filled (bucket pouring, see section 3.6.1).

2.4.2   Relief with Raster-Images

An Image (Raster-Image), that shall be processed as a Relief, should be grayscale and provided to Cenon in High Resolution (ex: 300dpi). Following the import of the image to Cenon, the image has to be scaled down to the desired size.
The diameter of the tool used for the Relief, should span as much pixel of the image as possible. As a rule of thumb, the image needs to be scaled down at least by factor 3. You can use the Transform-Panel to do so. The finer the tool, the more the image should be scaled down in Cenon.

Note: Scaling down the image in Cenon will keep the full resolution of the image.

Join of an Image and a Path

An Image can be clipped by a Path, by joining the Image with a Path (see Cenon Manual). When processing the clipped image as a Relief, the joined Path will be used as the contour, analog to processing the Relief of a vector graphics.

When joining an Image with a Path element (Path, Rectangle, Arc, PolyLine), the image should be slightly bigger (overlap) than the Path.

2.5   Camera-Gauging
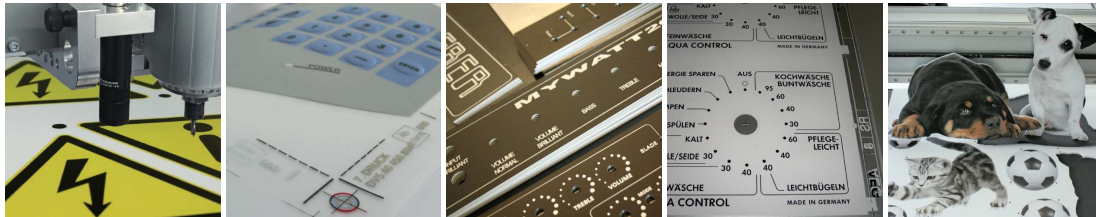
This feature allows the recognition of position, orientation, and distortion of a working piece by using a camera mounted on the machine.

The parts to be processed are placed approximately on the machine table. Now the camera-image can be analyzed to obtain the exact position, rotation, and deformation, relative to the constructed (original) graphics. During output, the graphics will be transformed, so that it fits the working piece.

Possible applications are, cutting of Large Scale Prints in the Sign Making industry, or the processing of Screen-Printed front panels or keyboards. Whenever multiple working-steps need to be combined (ex: Printing -> Cutting, Laminating -> Milling, Drilling, etc.), the camera function can be applied.
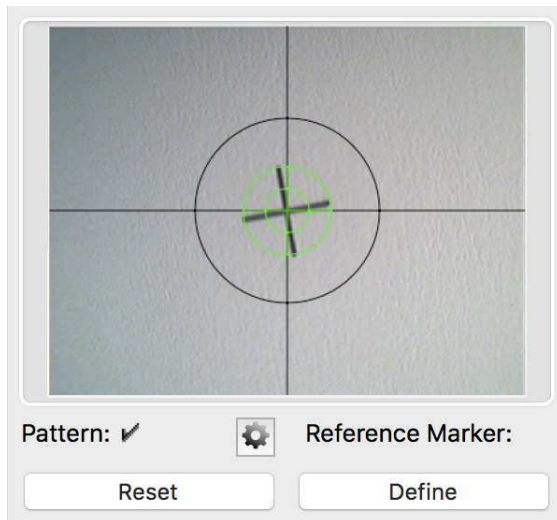
The connecting elements between Graphics and Working-Piece are Reference-Markers printed on the graphics (or corners of the material). In Cenon, the Reference Markers are placed as Markings on a dedicated layer.

The application is very easy using two buttons and three steps only:

1. Define Pattern (of markers)

2. Move first marker into camera-view

3. Start Output

To activate the camera function in Cenon, you have to enter the appropriate Key into the Licensing-Panel of Cenon (see section 1.6). You also need a camera connected. Please contact us for details.

2.5.1   Preparing the Project - building the bridge

The primary step to prepare a Camera-Project is to add a layer with the Reference Markers. This layer will be the bridge connecting the target graphics and the working piece on the machine. So first, create a new layer (see section 3.6.1).
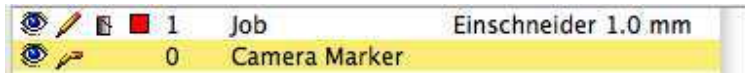
Then go to the Layer-Details (Kapitel 3.6.2) of the CAM-Panel, and change the Type of the layer to "Camera Layer".
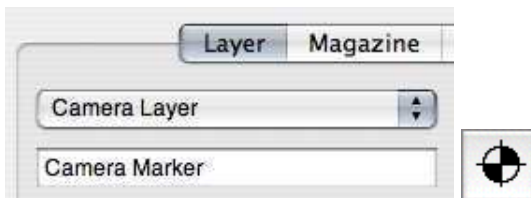
On the Camera Layer, you have to place Markers at the target positions (fitting the original Graphics on the other layer). These Reference Markers have to be present in some way (Crosses, Circles, ...) on the working pieces, also. Usually they are just printed or screen-printed with the first step of manufacturing. At least 3 markers are needed.
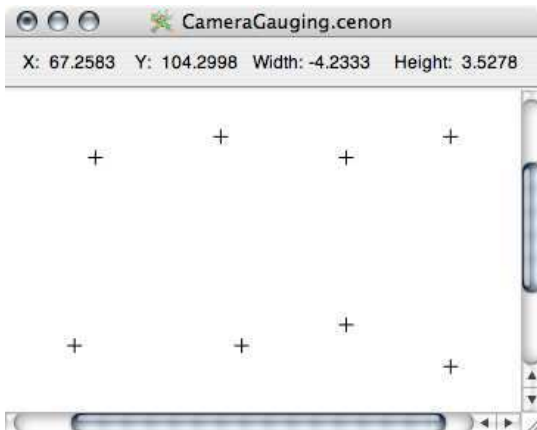
In Cenon, you will either place a Mark (see Cenon User's Guide, Markings) for each

of the Reference Markers, or another element like a cross (two crossed lines), a circle, a path, etc. The center of each marking object will be used as Target-Position. These marking objects can easily be extracted from an imported graphics, for example using the "Move to Layer" functionality.

You don't have to place the markings as wild as in our example, which is demonstrating the flexibility. Generally the best advice is to keep things simple and arranged.

For Batch Production it is suffitient to set the markings for the first piece of the batch. All other pieces can be processed automatically.

2.5.2   Import of Cut-Files

Cenon is able to import cut data from RIP processors in various formats, for example SVG or i-Cut.
The i-Cut format can contain all needed layers. If it does, Cenon will create all needed layers.
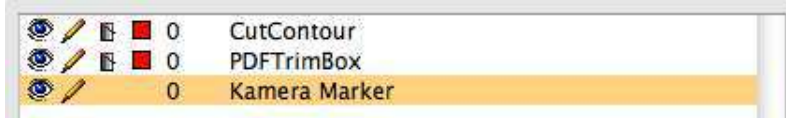
2.5.3   Action

The entire Output, is based on three buttons only: "Define Pattern", "Define First Point", "Start".

After opening a Camera-Project or creating the Camera-Layer, the Camera-Panel will open and displays the view of the connected camera.

1. Define Pattern

Now, you have to move one (usually the first) marker of the working piece into the camera view. To do this, you can use the Arrow-Buttons for X and Y in the Control-Panel (see section 3.6.5).
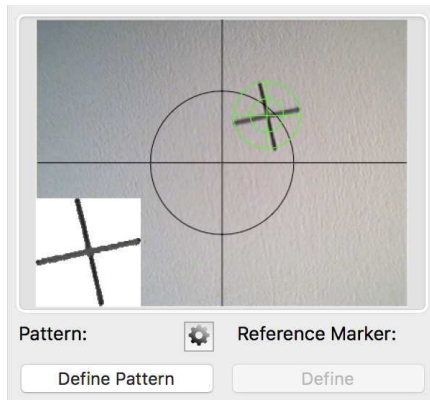
To avoid unnecessary distortion by the camera optics, the Reference Marker should be moved into the circle of the crosshairs.

After the Reference-Marker is recognized and its position and size is marked correcly and stable by a green circle, you can press the left button "Define Pattern". The pattern of the Reference-Markers is now defined and will later be used to recognize the other Reference-Markers.

The small image in the lower left corner of the camera view displays the pattern recognized, and is a help to decide for the correct recognition of the pattern. The small image will disappear after this step. Before pressing the "Define Pattern" button, make sure that the small image appears massive and stable.

This step of the pattern definition may be omitted, once the pattern is defined. The defined pattern will be saved with the document and stays defined for later use. It may still be necessary to redefine the pattern, if the light has changed.

2. Move first marker into view (Reference-Point) / Start Camera-Drive

If not already done in step one, move the first marker into the circle of the camera view. The first marker is emphasized by a blue circle in the Graphics Window - it is the one closest to the Document-Crosshairs.
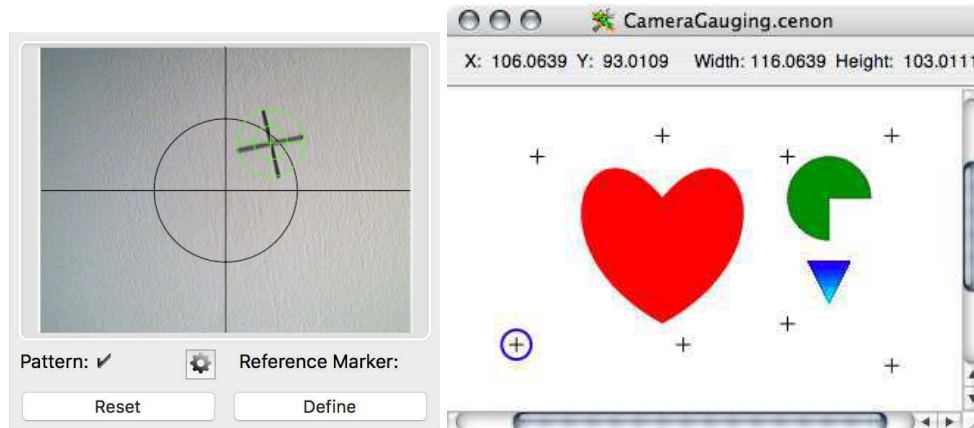
When the first marker is inside the view and marked by the green crosshairs, you can press the right button "Define First Marker"
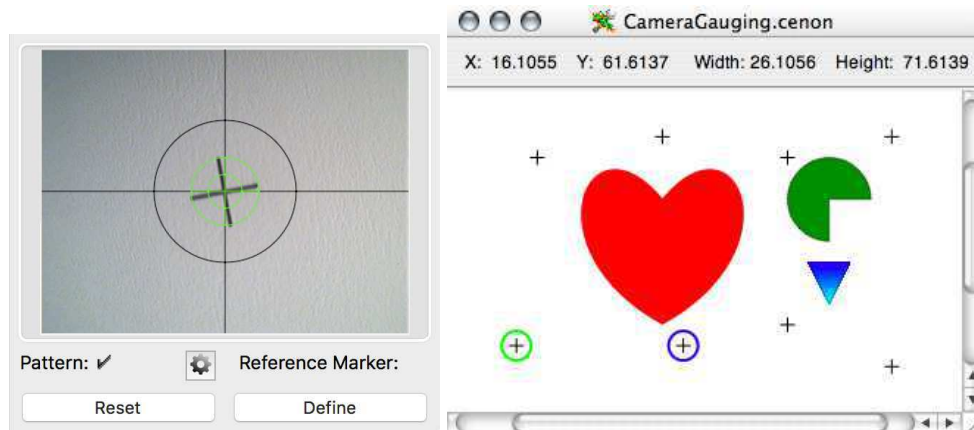
By pressing the button, the first marker is defined and is automatically moved into the center of the camera view. Immediately after centering the first marker, the Camera-Drive starts to collect all the other markers.

While moving the marker being approached next, is emphasized by a blue circle. If recognized the circle changes to green, and in case it is not found, it will be marked red.

Blue Circle   The Reference-Marker is being approached

Green Circle   The Reference-Marker has been successfully recognized

Red Cirle   The Reference-Marker has not been found and will be omitted
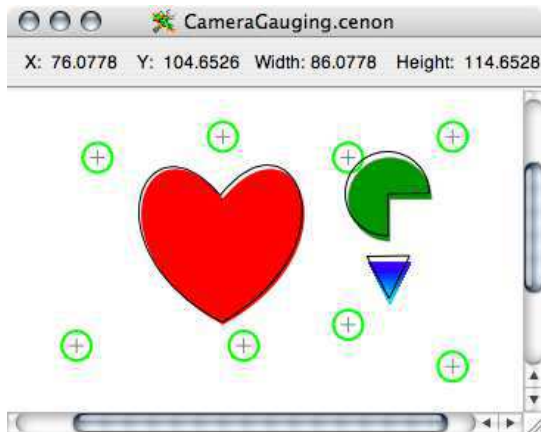
All reference markers have been recognized successfully. The output paths (enable the switch in the Layer-Panel) are transformed to fit the working piece placed on the machine. In the next step you will start the output.

3. Start Output
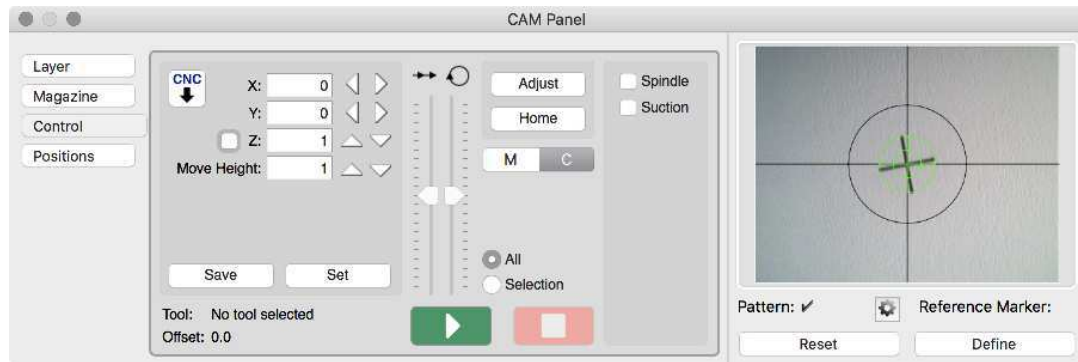
In the Control-Panel, you can start the output as usual by pressing the Start button. The start position has been set automatically to the First Marker (when centering the first marker). The crosshairs in the document window have no meaning for output with the camera.

A click with the mouse on "Set Position", will bring the camera (machine) back to the position of the Reference-Marker.
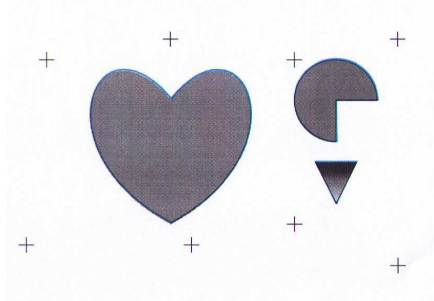
Image: our simple example was printed on a Laser-Printer, then the contour has been drawn by a pen-plotter

2.5.4 Other Applications

Corner-Recognition

This mode can be used for fast cutting of rectangular parts, recognizing corner marks (crop marks) to obtain the shape.

To apply the Corner recognition, follow these steps:

1. In your Cenon-Project, place a Marker for each Corner Point on the Camera-Layer. For a batch of Objects, you only have to place the markers for the first object of your batch. The first object is the one at the lower/left position.

2. For batch production generate the other markings using the batch-function (see the Cenon User"s Guide "Batch Production") of Cenon. Use the button "Set" to define your batch.

3. Position the machine to the lower/left Corner of your Material and define the pattern of this corner.

The recognized markers will be turned into a Path in Cenon, located on a dedicated output-layer. Cenon will create this layer if needed.

- If the corner markings on the material are true "Corners" that are not tolerant to rotation, then exactly 4 corners have to exist. Here, the lower/left mark must be used to define the pattern. Cenon starts with the Camera-Recognition on the lower/left corner and proceeds counterclockwise. To allow the recognition of the corners, the defined pattern will be rotated by 90° after each step.

  The marking of a corner in Cenon has to be at the exact position at the corner marking. The red cross in the picture shows the correct position relative to the printed Crop-Mark on the material for two different kinds of Crop-Marks.

- Using Circles or other shapes that are tolerant to rotation, any number of markings can be used to definde the shape.

Prototype Placement

The Prototype Placement allows to output graphics or apply manufacturing steps at positions recognized by the Camera. For example to place drills or threads at the position of markers printed on a working piece.

To be able to use this function, you have to define a graphic prototype (Drill, Thread, ...), that will be applied to the positions recognized by the Camera. To define the Prototype, you have to create a Template-Layer (see Section 3.6.2), and place on it the Prototype element. During the Camera-Recognition, the graphic element on the Template-Layer, will be duplicated on a dedicated output-Layer for each recognized marking. When the camera is done, the Output-Layer is ready for output without further preparation.

All settings of the camera, can be modified in the Project-Settings (section 3.2.2).

2.5.5 Problems and Solutions
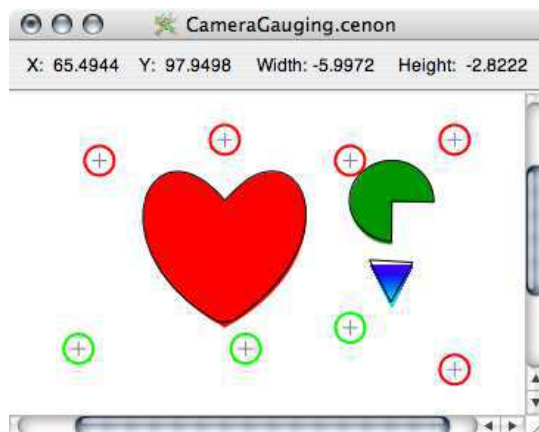
If some reference markers were not found, light could be a reason. If the light is not suffient, then a ring-illumination mounted at the camera may help.
Also, too much light might be the cause of problems. In this case less light helps, especially with reflecting material.

A wrong selection of a pattern may also be the cause of a failed recognition. For example, if the Pattern-Preview shows holes, that actually are not in the pattern. When defining the pattern, make sure the pattern is recognized stable.

If the objective of the camera is strongly rotated (camera image not angular to the axis of the machine), then the direction is not translated correcly and the markers are likely missed.

Also, if the second marker has been missed, then probably no other markers can be found as well.

The reaction of the camera gauging to errors are generally good-natured. Not recognized markers can be omitted and not used in the transformation, or they can be defined manually by the user.

Precision

The precision of the camera-measurement is dependant on the resolution of the camera image, and limited to about 2 pixel of the camera image.

If the section of the working piece in the camera-view is too small, then only a small rotation of the working piece is allowed and recognizable. Therefore, we have to accept a compromise between high precision and a large area of recognition.

Angularity

Move the camera over a marker and take a look at the camera image. If the position of the marker in the camera-image is gradually moving while zooming the camera, then your camera / Z-axis is not mounted angular to the machine table and the gauging results may suffer.

If the position of the marker on the camera image is jumping instead of gradually changing then the mechanic of the zoom is not good enough for this test.

Focus

The focus is only good within a tolerance of about 1cm of distance change. The focus should be adjusted for the average distance from the working piece. A camera with automatic adjustment of the focus is not recommended, as the ever-changing scale increases the problem of a correct recognition of patterns.

Corner-Recognition

To achieve good results when using the corner recognition of material, keep the following Tips in mind:

- the camera has to be focussed on the material surface, not the background (which might be considerably lower)

- a sharper image goes hand in hand with better results

- too much, especially dark shadow, can influence the results and may even shift the recognized position towards the shadow!

- On the other hand, reflections from the material may influence the reliability of the recognition.

2.5.6   Summary of the Steps

1. Place Reference-Markers on a separate Camera-Layer. The positions of the markers define then target net for the translation. If the camera layer exists, the Camera Panel will open.

2. Place Working Piece on the machine. The direction should be approximately correct.

3. Using the Control-Panel, move the First Marker into the Camera-Image.

4. Click on "Define Pattern", to define the pattern, highlighted by green Crosshairs.

5. Click "Define First Marker", to tell Cenon that the first marker is in the camera view. The Camera-Drive will start to collect all the other markers, providing the actual points for the Markers defined on the Camera-Layer.

6. After all deviations are collected, the transformation net is complete. You can check the transformed output paths on your screen by enabling the output paths in the Layer-Panel.

7. Start the output by pressing "Start" in the Control-Panel.

Note: the crosshairs in the graphics window are ignored for the camera. Origin of the output is the first Reference-Marker.

2.5.7   Tips

- Turning off the camera layer (closing the eye in the layer panel), stops the delivery of images from the camera. This can come in handy on slow computers to regain full power, if needed.

2.6 Prototyping of Circuit Boards (PCB)

This tutorial describes the process of making a double sided circuit board. The steps include export of all data from your PCB layout software, importing the data, engraving the insulations, drilling, cutting of the contour, etc.
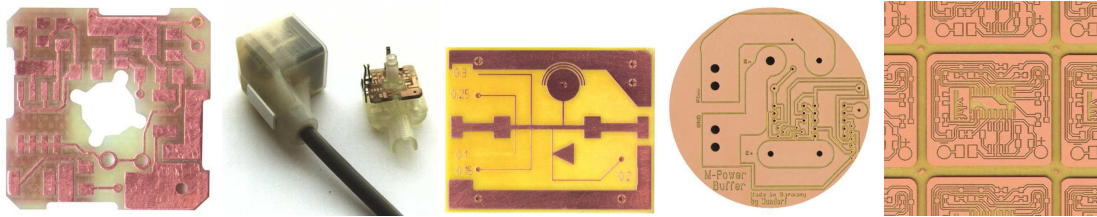
When editing with Cenon, there are often several ways to achieve the same thing. In this tutorial we will try to point out some of the different approaches, even if it makes the tutorial a little longer.

Please refer to our tutorial, which you can download from our Web-Site:
https://www.cenon.com/download_gb.html

Chapter 3

Reference part - the functions of Cenon

3.1 Preferences settings

You can reach the preferences panel with the menu entry 'Preferences' from the menu 'Info'. Here you can set basic settings for Cenon and its modules. The Cenon preferences are placed in different tab pages, which can be selected by the row of icons on top. The icon to set the CAM preferences displays a spindle.

3.1.1   CAM Preferences
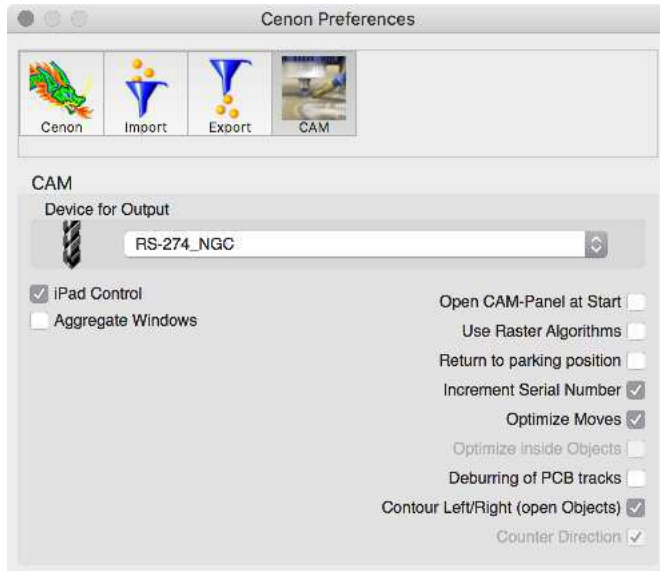
In this pane of the Preferences-Panel you can manage the general settings for manufacturing.

Device for Output   With the pop-up menu you can select the parameter-file for your machine. Please have a look at section 4.2 for the creation of your parameter-files or the adaptation of existing files.

Left Switches

iPad Control   (>= v5.0) if checked, the Cenon Control App on iPad can connect. You only have to disable this, if you have multiple Cenon versions and some shouldn't connect to the iPad App. [Default = checked]

Aggregate Window (>= v5.0) if checked, all Projects are opened in a Composite Window. You can still decide for each project to host it differently (Project Settings).

Right Switches

Open CAM-Panel at Start	This option determines, whether the CAM panel will be displayed at start-up of the application.
Use Raster Algorithm	This uses raster algorithms to render the output paths. This takes more time and is usually of less quality. However, if you have extreme data, this option will calculate what the normal algorithm can't.
Return to parking position	Here you can enter whether the machine should move back to the starting position after the output of your data or not. Otherwise it'll stop at the last entered coordinate.
Increment Serial Number	Enable this entry, if you want Cenon to increment your serial numbers automatically after each output. This works for batch production as well as for single peaces.
Optimize Moves	If you enable this option, the moves between the objects are optimized automatically. As this prevents yourself of adopting your own order, you can disable this feature. You will still be able to let Cenon optimize the moves by using the menu entry (Format ▷ Optimize Moves).
Optimize inside Objects	only available as Project-Setting
Deburring of PCB tracks	If this switch is activated, the isolation tracks of PCB prototypes will be deburred. This means, that tiny copper chips are removed at positions with sharp angles.

Contour Left/Right (open Objects) (>= v4.0) if checked, the tool radius compensation of open paths is calculated either to the left or right.

Counter Direction   (>=v5.0) if checked, the default direction is counter direction. You can still set the direction for each project. [Default = checked].
This preferences setting can only be changed when ALL projects are closed !

3.2   Project Settings

The Project Settings of Cenon allow every Document to have its own settings. This way one document can be in the unit Millimeter, while the other document is measured in Inch. Or one Production-Job can be calculated with Raster-Algorithms, and it's serial number is increased after each output.

The Project-Settings of Cenon are located in the Info-Menu right below the Preferences.
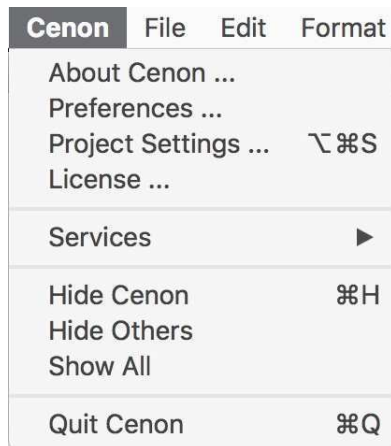
3.2.1 CAM-Settings

The CAM Settings allow each document to have different settings than the CAM-Preferences.

Switches

Use Preferences Settings	The settings from the Preferences Panel are used (Default)
Aggregate Window	If this switch is checked, the document will be hosted by a Composite (Aggregate) Window (section 3.8).
Use Raster Algorithm	As described in the corresponding entry of the Preferences Panel, Raster-Algorithms is given the priority over Vector-Algorithms. Raster-Algorithms may have advantage in calculation of critical graphics. So if the Vector-Algorithm fails, try the Raster-Algorithm.
Return to parking position	After each output, the machine will return to the set parking position. Also see the correspond-

	ing entry in the CAM-Settings of the Preferences Panel (section 3.1.1).
Increment Serial-Number	After each output, the serial number will be increased by one. Also see the corresponding entry in the CAM-Settings of the Preferences Panel (section 3.1.1).
Optimize Moves	The moves between the parts will be optimized automatically. Also see the corresponding entry in the CAM-Settings of the Preferences Panel (section 3.1.1).
Optimize inside Objects	If Optimize Moves is active, this switch allows to decide, whether to optimize the positioning inside objects (ex. groups). This can be an issue, if the order inside objects is crtical, for example the starting position of a path.
PCB: Deburring	For insulation engraving of Printed Circuit Boards, critical edges are deburred. Also see the corresponding entry in the CAM-Settings of the Preferences Panel (section 3.1.1).
Counter Direction	(>=v5.0) if checked, the output direction of this project is set to counter direction. [Default = checked]

Output Repeats (>= v5.0)

This field can be used to set the number of repeating outputs for a project.
First, you start the output as usual with the "Start" button. When the output has been finished, Cenon waits for the press of an external trigger. This allows changing the material on the machine. Once the external button is pressed, the output starts from the beginning.
It is recommended to prepare a parking position (section 3.6.6), so that the tool is out

of the way.

To be able to use the output repetition you will need an external trigger switch and the corresponding device configuration (see #LOP in section 4.2).

3.2.2   Camera-Settings

With the help of the Camera-Gauging, it is possible to automatically recognize the placement, rotation, and deformation of a working piece. Applications are in combining different technical steps, like processing screen-printed Front Panels or cutting Large Scale printings. Also in cases where the placement on the machine is not accurate.

The Camera-Settings are only active, if the Camera-Gauging has been licensed and a Camera Layer is present.
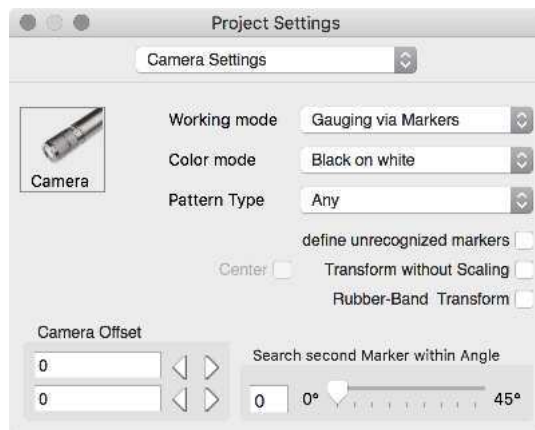
The Camera-Settings allow the configuration of the camera-function and alternating parameters.

Without a Camera-Layer (or for Camera-Positioning), most of the controls in this panel are disabled.

Camera-Positioning only allows the camera-offset to be entered.

Working Mode

Working mode [Gauging via Markers   ⬍]
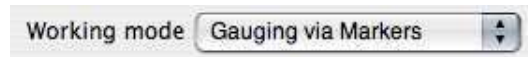
The Working Mode determines how to use the camera:

Gauging via Markers   The working piece will be measured with the help of Reference Markers. It works as follows: One set of markers is attached to the working piece for example by printing. The corresponding set of markers, has to be placed on the Camera-Layer of the Cenon-Job. After recognizing the real marker positions on the working piece with the camera, the output can be transformed to fit the working piece.

Corner Recognition   The Corner Recognition is used to find the crop marks of a working piece, for example to automatically cut out printed items.
The corner points are placed on the Camera-Layer, as described above for the gauging via markers. The identified corner points will be connected to a filled path and placed on a layer.
If the pattern type "Corner" is selected (see below), than the pattern of the corner will be rotated by 90 degrees after each recognized mark. Thus, the number of corner points is limited to four. Starting point must be the lower left corner of the working piece.

Place Prototypes   The Graphics placed on the Prototype-Layer (see Section 3.6.2) will be placed at the position of each recognized marker.

Color Mode

Color mode   [Black on white   ⬍]
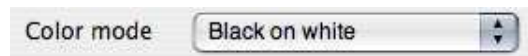
| Black on White | Markers are a dark pattern on bright background |
| White on Black | Markers are a bright pattern on a dark background |

Pattern Type

Pattern Type [Any   ▲▼]

Only connected patterns are recognized. However, small gaps are tolerated.

All	Everything is accepted as pattern, as long as it resembles a connected structure of sufficient size, e.g. every hair.
Circle	An accepted pattern has to look similar to a circle. The circle is tolerant to rotation, and works very well with rotated working pieces.
Cross	The pattern has to be a cross. A cross is not tolerant to rotation, this means that it may be necessary to define the pattern anew for every new placement of material.
Corner	This pattern type is active in the working mode "Corner Recognition" only. The defined pattern will be rotated by 90 degrees after each recognized corner. Only 4 markers are allowed in this mode.
Material Corner	Only active in the working mode "Gauging via Markers". The orthogonal corners of the material (ex. front panels or printed circuit boards) will be recognized. Material corners need no definition of the pattern.

Define unrecognized Markers

define unrecognized markers ☐
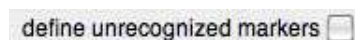
If this switch is checked, you can define positions of markers manually, if they haven't been found by the Camera.

In case a marker has been missed, a Alert-Panel appears. If you confirm this Panel with OK, the button "Define Point" in the Camera-Panel is activated.
Now, you have to move the Marking into the center of the camera view. Then you can set the position by pressing the button "Define Point".

Transform Without Scaling

Transform without Scaling ☐
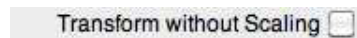
If this switch is checked, the transformation is limited to location and rotation (no scaling/stretching) of the objects recognized by the camera. This is important when exact size matters, for example when cutting front-panels and inlays. This transformation needs at least two markers to determine position and rotation of objects. If more than two markers are given, the average of all measured markers is used to determine the rotation.

The **Center** switch is only active when the "transform without scaling" switch is on. If you check the Center switch, all transformations are performed relative to the center (of all detected camera markers), instead of relative to the reference point (first camera marker).

Rubber-Band Transform

If this switch is checked, a different algorithm is used to transform the output, as if the working piece would be connected to the markers by rubber bands.

Camera Offset

These fields can be used to fine-tune the camera offset, so that you don't have to modify the device configuration (#COF in section 4.2).

Search second marker within Angle

For strongly rotated working pieces it may happen that the second reference marker doesn't appear in the camera view. In this case it is possible to search in an arc for the second marker.

If the Search Angle is larger than 0 an automatic search for the second reference marker will be started, if needed. If no marker is found, the point will be skipped.

If the Search Angle is 0, then an Alert Box will appear for markers that are not found. You have the choice to skip the marker, or to manually move the marker into the camera view.

3.3   The menus of Cenon

In this section we will describe the functions in the order of the entries in the menu. When you look for a special information about a special entry you can surely find it here.
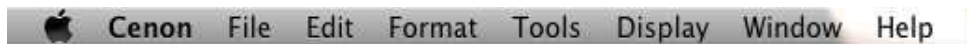
3.3.1   The File-Menu
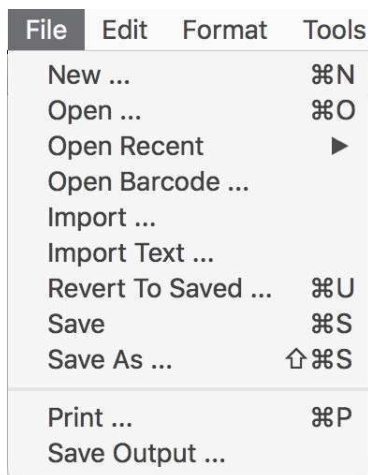
Open Barcode

With this menu entry you can load jobs via a code, for example a barcode. The menu entry does only exist, if the corresponding feature is configured. See section 3.10 for more.

Import Text...

Here you can load a text file. This can be used to produce different signs of the same geometry in mass production. The function is already explained in the Cenon Reference Guide.

The strings which are extracted from this file are distributed on Text graphics. Before you start to import a text file you have to place corresponding Text objects in your project.
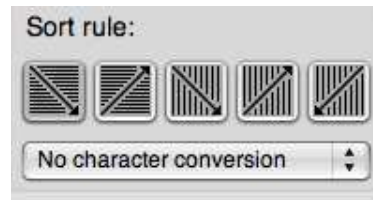
In the Open-Panel for the text import you can select how to sort the strings into your project's Text graphics:

- row by row from the upper/left to lower/right

- row by row from the lower/left to upper/right

- column by column from the upper/left to the lower/right

- column by column from the lower/left to the upper/right

- column by column from the upper/right to the lower/left

The file is a simple list of strings separated with a Space character, Newline, or Tabulator (TAB). If you have space in your strings you need to place the string inside double quotes or use TABs to separate your strings (Is a TAB in your text, TABs are used as the separating character):

text1 text2 text3

or

"text 1" "text 2" "text 3"

If you have to insert a Newline or TAB in your strings you can use '\n' respective '\t' in your text.

"Line 1\nLine 2" "Line 1\nLine 2"

Tip:

- If the text you want to import is in a different for-
  mat, the search/replace function of a common text
  editor can help you a lot to change the formatting.

Save Output...   Here you can save the data in a file instead of sending
                              the output directly to a machine. The same setting and
                              starting positions are used (as when you send it directly
                              to an output-machine).

3.3.2   The Format-Menu

Format	Tools	Display
Font		▶
Text		▶
Grid		▶
Bring To Front		⌘8
Bring Forward		⌘(
Send To Back		⌘9
Send Backward		⌘)
Working Area ...		⇧⌘A
Page Layout ...		⇧⌘P
Optimize Moves		⇧⌘O
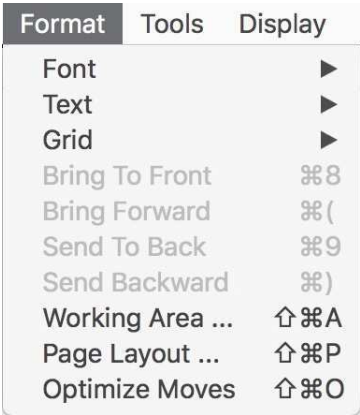
Bring to Front

Send To Back   With this menu items you can move objects to the fore-
                              ground or background. So you can influence the se-
                              quence of the display. When an object cannot be selected
                              because it is hidden, you can put on the others with this
                              command.

The selected graphic object can be send all the way to the back or front, or just a single graphic object further to the back or front.

The order of the graphic objects determindes the order objects are process on output. If you have enabled the automatic optimization of the output tracks, these entries are disabled! See section 3.1.1 for more info.

Optimize Moves   The moves between working pieces can be optimized. Therefor the order of the objects is changes like with the entries above.

You can display the moves with the Menu Display ▷ Show Moves.

Working Area...   The Working-Area panel appears. Here you can enter the size of the working area. The measuring unit of the size is taken over from the Preferences-Panel.

The working area is displayed as white background inside the Graphic-Window. If you open a new window, the working area is preset to the size of the machine.

3.3.3 The Tool-Menu

The tool menu gives access to the different tool-panels of Cenon. Some items appear only if the respective module is installed.
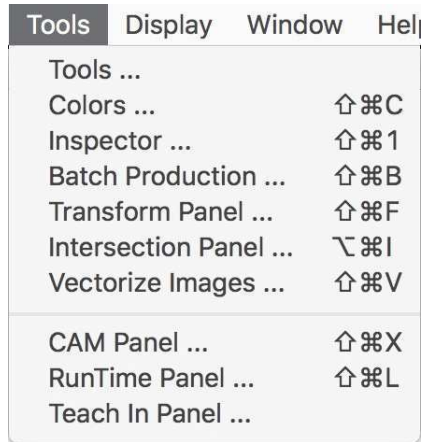
Batch Production... The Batch-Production Panel appears. Here you can distribute the graphic on the working area. The batch production is already explained in detail in the Cenon Reference Guide.

CAM-Panel...   The CAM-Panel of the optional CAM module appears. The CAM-Panel is opened automatically after you have started the program. It is used for the management of the layers and tools and to control the machine. See section 3.6.

Run-Time Panel... This menu item opens the Run-Time calculation (See section 3.9).

Teach-In Panel... The Teach-In panel of the optional CAM module allows the collection of positions from a machine. You can position a plotter or machine over a template using the Control-Panel (section 3.6.5). The positions then can be captured into the document as a mark via mouse click in the Teach-In Panel.

                   The collected mark objects can be converted to 2-D or 3-D lines from within the Teach-In Panel.

3.3.4 The Display-Menu

The items of this menu gardly depend on the loaded modules.

Display	Window	Help
Hide Coordinates	⌥⌘C
Show Directions	⇧⌘D
Show Moves	⇧⌘M
Show Tool Diameter	⇧⌘T
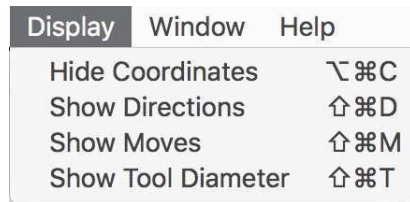
Show Directions
Here you can see the direction of the vectors displayed as little arrows on the border of the graphic objects. The output usually follows the direction of the arrows. Since, the quality of output depends heavily on the direction of the processing, you should have an eye upon this.

Show Moves
This menu item displays the moves of the machine between different working pieces. The moves are displayed as blue lines.

Show Tool Diameter
The tool diameter used for output is displayed in thickness of the output path. Usually the output path is displayed with thin lines.

3.4   The Tool-Bar

With the tool-bar you can change the editing-modes of Cenon.
Here, we only explain the additional modes of Cenon CAM, all other editing modes
are explained in the Cenon manual.

Mark. In this mode you can place marks. A marking is normally used to
set a drilling.

Countersink. In this mode you can place countersinks at the position of
the mouse. See the Inspector in section 3.5.2 for Details.

Threads. In this mode you can place threads in the graphics window. See
the Thread-Inspector in section 3.5.3 for Details.
Creating a thread:

1. Decide whether you want to create an inside or outside thread. Create
   a hole for an inside thread, or a cylinder for an outside thread. The
   dimensions of the hole depend on the data of the thread cutter you
   use. Consult the data sheet of the tool. This step doesn't apply to
   combo-tools.

2. Create a layer for the threads (CAM Layer-Panel).

3. In the Layer-Panel set the tool-radius compensation to the kind of
   thread you need:
   Inside correction = inside thread, Outside correction = outside thread
   (see section 3.6.1).

4. Assign a thread cutter to your thread-layer (see CAM Layer-Panel in
   section 3.6.1).

5. In the Tool-Bar change to the thread-mode (see section 3.4), then set the thread with a click to the desired position.

6. Set the nominal diameter of the thread in the Thread-Inspector (see section 3.5.3). The nominal diameter is the diameter the screw diameter got its name from. For example: M6 for a 6 mm screw and thread.

Webs (Bridges). Webs are used in CAM applications to keep the working piece at its position during cutting. The webs are spared on cutting. Place the webs at good positions around the outline of your working piece. You can adjust the width of the webs in the Web-Inspector. For more info see section 3.5.4.

3.5   The Inspector-Panel

The inspector gives information about the selected graphic. In addition to the object parameters, the inspector is also used to manage the document layers too.

Here we only explain the additional Inspectors of Cenon CAM, all other Inspectors are explained in the Cenon manual.

Mark Inspector   Section 3.5.1

Sink Inspector   Section 3.5.2

Thread Inspector Section 3.5.3

Web Inspector   Section 3.5.4

3.5.1   The Mark-Inspector

The Marking-Inspector shows the position of the selected marking. You can use a marking for marking or for drilling.
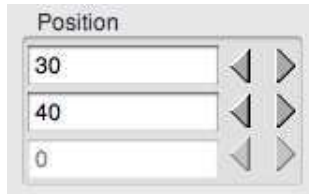
The coordinate of a marking. The coordinate can be three dimensional.

Here you can select, if the marking shall be three dimensional. If you check the switch the Z field of the coordinates is editable.
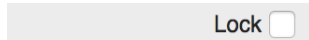
Here you can lock the position of the mark against accidentally moving with the mouse. You can still select the mark and change values with the inspector.

3.5.2 The Countersink-Inspector

The Countersink-Inspector shows information about the selected countersink. The selected item (or more than one) can also be changed here.
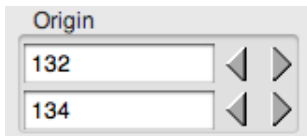
Here you can set the position of the item. This is the position of the center.

This part lets you choose the type of the countersink. The main difference between the two types is the rim. The pop up allows you to toggle between metric and inch type.
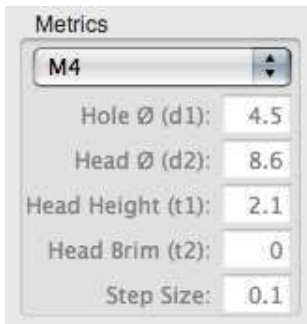
This area shows the metrics of the countersink. In the pop up menu you can select the desired metrics by name. The metrics are then displayed in the fields.

Hole Ø (d1)	The diameter of the hole for the screw
Head Ø (d2)	The diameter of the head of the screw
Head height (t1)	The height of the entire head of the screw including brim

Head brim (t2)   The height of the head brim of the screw (only second type)

Step size   This entry is used for cutting. It is the step size the cutter increments while stepping down the cone of the head part of the countersink.

medium   fine
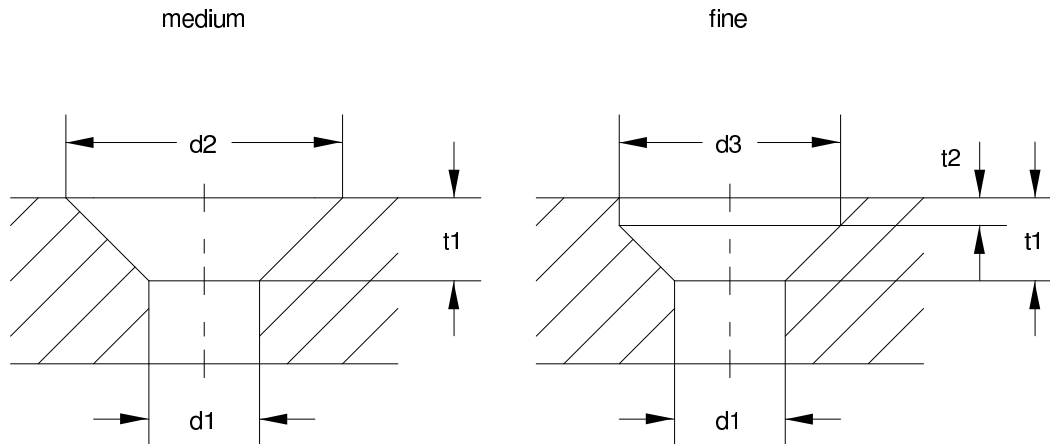
If you need to customize the settings choose *Custom* from the pop up menu. Then you can modify the values in the text fields.

You can modify the names (and relating parameters) listed inside the pop up menu by editing the file SinkingMetrics.plist. The file is located within the Cenon application bundle and has to be copied to the User Library for editing (example for Apple): Cenon.app/Contents/Resources/SinkingMetrics.plist ▷ USER/Library/Application Support/Cenon/
(see section 5.2).

3.5.3   The Thread Inspector

The Thread-Inspector shows information about the selected thread. The selected thread (or more than one) can be altered here, too.

The output of a thread performs a 360 degree spiral starting at the bottom of an existing hole, and lifting the tool by the value of the pitch of the assigned tool. Note: You have to assign a thread cutter to the layer, to get this work!
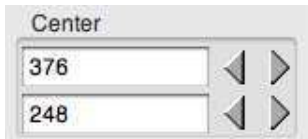
Here you can see and set the position of the thread. This is it's center point.
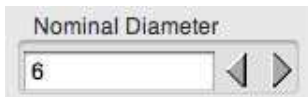
Here you can see and set the nominal diameter of the thread. This is the same as for the screw which should fit.
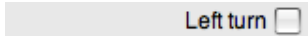
Activate this switch if you need left turned threads.
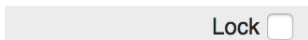
Here you can lock the position of the thread.

3.5.4   The Web-Inspector

In the Web-Inspector you can set the positions and size of webs (bridges), which will not be removed entirely from the material during output.
The result is, that the working piece will not be completely separated from the material, because the webs will still connect them with the material.

Here you can set the center position of the web.

Here you can set the width of the web. The width determines the size of the gap in the calculated output of the paths this object sits on.

(>= v5.0)
The height of webs can only set, if step-wise output is turned off for the layer.

= 0	Special case: the bridge will get the maximum height. The Z axis lifts with moving speed and lowers with Z-feeding speed (this is the behavior prior to version 5.0, and with projects older than version 5.0).
> 0	a bridge with the given height (and width) is created (left standing). The Z axis moves with X/Y-feeding speed, even for rectangular shaped bridges.

The maximum height is the full depth (see CAM Layer-Panel). With Step-Wise depth (see CAM Layer-Details), the final step provides the height of bridges.

Shape (>= v5.0)

Shape

Sinus

(>= v5.0)
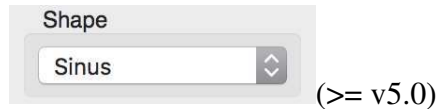
Rectangle   rectangular shape of web.
Despite beeing the perfect shape, the machine has to come to a full stop, the Z-Axis has to lift before the bridge then lower afterwards, all in all this is quite slow.

Sinus   the web will have a curved shape.
The advantage of this is, that the the machine is lifting and lowering the Z axis gradually, which makes this a lot faster.

Lock
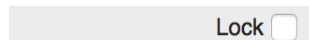
Use this switch to fix the position of the web. The web can still be selected, but not moved with the mouse.

Exclude   (>= 4.0)

This switch excludes the element from output (for example to a machine). This is usefull to add commenting elements to a layer, which will not be processed on the machine. The element will still be printed or exported.

Placement of Webs

Webs have to be placed on the output path (not on the graphics path itself).

Display of Webs (Display Output):

To properly display webs you should turn on the display of the tool diameter (Menu: Display ▷ Show Tool Diameter).
To make webs more visible, they are displayed with inverted colors: the brighter the color, the lower the height of the web (from the bottom of the material).

3.6   The CAM-Panel

The CAM-Panel offers almost all management functions for CAM. With the different areas the panel offers, you can manage layers, tools, positions, and you can control the CNC machine.
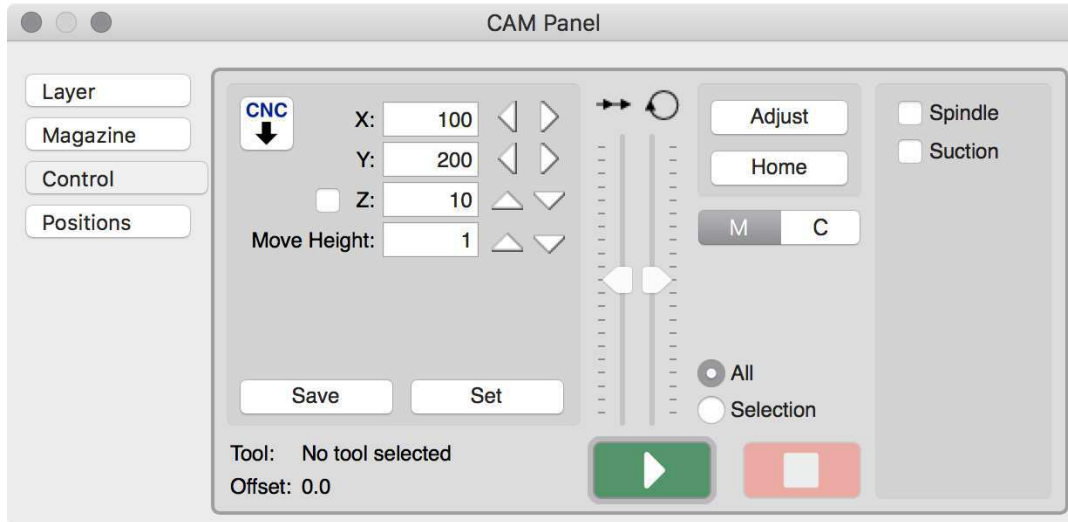
In this bar you can choose the functions of the CAM-Panel like in an index-card-box. Depending on your choice the look and the setting possibilities of the panel change.

You have got the following possibilities:

- managing of the layers (see section 3.6.1)

- setting of further details to the layers (see section 3.6.2)

- managing of the tool-magazine (see section 3.6.3)

- setting of the tool-parameter (see section 3.6.4)

- control of the output and the machine (see section 3.6.5)

- management of the position memory (see section 3.6.6)

Note: In case you prefer the horicontal Apple tabs, you can change this via a terminal command, only (>= v5.0):
defaults write com.Cenon verticalTabView -bool NO

3.6.1 Layers
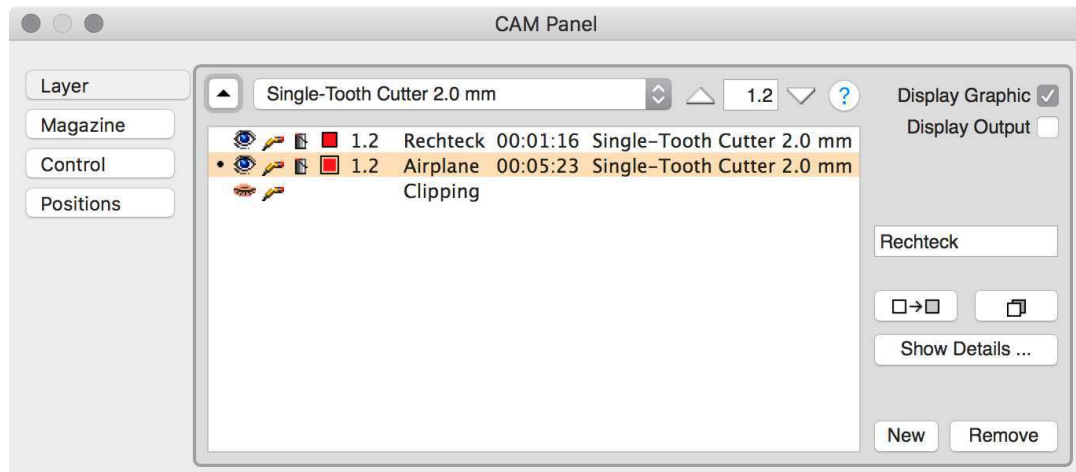
The Layer-Panel is for the management of the different layers. The layers are used by Cenon to separate the single steps (e.g. engraving and milling).

Here you can choose whether you want to show the original graphic (tick next to graphic) or the moving range of the tool (tick next to output) in the graphic window. When the output is turned on a new calculation of the output path is started whenever you change the parameter. To be able to work without any difficulties we recommend to switch off the output while editing.
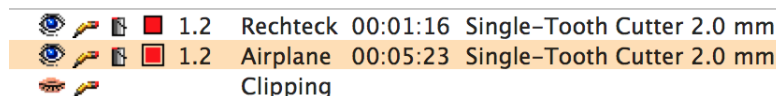
This area is the heart of the Layer-Panel. With the small icons you can already carry out the most important settings for the layers.

With the eyes you can switch on and off the display and/or the output of the layer. A layer with closed/shut eyes is not displayed and output/given out. You can use the little pencil to switch on/off the possibility to edit the layer.

A layer with a broken pencil can not be edited and is therefore protected against unintentional/unintended transformations/changes.

Here you can choose whether the elements of the present layer are to be filled (pocketing) or not during the calculation of the output paths. A bucket that is poured out indicates that an element is filled so that the appropriate area is pocketed during the engraving.

In the two right images the element is filled in the two alternative ways (Standard or Contour-Fill). The output path is calculated for a given tool diameter.

Here you can select the kind of tool-radius-correction. You can choose between no correction, inward correction, and outward correction. Certain special algorithms can be chosen in the Layer-Details, for example Pick-Out (Carving).

Filled Paths:

The left image shows an output path without tool-compensation. In this case, machining the circle would reduce it in size by the radius of tool.

The center image shows an example of an inward correction of the tool-radius. This operation is necessary when you want to engrave the graphic into the material.
The right image shows a graphic that has been corrected outwards (by tool-radius). This operation is necessary when you intend to cut the graphics in its original size from the material.

Open Paths:
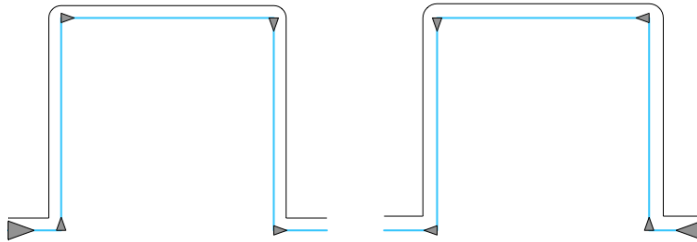
The left open path is corrected to the inside, the right open path is corrected to the outside.
In these examples the Preferences setting for "Contour left/right" is checked (see section 3.1.1). Otherwise the correction is all around (outside and inside). Additionally, the Project-Setting for co-/counter-direction has an influence of the corrected side (see section 3.2.1).
Open Paths don't get any direction set automatically, you have to set the direction according to your needs (Menu: Edit ▷ Revert Direction).
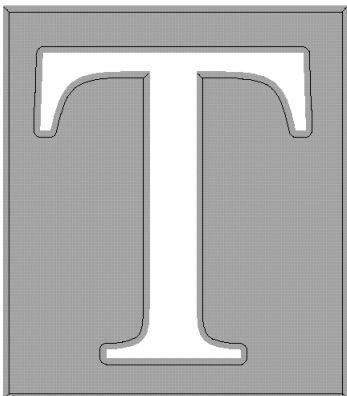
This is an example for the Pick-Out (Carving). This algorithm (and others) can be

set from the Layer-Details only. See section 2.3 for details of the Pick-Out.

Here are some hints to achieve a precise and correct tool-radius-compensation:

- Use only curves that are simple. The more extreme a curve is the more in-accurate its resulting contour. Connect curves tangential (connecting handles should create a straight line).

right: wrong:
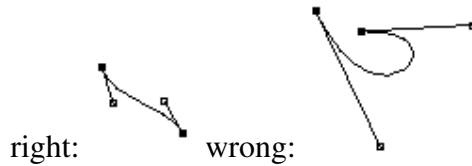
- A path must not have any gaps between the elements building the shape.

- You should not use too many elements to create a graphic.

- If the tool is too big for the compensation, the outline of the graphics will not calculated correctly.

Error messages that appear during the calculation of the drive way are displayed in the console window of the workspace-manager.

- (>= v5.0)

The dot marks layers with selected content. Please take a look at the end of this section for an explanation on how Cenon finds the layer on which to paste.

`1.2`

This area shows the dip depth of the selected tools in this layer. The dip depth is the distance that the z-axis from the scratch-height dips into the material (you can set this in the machine Control-Panel (see section 3.6.5). The measuring unit is taken over from the Preferences-Panel. Here you can see the name of the layer.

`Airplane`

You can enter the name into the edit-field on the right of the window. You get to the panel layer-details with a double-click on this field (see section 3.6.1). You can set further settings for each layer here.

`00:05:22` [>= v5.0]
This part displays the output time of the layer. The information is displayed only, if the output is displayed.
With a double click the Run-Time Panel opens.

`Single-Tooth Cutter 2.0 mm`
Here you can see the name of the assigned tool. The tool can be chosen with the pop-up menu. With a double-click on the tool-name you reach the tool-parameters (see section 3.6.4) of the assigned tool for this layer (>= v5.0).

×

If the tool parameters of the assigned tool are different from the values in the magazine, then a small cross marks the tool as modified.

Move Layer:
If you move the name of the layer with the mouse and by pressing the Ctrl-key at the same time you can change the order of the layers in this panel and also the order of the display and output. Cenon gives out the layers in the same order as they appear in the panel. Therefore we recommend to work on engraving layers first and to cut the outline in the last step.

[▲] (>= v5.0)
This button allows you to change the output order, either "bottom to top" or "top to bottom".
Changing the output direction will also change the position of the passive layers, which, depending on their purpose, can be displayed on top or below their parent layer!

`Single Tooth 2.0 mm` [↕]
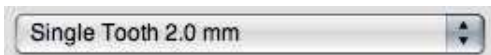
In this pop-up-menu you can set the tool for the selected layer. Here the tools of the magazine that you have chosen in the magazine-panel are shown (see section 3.6.3).

`△ 1.2 ▽`
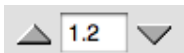
Here you can enter the dip depth. The dip depth is the distance which the z-axis dips into the material from the scratch-height on (you can set this in the machine-control-panel). The measuring unit is taken over from the preliminary settings' panel.

? (>= v 5.0)
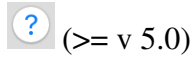
The button opens tool tip information to the layer list.

Airplane
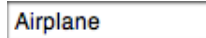
Here you can see and edit the name of the selected layer.

Show Details ...

With this button you get into further panels where you can set further details that you don't need very often. (see section 3.6.2).

□→□   ◫

The left button move all selected elements in the graphics window to the selected layer.
The right button copies the selected layer itself (not the selected items on the layer).
The function of this button is different to the similar button in the Inspector Panel !

New   Remove

Here you can create a new layer or delete/erase a selected layer.

00:03:10
00:16:02
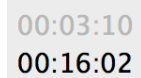
The two output-times in the lower/left corner of the Panel are visible with the output displayed, and show:
the previous true output time (gray).
the estimated output time of the entire project (black).
Both times can differ considerably, in case different layers are displayed.

Copy / Paste

Graphic objects are pasted to the same layer they are copied from.
If graphic objects from multiple layers are selected, they each are pasted to their source layer.
If the source layer is not editable, graphic is pasted to the selected layer instead.
If the selected layer is not editable, nothing gets pasted, and a warning appears.

3.6.2 Layer-Details
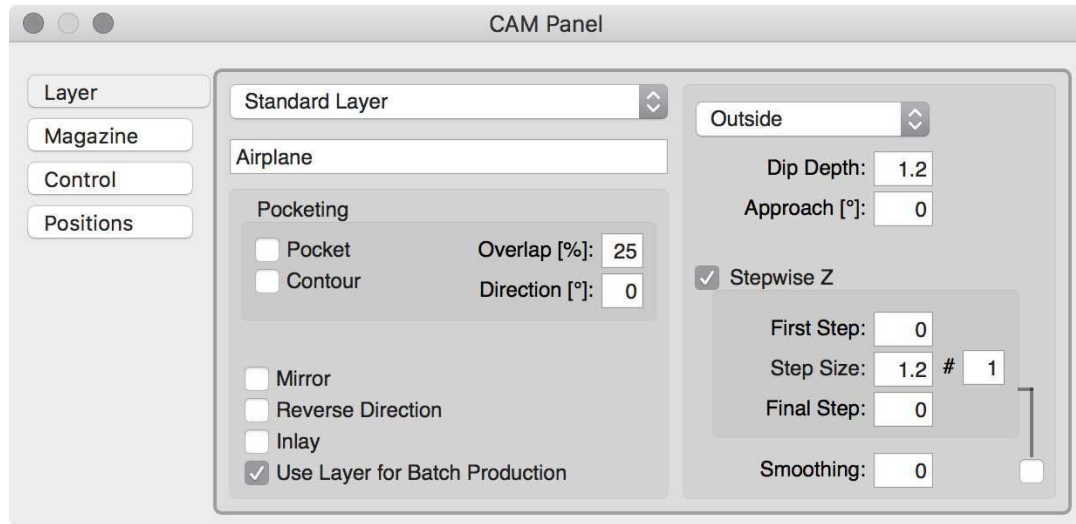
Here you can enter further settings that you don't need very often for the respective layers.
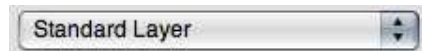
Here you can set the type of the layer. The type is usually 'Standard'. If you need a special layer like a Fitting-Layer or a clipping layer, you can change the type of a layer using this pop-up.

Standard Layer   The normal layer for all tasks, that are not special.

Standard+Smoothing   (>= 5.0): A separate smoothing layer adds additional features for smoothing, for example it's own dipping depth.

Clipping Layer   On this layer a Rectangle or Path can be placed to crop the output area (ex: Panelling).

Fitting Layer   On this layer, you can place markers for fitting bolts, allowing the exact placement of material. As an example, this layer is

	used to flip a dual-sided Printed Circuit Board to process the second side.
Passive Layer	The layer you create here contains no graphical elements and has no tool assigned, the purpose is mainly as a separator in the layer panel.
Leveling Layer	A levelling layer can be used to measure the topographic Z levels of an area. The leveled area will then be used as the surface reference for the output.
Camera Layer	A camera layer (Option: Camera+Targeting) is used to place markers, which will be measured by a camera. If this layer exists in a project, the camera is turned on automatically.
Template Layer	Special Layer, for example to place Prototype-Graphics, that are later used for automatic output of multiples (see Section 2.5 for an example using a Camera to recognize the positions for placement).

Airplane

Here you can see and edit the name of the layer. This field has got the same function as the editing-field in the Layer-Panel.

Dip Depth: 0

Here you can enter the dip depth of the tool in the basic material. The setting has the same value as in the Layer-Panel.

Approach °: 0

This field allows setting of an Approach Angle to smoothly approach the full dipping depth. If you enter an angle greater than 0, the tool will approach the dipping depth in this angle, until the full dipping depth is reached. The angular approach lowers along the contour of the path - for a circle this would be in form of a helix.

The advantage of the angular approach ist a constant working speed, without stops and unnecessary changes of the feeding speed. Consequently, ugly rattle marks are avoided and the results get more beautiful. Also the tool is burdened less.

Special Behaviour:

Rubbing out a Circle	If a circle is pocketed without angular approach, then the Circle will be filled from inside to outside. With Angular Approach, the circle will be filled from outside to the center.

The Angular Approach is available for closed Paths, and otherwise ignored.

Outside ⬍

Here you can choose the kind of tool-radius-correction. You can choose between several kinds of correction. The setting-possibilities correspond to the icons in the layer-panel, but extend these for some special types of correction.

Correction	Description
Inside	The tool radius will be corrected to the inside (Engraving)
Outside	Correction to the outside (Cutting)
No side	No correction at all
Pick-Out inside	For detailed engraving (see section 2.3)
Pick-Out outside	For raised carvings like letters (see section 2.3.4)
PCB Isolation	Special correction of isolation tracks for PCB prototyping
PCB Blow Up	Special correction of Blow Up tracks for PCB prototyping
PCB Rub Out	Special correction of Rub Out for PCB prototyping
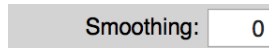
☑ Stepwise Z			
First Step:	0		
Step Size:	1.2	#	1
Final Step:	0		

Cenon supports stepwise working of workpieces. Here you can enter how deep the tool dips into the workpiece during the first operation and how the other operations can be worked on at most and what should be leftover for the final operation. The machine does not dip deeper than the maximum dip depth of the layer. With the switch on the upper left you can switch on/off the stepwise working.

Smoothing:	0

Here you can set smoothing for a grinding tool. Smoothing only removes a very thin layer of material. Smoothing is enabled by a value greater than zero. In this case, a final smoothing run is added, which removes the given thickness of material for the entire depth.

Final Step:	0
Smoothing:	0

When this switch is turned on the settling is already inserted before the final step of the stepwise operation. This can makes sense because the material might not cope with all the forces of the settling when it is completely cut through.

Pocketing	
Pocket	Overlap [%]: 25
Contour	Direction [°]: 0

This area offers more settings for the selected layer for pocketing (filling).

Pocket   This switch enables pocketing (filling) for the layer. The switch has the same function as the filling-icon (bucket) in the Layer-Panel.

Overlap [%] In this field you can enter the fill-overlap. The filling paths are denser for higher percentages.

Direction [°] This field provides the filling direction for the standard fill (not contour fill).

Contour   Activates the contour fill algorithm for this layer, and disable the Standard Fill algorithm. The contour fill fills along the contour of the graphic, instead of moving back and forth. The contourfill usually looks better than the Standard Fill, in some situations like a filled circle, the Contour Fill is also faster.

- ☐ Mirror
- ☐ Reverse Direction
- ☐ Inlay
- ☑ Use Layer for Batch Production
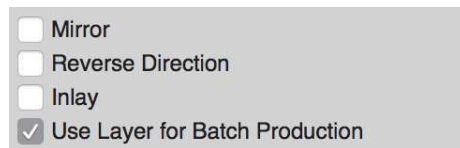
Mirror   Here you can turn on/off mirroring during output for the entire layer. Usually you mirror your graphics using the editing functions of Cenon. However, if you want to flip your working piece during output (eg. for production of two layer PCB prototypes), you only want to mirror the output, not the display. This is the purpose of this switch.

If you mirror the layer, the switch to reverse direction is automatically inverted [>= v5.0]. This will keep the graphics (and output) direction conform to the Project Settings (see counter-direction switch in section 3.2.1).

The output will be mirrored by the axis between the two fitting

marks on the Fitting-Layer (see section 3.7.3). No passer and nothing will be mirrored during output !

Reverse Direction This command reverses the direction of filled objects on this layer. With this function you can override the machining-direction for this layer (also see "Counter-Direction" in section 3.2.1, and "Show Direction" in section 3.3.4).

Pay attention when changing the direction of graphics objects manually (Edit ▷ Reverse Direction or Cmd-d), which is void, when applying this switch.

Inlay   If you activate this option, the tool-radius correction is calculated in a different way: Sharp angles are rounded so a outside correction would fit in a inside correction.

A successful calculation using the inlay option demands the right placement of vertices:
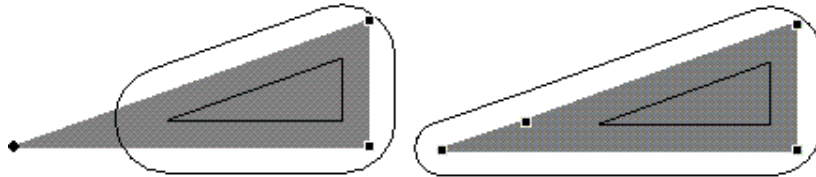
In the left image the vertices are placed right. The angle for the inlay is calculated correctly, and the result of the inner contour will fit inside the outer contour. In the right image the correction for inlays fails. Always try to avoid vertices close to edges, especially inside the tool radius!
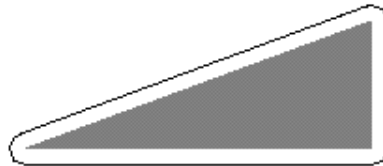
This is a usual tool-radius-correction without the inlay option.

Use for Batch   Here you can enter whether the layer should be used for batch production or not. For details, see the description of the panel for

batch production in the Cenon manual.

3.6.3   Tool Management
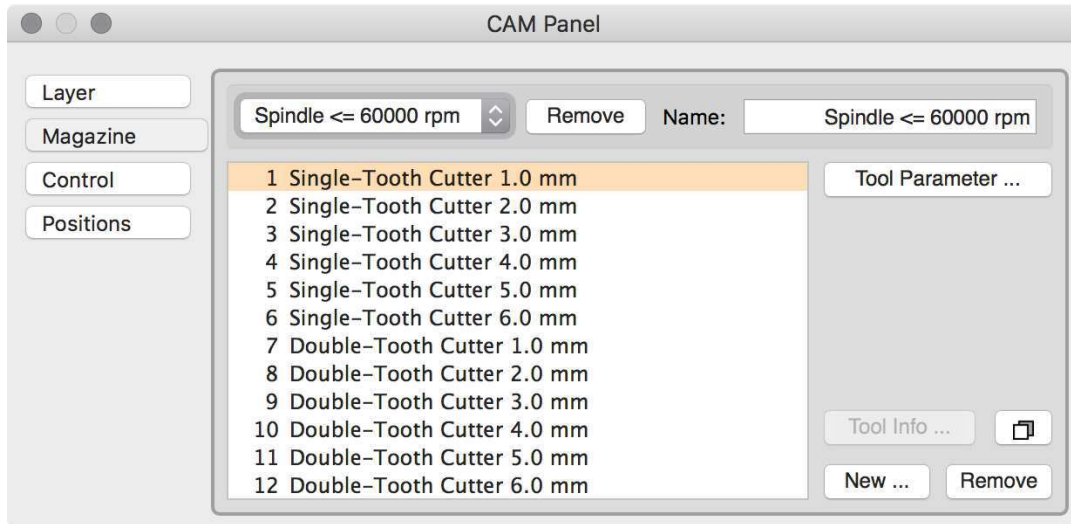
The Magazine-Panel is for the management of the tools. Tools can be distributed on magazines to arrange them for the different operation purposes.
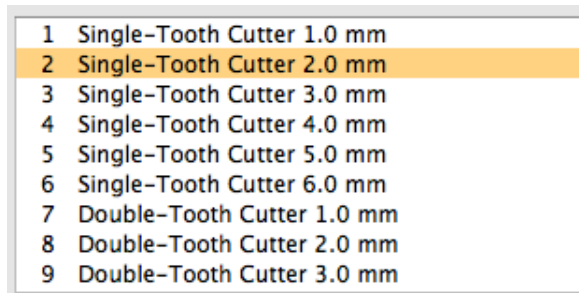
This list shows all the tools of the selected magazine. With a double-click on a tool you reach the window where you can set the tool-parameter of the tool (see section 3.6.4). When you move the tool name with the mouse and press the Ctrl-key at the same time you can change the order of the tools and you can sort the list according to the tool-types and sizes.

In this pop-up-menu you can select the magazine that you want to use for the actual/current/present graphic: The last entry of this pop-up-menu is for the creation of a new (empty) magazine.
With the remove button, the selected magazine is deleted.

Name: My Magazine

Here you can enter the name of the magazine.

Tool Parameter ...

With this button you get to the Tool-Parameters of the selected tools (see section 3.6.4).
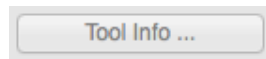
Tool Info ...

With this button you can reach further tool-information in a later Cenon-version.

(>= v5.0)
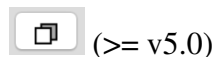
This Icon creates a copy of the selected tool. The name of the copy has a suffix with an incrementing number, for example "Cutter 1.0mm_1".

New   Remove

A click on the New button creates a new tool and changes the appropriate Tool-Parameter (see section 3.6.4).
The Remove button deletes the selected tool.

3.6.4   Tool-Parameters
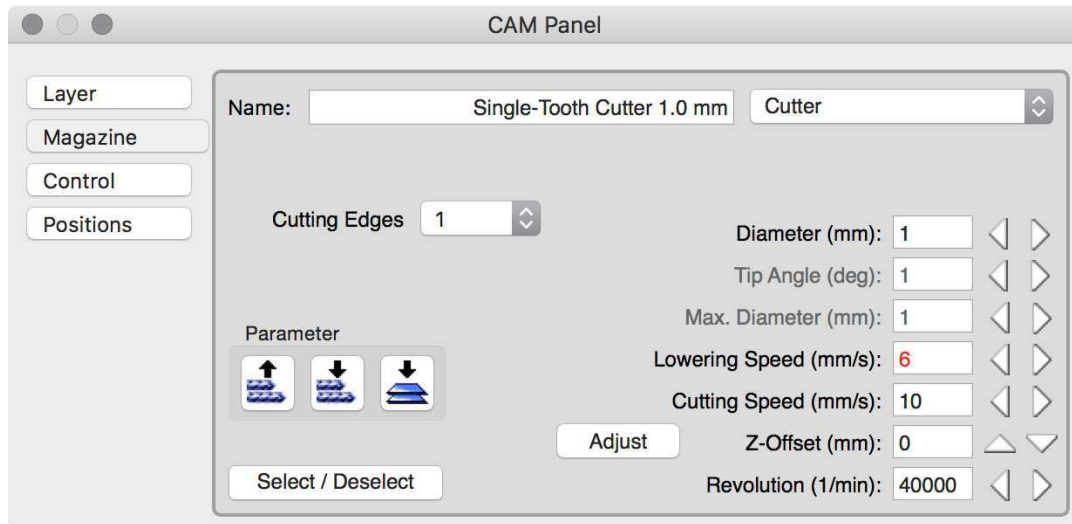
In this pane you can set the parameters for the tool, selected in the magazine.
To modify tool parameters of the tool magazine (globally), you have to open the tool-parameters from the "Magazine" tab.
If instead you open the tool parameters from the Layer-Panel (double click on the assigned tool), you will modify the tool parameters for the layer only (>= v5.0) !

In this field you can see and edit the name of the tool.

A tool can be a cutter, a conical cutter, a drill, a thread cutter, etc. A drill can only be moved up and down in the workpiece. A thread cutter is a special tool to cut threads.

The fields for non-standard tools are described below.

Here you can set the diameter of the tool. Cenon calculates the output tracks with the diameter.

Here you can set the lowering speed of the tool. The lowering speed is the speed with which the tool dips into the material.
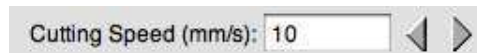
Here you can set the cutting speed of the tool. The cutting speed is the speed with which the tool is moved in(to) the material.
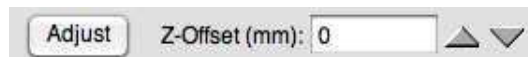
Here you can set an offset for the z-height. This offset levels out tools that have not the same length when you use tools with stopping ring. The proceeding is: first you set the z-position in the Control-Panel for the longest tool. Then you can set the Z-Offset for the shorter tools. When you press the adjustment-button the machine follows your input, and allows for exact adjustment of the offset. When you switch off the adjustment-button the machine moves back to the initial z-position. The offset is then saved for the tool and during the operation this tool is lowered with the Z-Offset added.
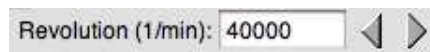
Here you can set the number of revolutions of the spindle. When you have got a powerful controller the number of revolutions is set automatically. Otherwise the value can help you to remember which number of revolutions you have to set manually.

(>= v5.0)
These icons are only visible, if you modify the tool parameters for a layer. If a tool parameter differs to the one of the tool-magazine, the value is displayed in red color. The left icon restores the local parameters of the layer from the (global) tool magazine.
The center icon transfers the local tool parameters of the layer to the tool magazine.

The right icon copies the layer parameters to all other layers of the project, which have the same tool assigned.
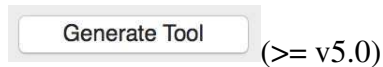
| Generate Tool | (>= v5.0)

If a tool, which has been saved with the layer, is not available in the tool magazine, then this button appears to allow generating the tool in the magazine.

| Select / Deselect |

If your machine has an automatic tool exchange, you can select and deselect a tool here. Even if you don't have an automatic tool selection you should use this button to let Cenon know which z-offset and revolution it has to use for your adjustments.

Conical Tools

Tip Angle (deg): 10
Max. Diameter (mm): 2

This part is only active for conic tools. Here you can set the tip angle and the maximum diameter of the tool. In this case you have to set the diameter at the tip of the tool for the diameter field.

Thread Cutters

Pitch (mm) 1
Core Diameter (mm) 2
Overshoot (mm) 0
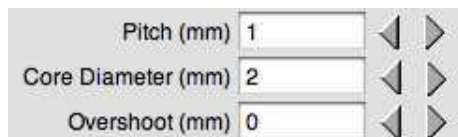
This part is only active for thread cutters. Here you can set the pitch, the core diameter and the overshoot offset.

- Pitch is the pitch of the thread (the distance measured from one tooth to the next).

- the core diameter (ØC) is the core diameter of the tool.

- the overshoot offset (lo) is only used for a special kind of thread cutter and is 0 for normal tools.
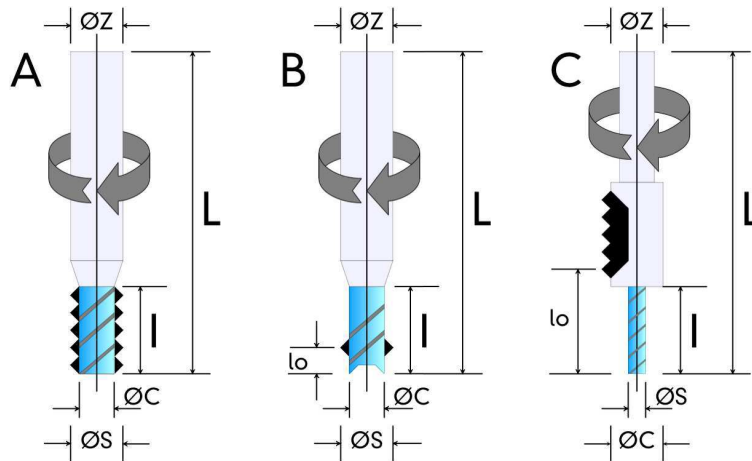
A Standard Thread Cutter.

B Drill Thread Cutter (DTC). The special cutter is able to cut the hole and the thread at once. The overshoot (lo) is the distance from the tip of the tool to the cutting teeth.

For inside threads the cutter lowers to the surface of the material, from there spiraling down to the bottom of the thread + overshoot. Finally, the tool is lifted out in the center of the thread.

For outside threads the cutter approaches from the outside and has to be lifted outside of the radius of the thread. Therefore you have to provide enough room for lifting the tool!

C Combi Thread Cutter (Combi or DTC1). This type is used for inside threads only. The tool diameter (ØS) is the diameter of the inserted tool plus the depth of the teeth! The core diameter (ØC) is the diameter of the thread section without teeth. The overshoot (lo) is the distance between the tip of the cutter and the thread section.

ØS	Tool Diameter
ØC	Core Diameter
lo	Overshoot (Type B and C)

Knifes

| Distance before corner | -0.3 | ◁ ▷ |
| Distance behind corner | -0.3 | ◁ ▷ |

This part is only active for knifes. Cenon allows over-cutting or under-cutting corners. This allows compensation of real-world limitations of knifes and materials.
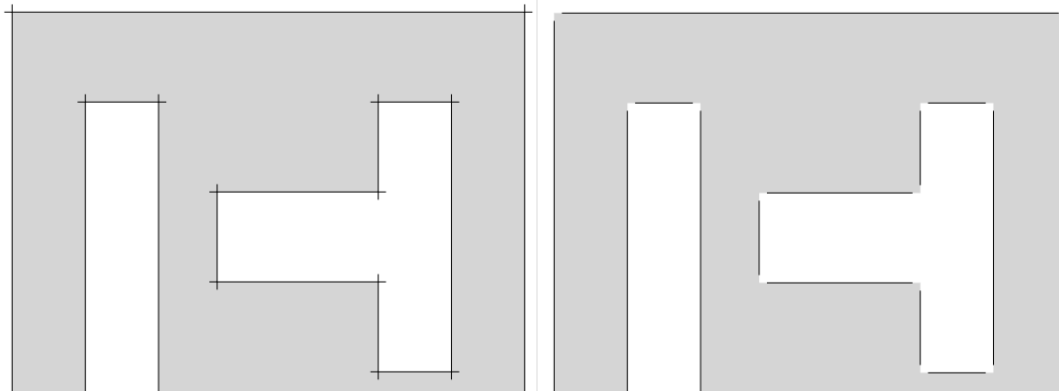
Examples for negative (left image) and positive (right image) distances from corners.

3.6.5 Machine-Control
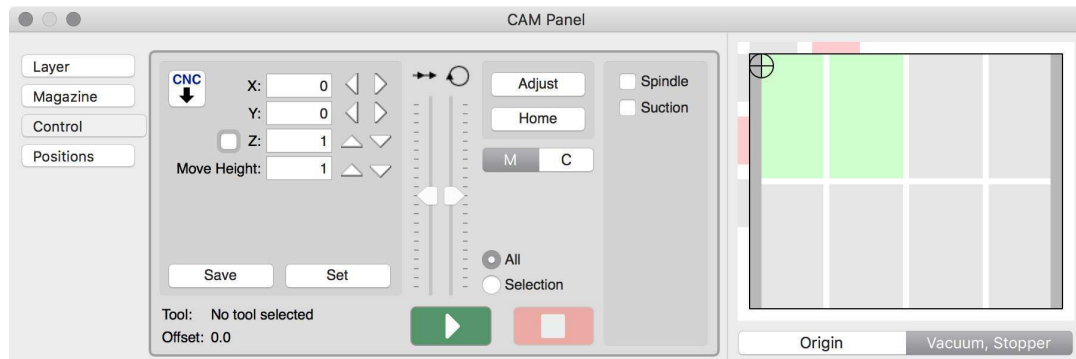
Here you can position the machine. You can also start and stop the output with this panel.
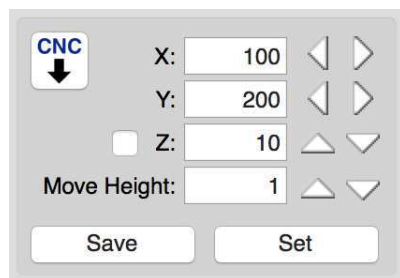
In this field you can set the starting position.

Using the buttons, the machine moves in 0.1 mm steps. If you keep the Ctrl-key pressed while moving the machine, the machine moves in 1.0 mm steps.

If you change the x or y positions, the z axis is always lifted to Move Height for security reasons!

The setting of the x- and y-position you can also carry out with the cursor-keys on the numeric part of the keyboard (as long as no text is edited).

Arrow up (8):   moves the y-axis in positive direction

Arrow down (2):   moves the y-axis in negative direction

Arrow right (6):   moves the x-axis in positive direction

Arrow left (4):   moves the x-axis in negative direction

Note: If you control the machine via the arrow keys, the machine may happen to move a little longer than you pressed the key! Please take this into account.

☐ **Z:** 1   △ ▽

Here you can set the position of the z-axis. The z position is the surface of your material. The button for lowering the Z axis has a little magic in it: If you click it the first time, the Z position is set. Only the next clicks will modify the Z position.

This setting you can also carry out with the cursor-keys (as long as no text is edited):

Arrow up (9)   lift the z-axis

Arrow down (3)   lower the z-axis

If you activate the Adjust Switch (left of the Z field), you can adjust the Z-position. This means that you can move X and Y to a position of your choice to set the Z-position. If you turn off the switch, the X- and Y-axis return to their initial positions.

If you use a measurement sensor, the measurement will be started by clicking on the down button (see #SFM in section 4.2).
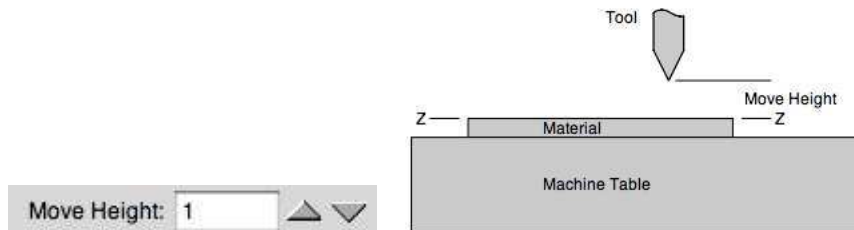
Move Height: 1   △ ▽

Here you can set the move height (or flight level). This is the distance the tool stays above the surface when positioning. This height is not very critical. However you must ensure that the tool moves height enough to get over all obstacles.

"Get Position" asks the CNC controller for it's position. This is only available, if your CNC controller supports this feature. The button enables you to set the starting position more comfortable with a hardware control panel. When pressing the get button, the machine position will be taken into Cenon as the start position. For Z this is the surface position on your working piece. (Also take a look at the configuration entry #GPA in Section 4.2)

With the button "Set Position" you can move the machine back to the start position, for example after a Home drive or after finishing the output.
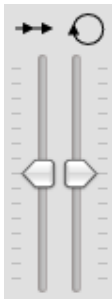
The two sliders allow the relative changing of the feed and spindle revolution during the output. The parameters are altered from about 20 to 200% of the values entered for the tool.

The sliders are available only, if your CNC controller supports this feature. (Also see the configuration entries #AVS and #ARV in Section 4.2).

Here you can carry out an adjustment drive or a zero drive. An adjustment drive justifies the machine and moves it back to the start position. A zero drive (Home) moves the machine back to zero and remains there.

Here you can choose whether all layers that are displayed with an open eye should be given out (that means all the layers) or only the selected elements in the graphic window (selection).

  (>= v5.0)

Start   The green button starts the output. Without an automatic tool changer, you may be asked to insert the tool.
               Once the output has been started, the Start-Button will be disabled.

Pause   The red button pauses the output. Once the output has been paused, the green button turns into a Continue button and the red button turns into a Stop button.
               Please keep in mind that the machine may process a few more vectors before it pauses.

Continue   The green button is now used to continue the paused output.

Stop   The red button is now used to stop the paused output.
               In case of emergency press the emergency-stop-button of the machine!

Here you can control up to ten features of your machine, if your CAM controller offers in/out ports. The switches can be defined in the device configuration file (see section 4.2).

(>= v5.0)

These Choice-Buttons can be used to change the content of the right view, in case there is a choice at all (for example: Maschine and Camera).

The right side of the Control-Panel (>= v5.0)

Currently the right side of the CAM-Panel can contain a machine view or a camera view. The right side doesn't have to be open - if the CAM-Panel is not wide enough, or has been closed by the user, the right side is not displayed.
The right side of the CAM-Panel can be resized and closed at the line between the Control-Pane (left) and the right side.
If the right side is closed, you can use the mouse to drag it open from the right side of the CAM-Panel (if the CAM-Panel is wide enough).

Maschine View
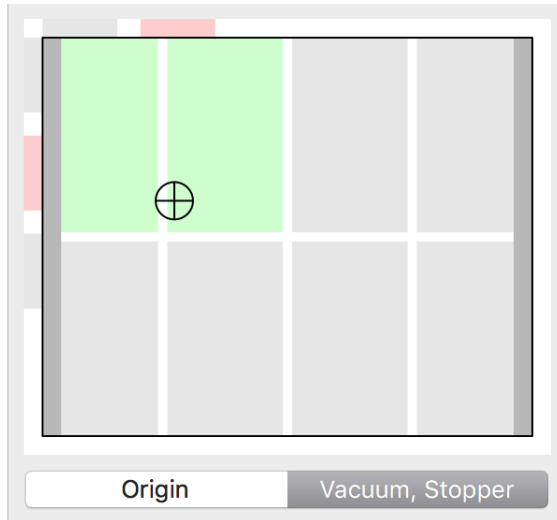
The Machine view shows the XY position of the machine graphically. Additionally, the status of vacuum tables and Stoppers can be displayed.
Set the Choice button to "Origin" to position the machine with a mouse click to the desired position.
Set the Choice button to "Vacuum, Stopper" to switch vacuum tables and Stoppers. Please refer to section 4.2 to configure vacuum tables and Stoppers for your machine.

Camera View
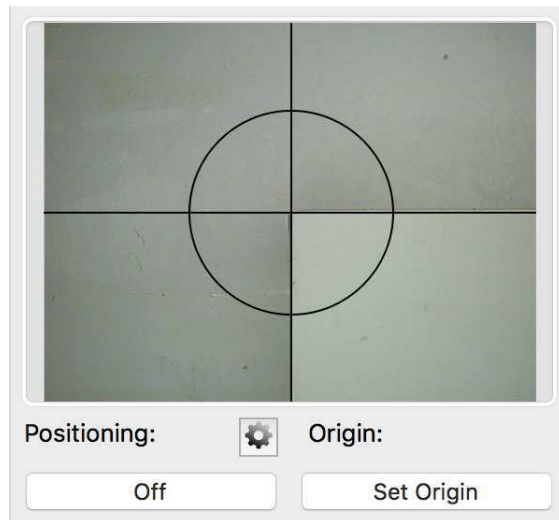
The Camera View displays the image from the camera. Here you can direct the optional features Camera-Positioning (>= v5.0) and Camera+Targeting.

Camera-Positioning You can use the camera image to move the starting position of the output to the center of the cross-hairs.

The left button is used to turn the camera on and off.

The right button sets the starting point (origin) for the output. The machine will move immediately by the camera-offset (section 3.2.2 and #COF in section 4.2) to bring the tool (spindle) into the center.

If the camera-positioning-mode is enabled in the device configuration (see entry #CPM in section 4.2), the right button is disabled. The machine will move automatically to the tool position once the output has been started, and back to the camera after.

If a knife is selected as tool, the machine will move to the knife position (#KOF in section 4.2), instead of the normal tool position.

Requirements: external camera, #COF entry in device configu-
ration, Camera-Positioning or Camera+Targeting option.

Camera+Targeting   The left button is used to define a pattern.
The right button is used to start the gauging and output (see
section 2.5).

Cenon Control for iPad (>= v5.0)

Cenon offers an alternative way to control the machine via iPad. You can find documentation on our web-site (`http://www.cenon.biz/CenonControl`).
You can deactivate the iPad feature in the CAM-Preferences (see section 3.1), for example to avoid potential danger from a second person remote-controlling the machine.
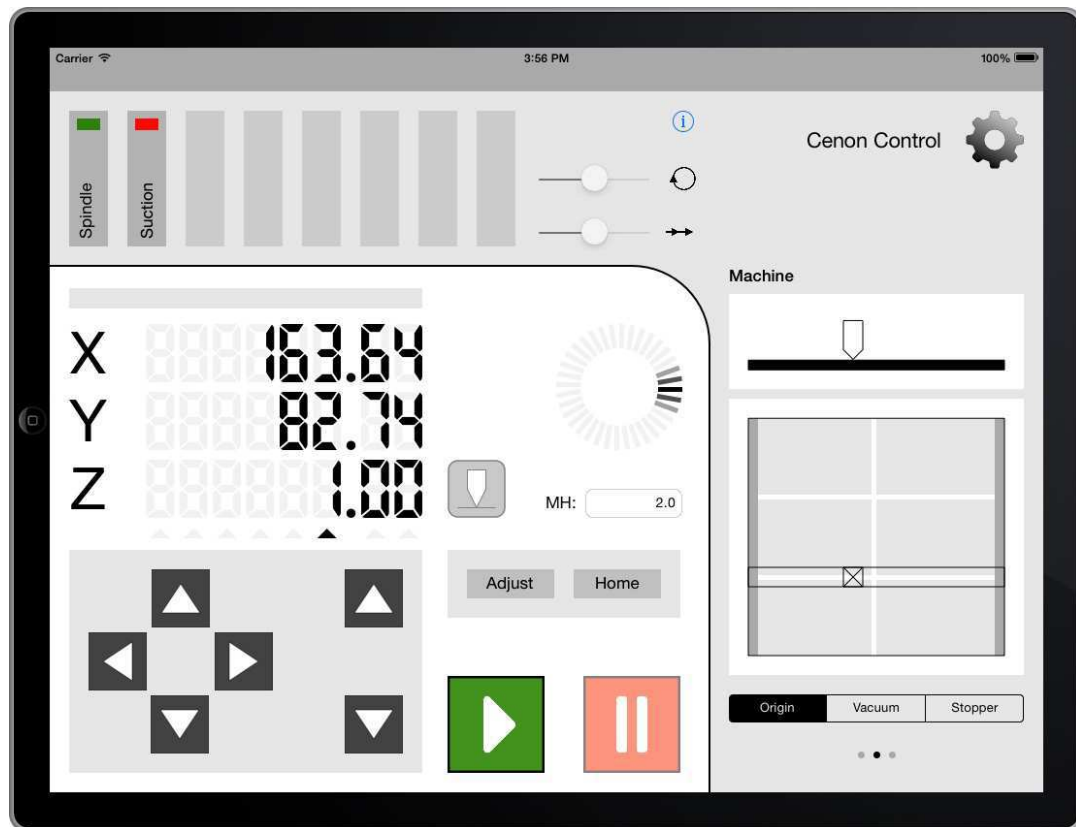
The Cenon Control (for iPad) can be used parallel to the CAM-Panel of Cenon. All you need is a WiFi connection.
Once connected you can control the machine from your iPad, including Camera-Positioning, Camera+Targeting, etc.

You find the "Cenon Control" App in the Apple App Store.

Display progress of output (Coming soon)
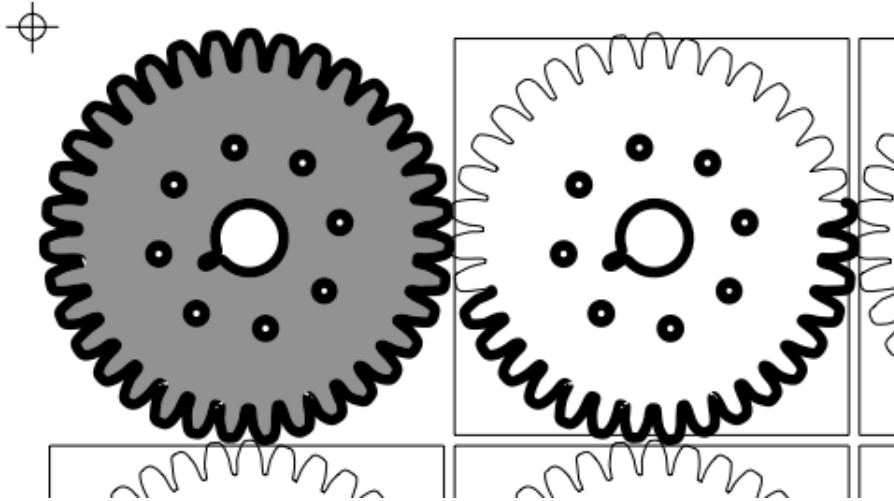
During output, the progress can be displayed inside the graphics window (not yet). The position on the screen can be ahead of the machine. The exactness depends on factors like the look-ahead or the use of commands to query the exact location of the machine.

3.6.6 The Positioning Memory
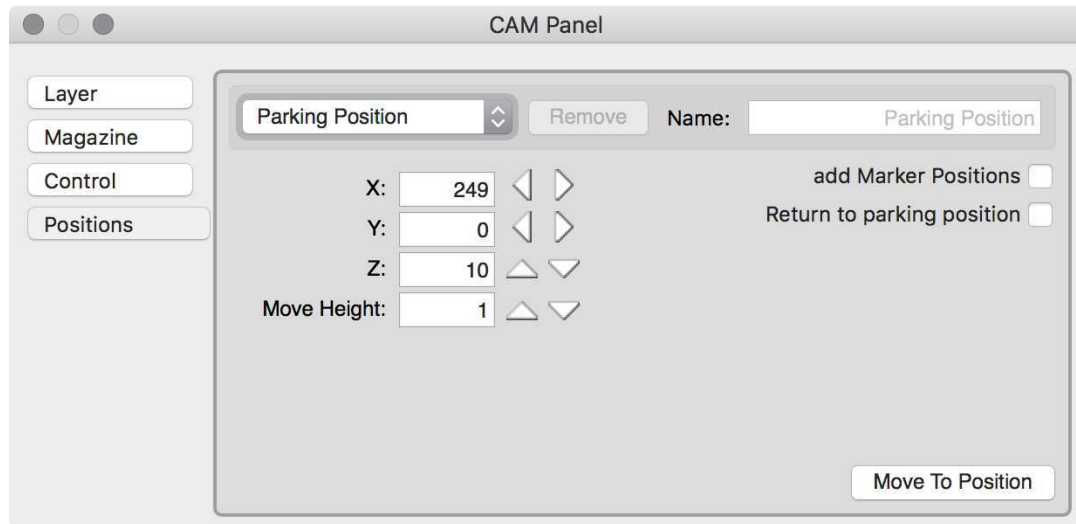
Here you can set the starting positions of the machine for different purposes.

With the pop-up-menu you can choose the starting position. The last item "new position" creates a new position entry. The current starting position is taken from the Control-Panel as the value of the new position.

The Remove button removes the selected position-entry.
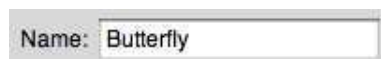
Here you can enter the name of the position-entry. We recommend to name the position memory after the material that is worked there.
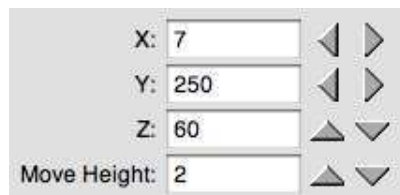
With these buttons you can set the starting position in the same way as in the Control-Panel.

add Marker Positions ☐

With this switch active, all the drill markings from the current document will be added to the position list. Only markers with name are added to the list. When positioning to a marker position, the move height is not set.

Return to parking position ☐
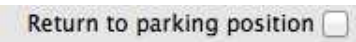
If you activate this switch, the machine returns to the parking position, after finishing output.

Move To Position
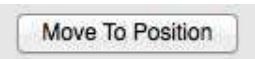
The machine moves to the entered position and switches to the Control-Panel.

3.7   Layers

Additionally to normal layers, Cenon provides some special layers, which will be described here. This special layers are for example the Clipping Layer (see section 3.7.2) and the Levelling Layer (section 3.7.5)

3.7.1   Smoothing Layer (>= v5.0)

You can create a Smoothing layer in cases where the standard smoothing function (section 3.6.2) is not sufficient, for example if you want to use a different tool for smoothing.

To create a smoothing layer, you have to select "Standard+Smoothing" in the layer details. The Smoothing layer is a passive layer and gets the suffix "-S".

| 👁 | | 2 | Smoothing Layer–S | 00:00:20 | Single–Tooth Cutter 2.0 mm |
| 👁✏️📄🟥 | 3 | Smoothing Layer | 00:00:16 | Single–Tooth Cutter 3.0 mm |

As an example, the Smoothing layer can maintain it's own depth.

With Smoothing-Layer, the smoothing distance has to be entered for the Smoothing Layer !

3.7.2 The Clipping-Layer

The clipping layer is a special layer used to clip objects on other layers for output. It can be used for long signs which don't fit on the machine table, and thus can't be processed at once. This process is also known as Panelling or Push-Through.

You can change a layer into a clipping layer by setting the layer type in the layer details (see section 3.6.2).

Long signs can be divided in two groups:

1. Signs which can be produced in two parts, and are assembled later (example 1). Here you just can run two separate jobs

2. Signs where the working piece can't be devided (e.g. a handwriting). In this case the entire sign is divided into areas which are processed one after the other (example 2).

Example 1

Example 2

Before you start, you should prepare a guide on one side of your machine. This way you can move the working piece along the guide without worrying about the positioning in this direction. By using markings you can even get highest precision for moving the working piece.

1. Place the material on the machine table.

2. Load the file with the complete sign (see example 2).

3. Prepare all necessary steps for cutting (tools, radius-correction, parameter etc.), and calculate the output tracks

4. Now, the first part of the sign can be activated. To do this create a rectangle on the Clipping-Layer. Use the Rectangle-Inspector to set the exact dimensions of the rectangle.
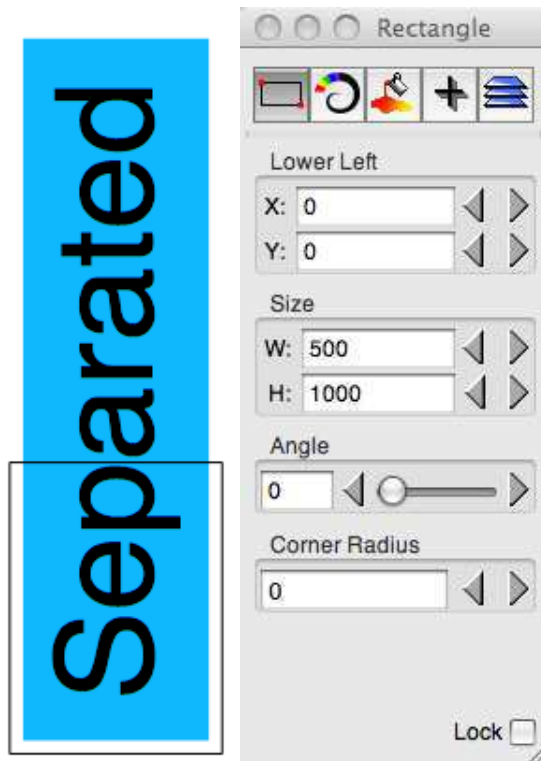
In this example the first area includes approximately half of the sign. Be sure to place the rectangle for clipping on the clipping layer. In the Rectangle-Inspector the size and position are displayed. Position the crosshairs to the same position as the rectangle.

5. Now, move the machine to the lower left corner of the material and adjust the

tool. Then you can start the output of the first part.
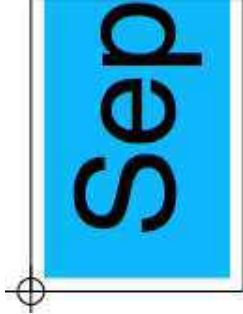
6. Now you can define the second part of the sign: Therefore move the rectangle on the Clipping-Layer to its new Y position using the Rectangle-Inspector. For our example we get the following:
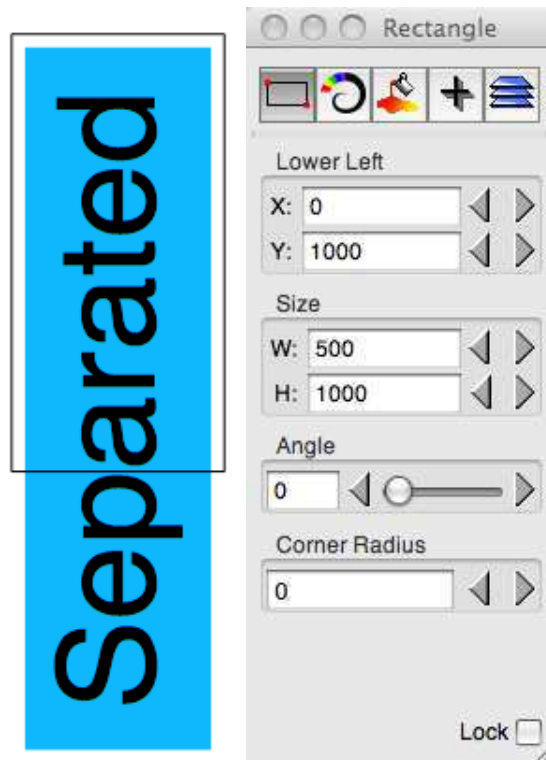
As you can see, we moved the rectangle from the position Y = 0 to Y = 1000.

7. Now we move the crosshairs the same distance in the same direction:
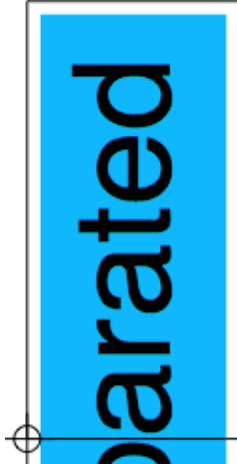
At third we have to move the material the same distance in the same direction. If you need highest precision use markings.

8. Now start the output.

9. Repeat the steps 6 to 8 until the complete sign is finished. Keep in mind, that you have to move the clipping rectangle, the crosshairs, and the material. They all have to be moved the same distance and in the same direction.

Note: The crosshairs are your zero point as well as the start point of your machine. So, the rectangle inspector displays the position relative to the crosshairs, and on the other side, the Crosshairs-Inspector displays the coordinates of the crosshairs measured from the zero point of your window.

3.7.3   The Fitting Layer

The Fitting Layer is used to place exactly two fitting marks. They are used, if you have to process a working piece from both sides.

To achieve this goal, the output can be mirrored by the axis between the two fitting marks. Select the switch 'Mirror' in the Layer-Details (see section 3.6.1) to activate the mirroring for a layer.

You create a Fitting-Layer by creating a normal layer ('New' inside the Layer-Panel), and afterwards changing the type of the layer to 'Fitting bolts' (Layer-Details panel).

The use fitting bolts is rather straight forward:

1. Create a fitting layer and place the two marks in a way that allows you to flip your working piece by the axis between the two marks.

2. For all layers which shall be mirrored after filpping the working piece, activate the switch 'Mirror' in the Layer-Details.

3. Start output by drilling the holes for the fitting bolts, so that you can fix your working piece with two bolts.

4. Continue the usual output of the first side.

5. Now, flip your working piece, and process the mirrored layers.

You can find some examples using fitting bolts in the distribution of Cenon.

3.7.4 Passive Layer

Passive layers that are tied to a standard editable layer, are created automatically. Their purpose is to manage specific tasks that need a separate tool assigned, for example the Filling of the Pick-Out.

You can, however, create a passive layer yourself for the single purpose of separating other layers (>= v5.0):

- - - - - - - - - - Layer Name - - - - - - - - - -

When you set the layer type to passive, you will be warned that all graphics on this layer will be deleted. Afterwards, you can only change the name of this layer.

Passive Layers have a name extension to show their purpose (>= v5.0):

C   a layer for cutting, created for outside carving (Pick-Out) (see section 2.3)

F   a layer for filling, like created for the Pick-Out (see section 2.3)

S   a Smoothing Layer (see section 3.7.1)

3.7.5   The Leveling Layer

The Leveling Layer appears if your CNC controller supports the surface measuring of working pieces. This is the case for the vhf CNC 950.

In this case you can create a rectangle on this layer, which defines the area of measurement.

In the Layer-Details (see section 3.6.1) of the Leveling layer, you can provide the number of test points for the x- and y direction. The created rectangle will be measured using the given number of test points for each direction.

If you want the surface of your working piece measured, be sure to display the levelling layer, before starting the output. The Leveling layer is processed first, before other layers are processed.

If you have measured the surface once, the surface usually remains measured until you switch off the CNC controller (this can vary in different configurations).

3.8   Composite Window(>= v5.0)

The Composite Window combines the document window (Project) and all major Panels in a single Window:
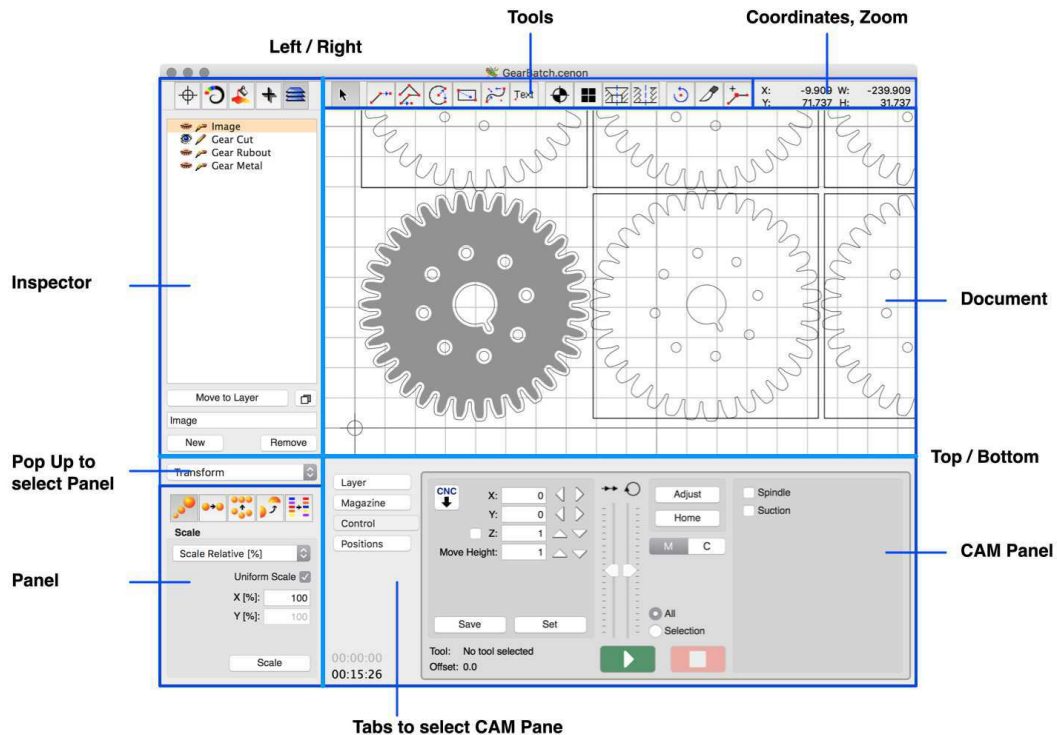
Areas

The Composite Panel is split in four areas, which can be resized. Certain areas can be collapsed:

Left / Right The left and the right side are separated by a thin line (displayed in the image as a thick blue line) and can be resized. If you position the mouse in the proximity of the separation, a Split-Cursor will appear. Dragging to the right or left side will resize the areas.
If the left side becomes too small to keep the Panels displayed, it will collapse.

Top / Bottom The top and bottom area can be resized and are separated by a thin line (displayed as a thick blue line in the image). If you position the

mouse in the proximity of the separation, a Split-Cursor will appear. Dragging to the top or bottom side will resize the areas.

If one side becomes too small to keep the Panels displayed, it will collapse (with the exception of the document).

Interface Elements

Inspector	The Inspector Panel (see Cenon Manual) is located at the top/left of the composite window.
Panel	Use the Pop-Up of the Panel area to select the Panel (for example the Transform-Panel or Batch Production) you want to be displayed. All major Panels are listed in the Pop-Up.
Tools	The Editing Tools (see Cenon Manual) are all lined up at the top.
Coordinates	The Coordinate Display is located at the top. It is only displayed, if the window is wide enough.
Zoom	The Zoom is displayed at the top. It is only displayed, if the window is wide enough. Without the Zoom Pop-Up you can still zoom, using the Scroll-Zoom (Cmd-Mouse).
CAM-Panel	The CAM-Panel (see Chapter 3.6) is located at the lower/right of the composite panel.

Managing Coomposite Windows

The Composite Window can be activated in general or for a Project.

Preferences ▷ CAM	Use the Preferences Panel (see Chapter 3.1.1) to activate the Composite Window for all Projects.
Project-Settings ▷ CAM	Use the Project-Settings (see Chapter 3.2.1) to keep a certain Project in a Composite Window.

3.9 Statistics Panel / Run-Time Panel (>= v4.1)

You can open the Run-Time Panel via the Tool menu: "Tool ▷ Run-Time Panel", or the keyboard shortcut: "Cmd Shift L". Additionally by a double click on one of the time displays in the CAM-Panel (>= v5.0).

Layer Name	Moves [m]	Drives [m]	estimated Time	Time left	actual Time
All Layers	2.33	1.79	00:07:53	00:04:15	00:03:38
Contour	0.14	0.11	00:00:18	00:00:18	00:00:00
Soldering	1.28	0.87	00:04:03	00:03:48	00:00:15
BlowUp	0.71	0.67	00:02:39	00:00:04	00:02:35
RubOut	0.20	0.15	00:00:53	00:00:04	00:00:49
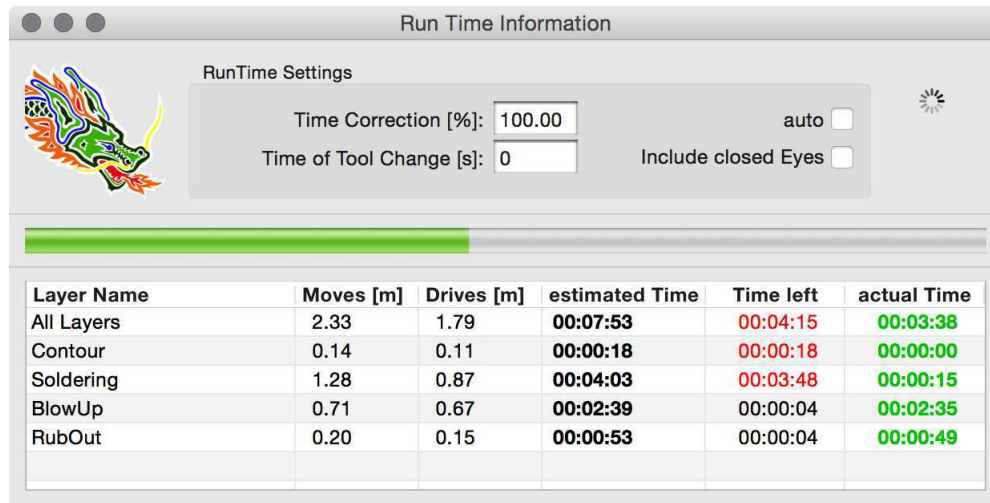
The image shows a Run-Time Panel during output. The layer "Soldering" is currently processed. Times in red show the remaining time, times in green are completed.

Pre-Conditions: To get useful results, the following has to be provided:

- in the CAM Preferences, you have to choose the correct device file (see section 3.1.1).

- you have to assign tools with all parameters correctly set (see section 3.6.4).

- the tools need correct speeds (XY and Z).
  Possible changes of the speed during the output are not included in the calculations and will .

- you have to set the move height inside the CAM-Panel (see section 3.6.5).

- the output has to be calculated (for example by displaying the output from the Layer-Panel).

In short, the job needs to be fully prepared for output to the machine.

Settings:

Time Correction [%]	the adjustment in % (Default = 100%). This affects the total time of the output job. Meaningful values can be between 50 - 200 %.
Time of Tool Exchange [s]	if a time is provided, it is used for the tool exchange. For certain CNC controllers (vhf CNC 950 series), the tool exchange times can be calculated.
auto	the time-correction will be calculated automatically after a complete output. This only makes sense, once the job will not be modified any more.
Include closed Eyes	this will include layers, which are not displayed into the calculation

Table:

Layer Name	This column lists the layer names. Only included layers are listed (see settings). The first line "All Layers" displays the sum of all layers.
Moves [m]	This column displays the length of positioning moves.
Drives [m]	This column displays the length of the output paths.
Estimated Time	The estimated time of output.

Time left	The time left to finish the output. On Start this is identical to the estimated time. An the end of the output, this is 0.
Actual Time	The actual time needed for the output. On Start this is 0.

Colors (columns "Time left" and "Actual Time"):

Red	Scheduled for output (not processed yet), or currently being processed
Green	output completed
Gray	previously obtained (and saved) values
Black	calculated values, or layers which are currently not machined

If the output to the machine is halted, or during an Alert-Box from Cenon, the time will be halted and the pause is not counted (in the column "actual time"). This is also true for manual tool exchange.

3.10   Barcode Import

This special feature allows the import of files via a code, which is entered into the following panel. The code can also be entered using a bar code reader. Application of this function is in large series production. The required lists of codes can be generated by a spread sheet or a database program.

If the feature is activated, the panel can be reached through the menu "Document ▷ Open Barcode...".

To use this function, a configuration file must be placed into the library folder (See Section 5.2) of the user. The configuration file describes the format of the list of codes and filenames. The filename of the configuration must be "barcode.plist".

Example of a "barcode.plist":

```
/* This file configures the loading of files via bar codes entered
 * into the Barcode Panel of Cenon.
 *
 * All paths are relative to "Library/Cenon/CAM" or absolute "/...".
 *
 * If the name (2nd entry) from the list file (listPath) is relative,
 * an optional folder name (3rd entry) may be added.
 *
 * examples of formats ('listForm'):
 * " 57975;00006427.dwg;00006" -> "%5s;%12s;%5s"
 * " 57975;00006427.dwg;00006" -> "%[0-9];%[^;];%[0-9]"
 * "123456 fileName folder"    -> "%s %s %s"
 */
{
    enabled = 1;                   // 1 = enabled, 0 = off
    listPath = "zeichnvz.txt";   // HOME/Library/Cenon/CAM
    //listForm = "%s %s %s";       // identifier, file name, [folder name]
    listForm = "%[^;];%[^;];%s"; // identifier, file name, [folder name]
    filePath = "";               // HOME/Library/Cenon/CAM
    setMarker = 1;               // 1 = set marker at UR position
    layerName = "Bounds";        // name of layer for marker
}
```

Description of the Entries:

enabled   is this entry = 1, the function is activated and the Menu item appears.

listPath   Here, the name and path of a list, containing the mapping of codes and file names, is defined. If only a name is given, the library path is assumed.

listForm   This entry defines the format of the list. Each line must be in the order code, file name, and an optional folder name.

%s   is a wildcard for any characters

%[^;]   is a wildcard for any character up to a semicolon

%5s   is a wildcard for a string of exactly 5 characters

%[0-9]   is a wildcard for the characters 0 - 9

filePath   This entry defines the path of the imported files. If empty, the library path is used.

setMarker   If this entry is = 1, a marker is placed at the position of the bounding rectangle of the imported graphics. This marking will get a name and may be used inside the position memory (See Section 3.6.6). The marker is playced on its own layer.

layerName   The name of the layer, which will be added for the marker.

The Syntax of the configuration file:

The syntax of the configuration is the same as used for most other configuration files in Cenon. Each entry is a relation of the form KEY = VALUE;
An entry must be terminated with a semicolon.

{...}   encloses the contents of the entire file

/*...*/   encloses a comment

//   starts a comment up to the end of line

KEY = VALUE;   an entry

The mapping file:

The list for the above configuration may look like this:

```
" 57975;file001.dxf;folder1"
" 57976;file002.dxf;folder2"
" 57977;file003.dxf;folder2"
```

3.11   Embedded CNC Commands

Text in a Textbox starting with #COMMAND_BEG#" or "#COMMAND_END#"
will be interpreted as direct CNC command. The rest of the string will be transfered
as it is to the CNC controller / machine.

COMMAND_BEG will be send to the machine at the beginning of the layer, but
                     after the tool has been selected (if applicable).

COMMAND_END is send to the machine at the end of the layer. See example:
                     LIBRARY/Cenon/CAM/Jobs/EmbeddedCNCExample.cenon
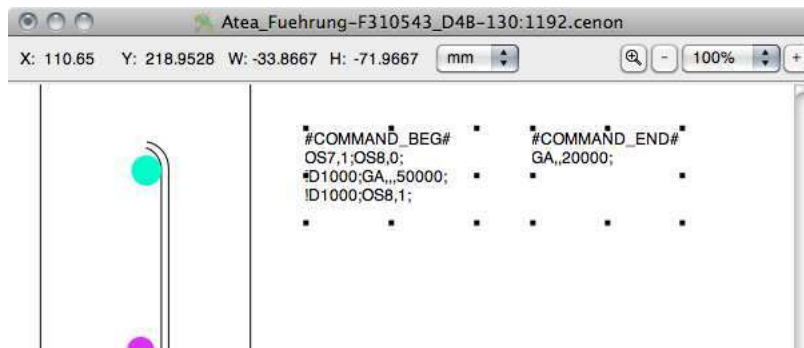
Chapter 4

Device Configuration

4.1 General Information

The configuration files of Cenon are ASCII files containing all the information needed for the definition of devices and import formats.

This section will describe how to configure Cenon for the different "dialects" of Gerber, HPGL as well as for your own XYZ-units and controller. Although Cenon comes with a number of predefines configuration files (*.dev), there is a chance that the commands of one or the other program is not understood properly or that there is no 100% matching configuration file available for your controller or device. Unfortunately, there are slight differences in the command set of the different programs and controllers.

4.1.1 Creating your own configuration files

In case you do not find a suitable configuration file for you purpose in one of the device directories (HPGL, DXF, xyz etc.), you can alter an existing file.

- Start a text editor.

- Load an already existing configuration file (extension: *.dev). Only load files from the appropriate directory and save them in the same directory after modification. This is very important, because Cenon uses the directory name for accessing the right file format. The setup directory names, for these reasons, should not be changed. Therefore, a Gerber configuration file should only be placed in the directory Gerber, etc.

- To avoid duplication of work you should load a configuration file which matches the command set of your computer. You can change the configuration file to your needs using the information provided in the output device manual.

- After changing all necessary entries you have to save the file (to the same directory under a new name) and quit the text editor.

- Load from within Cenon the newly created file (Menu: Info ▷ Preferences) and you are ready to start.

4.1.2   Important Notes

- The comments before the number sign (here: controller) are not important for the program (comment here: device name). These can be changed to your needs or even deleted. Cenon is recognizing only the characters from the number sign to the end of the line (here: "CNC750"). Example:

```
controller                    #CNC ''CNC750''
```

- The entries are not permitted to exceed more than one line.

- The order of the entries is not important, unless there are several entries with the same #-code. You can also delete an entry if it is not needed.

- Within a command line you can add after a backslash () certain sequences to the code. You could for example, write in a new line each single command in the output file:

\n	Neue Zeile (Zeilenvorschub)
\e	Escape-Sequenz
\r	Carriage Return (Wagenrücklauf)
\"	Anführungszeichen

- If you have to leave space for variable parameters, which will be provided by Cenon. This is done with a percent sign (%) followed by a letter:

%f	will accept a floating value (with decimal values entries). The output format can be regulated with these entries. Examples:

%.0f	-> 1
%.2f	-> 1.00
%2.2f	-> 01.00
%2f	-> 01

%d	is describing decimal integers
%x	is describing hexadecimal values
%ld	is describing decimal long integers
%e	is describing numbers with exponents

- Transmitted commands are always in quoted and also contain the appropriate variable (e.g. pen selection for a HPGL-Plotter:

```
select pen                 #PEN "SP%d;"
```

- Parameter providing information to Cenon (e.g. number of pens for HPGL-plotter or the size of the working area) are not quoted:

```
number of pens          #NPN 8
```

- If several values are passed on to the program in one command line, these values have to be separated by at least one space (e.g. maximum working area of a unit):

```
X Y Z-maximum range (mm) #SIZ 380 235 63
```

4.2   CNC Devices (CNC controller)

4.2.1   General Information

Almost all CNC-controllers are different in their command set and almost each single output device has different scaling or resolution. For Cenon to address your configuration properly, you should check the configuration file before you first use your output device. As mentioned earlier, you can find this configuration file in the folder Devices/xyz. The files have the extension *.dev. You can edit these files, make your changes accordingly and save the file. The name of the *.dev file will then appear in the appropriate pop up in the Cenon Preferences-Panel.

In the following section, we will explain how to change certain parameters to suit your specific device. These parameters are needed to drive the CNC-controller. If you do not know the parameters for your device, please refer to the device manual or determine the correct values by carefully measuring and testing. Many of these command set are similar to HPGL command sets.

4.2.2   Commands in the configuration file

```
    description                                      #DES
```

Enter in this line the name of your device or of the controller used. This line has only explanatory value.

```
    controller                                       #CNC
```

Here you have to enter which controller principle your device is using. You have the following choices:

"HPGL"   HPGL compatible devices

"DIN", "ISO"   DIN 66025 compatible devices, G-Codes, NC

"CNC450"   using extensions for vhf controller CNC 450 (deprecated)

"CNC750"   using extensions for vhf controller CNC 750 (deprecated)

"CNC550"

"CNC950"

"CNC1050"   using extensions of the vhf CNC 300, 550, 551, 580, 800, 950, 980, 1050 controller series

"ISEL"   support for the ISEL command set

"MCM"   support for the MCM command set (deprecated)

```
    spindle lift time [ms]                    #TIM
```

Time in milliseconds needed to lower or lift from the working part. This is only necessary for devices with a switching axis.

```
    origin (0=lower/left 1=upper/left)        #ORI
```

You can enter here if the origin of the output device is located in the upper left corner (for XYZ devices) or in the lower left corner (for plotters). If for any reason this entry is missing, it is automatically assumed that the origin should be located in the upper left corner.

```
    Z origin (0=down zero, 1=up zero)         #ORZ 0
```

Here, the Z coordinate system can be inverted.

```
    look ahead                                #AHE
```

Number of commands (not characters) which are send to the device before checking the return values.

```
terminator (for removal of return values) #TRM
```

Separator between commands. It is used to keep track of the number of commands
send to the device.
Example: ";"

```
comments ('*' = wildcard)                       #REM
```

This entry may be used to remove remarks from large initialization sequences (#INI,
#INI1). The entry must start with the starting character(s) of the comment, followed
by an asterisk (*) and the terminating character of the comment, usually a line feed
(\n).
Example for CNC 550: "/*\n"

```
debug level (0=off)                             #BUG
```

To test the connection and processing of a new controller, you can activate the debug
output. If you set a value other than 0, the machine initialization, outgoing commands
and return values are logged to the console window.

```
baud rate                                       #BAU
```

If your controller is connected to a serial port or USB port, you have to enter a baud
rate. This rate indicates the speed of data transfer between computer and output
device. The baud rate has to be set to the same rate of the controller to be able to
communicate with the device.
The following baud rates are supported by Cenon (if the serial port supports the baud
rate):
1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115200, 230400, 460800
baud

```
device                                          #DEV
```

The Unix device used for output. Example: "/dev/ttyS0"

```
    parameter (0=8N1, 1=7E1)                    #PAR
```

Set the transmitting values for the serial port here. Enter a 0 for 8N1 (8 data bits, no parity, 1 stop bit) or a 1 for 7E1 (7 data bits, even parity, 1 stop bit).

```
    handshake (2 = XON/XOFF)                    #HSK
```

This can turn on a software handshake.

```
    X Y Z-maximum range [mm]                    #SIZ
```

You should enter here the unit of measurement for your controller in points per inch for all three axes. If you use a switching axis for z, insert the same value than for x and y.

```
    X Y Z-resolution controller [points/inch] #RES
```

This entry holds the resolution of your CNC controller for all three axis in points per inch. If you use a switching axis for Z, set the value for Z equal to X or Y.

```
    X Y Z-resolution of mechanics [steps/mm]  #SCL
```

These values describe the mechanical resolution of your device for all three axes. It indicates how many steps are necessary to cover one millimeter. Calculated example for the device CAM 100:

[steps/rotation] / [pitch of spindle]

= [steps/rot] / [mm/rot] = [steps/mm]

= 400 / 5 = 80

this entry would look like this: #SCL 80 80 80

```
Flatness                                      #FLT
```

Enter here a precision factor with which bezier curves (and arcs) will be divided for the output device. If this value is large the curve appears very coarse. In case a value is missing a default value is assumed. If this entry is missing, the default(0.15) is used.

```
Maximum length of line [mm]                   #MLN
```

Some CNC controllers don't provide a command to stop the output process. If you would stop the output, the machine would continue to draw the last command completely before stopping. If this was a long line you have to wait quite a time before the machine finally stops. To set the maximum length of line to a reasonable value (eg. 5 mm) will allow you to stop the output immediately. Additionally, some CNC controllers move smoother with shorter line segments.

```
X Y Z Positioning Offset (cartesian) [mm] #POF
```

If you have attached a surface sensor etc. to your machine for more exact interactive positioning, you can enter the distance of the sensor to the tool. If you adjust the position using the Control-Panel of Cenon, the offset is added to the real position. For normal applications this offset is zero for all axes.

```
Camera Offset (X Y Angle) [mm]                #COF
```

This offset is used for a camera to allow a camera being mounted together with a tool-head and surface sensor. The offset is the distance of the camera relative to the tool (origin). Additionally, the rotation angle of the camera can be set in multiples of 90 degree.
Example: #COF 60.0 5.0 0
To get the offset, you can use the following procedure:

1. In the Control-Panel, move the tool to an integer position (ex: 100/100). At this position create a marking dot (ex hole).

2. Move the dot into the center of the camera image.

3. Read the X and Y position from the Control-Panel (ex: X = 129.93, Y = 78.95)

4. The offset calculates now as: X-Offset = 100 - X, Y-Offset = 100 - Y
   For our example: X-Offset = -29.93, Y-Offset = 21.05

```
Knife Offset to spindle (X Y) [mm]        #KOF
```

If you are the owner of a Multi-Head option (>= v5.0) you should add an additional offset for a knife, which can be used in parallel to the main tool (spindle). If the selected Layer in Cenon has a knife assigned, then this offset is included in the display of the machine area (gray rectangle in the graphics window). Additionally, the offset is included in the range checks during the start of output.
The offset is relative to the main tool (usually a spindle).
Note: The offset of the knife tool itself is set in the tool macros send to the CNC controller (the offset here is not added to the output-coordinates).
Example: #KOF 0.0 -87.0

```
tool gauging offset to spindle (X Y) [mm] #MOF
```

With Multi-Head option there is another offset available. If you use a separate gauging-tool to measure the surface of the material (instead of the spindle itself plus a contact plate), you have to provide the offset here.
This offset is applied for leveling (see section 3.7.5), and to measure the tool from the CAM Control-Panel (see sectionl 3.6.5).
If the leveling layer is open and selected in Cenon, this offset is included in the display of the machine area (gray rectangle in the graphics window). Additionally, the offset is included in the range checks during the start of output.
The offset is relative to the main tool (usually a spindle).
Example: #MOF 10.0 10.0

```
     XY-minimum speed for draw [steps/s]       #XMI
```

This entry describes the minimum working speed in steps per second the device can use to complete the job (engraving or routing mode). The working speed entered here and the following entries describe the minima and maxima for the speed. The actual used speed can be entered from the depot window where you have access to the different tools available or configure new tools.

```
     XY-maximum speed for draw [steps/s]       #XMA
```

Maximum working speed in steps per second.

```
     Z-minimum speed for draw [steps/s]        #ZMI
```

Minimum speed for lowering the tool onto the working part.

```
     Z-maximum speed for draw [steps/s]        #ZMA
```

Z-maximum speed for the z-axis while lowering the tool into the working part.

```
     XY-speed for move [steps/s]               #XPV
```

Speed for positioning the tool on the move height (flight level).

```
     Z-speed for move [steps/s]                #ZPV
```

Speed to adjust the positioning of the tool in z-direction above the working part.

```
     initialize                                #INI
     initialize 1                              #IN1
```

To configure your output device to your needs, all data to initialize the unit (e.g. steps per rotation, etc.) have to be available first, even before any data of the actual task will be passed on. You can insert any necessary command to initialize your device. IN1 is send directly after INI, so you can split your initialization into two parts.

```
adjustment drive                              #REF
```

Code to start the adjustment drive (referencing). Example: #REF "!N;RF;"

```
adjustment drive time [s]                     #RFT (>= v4.1)
```

Number of seconds to do reference the machine. Example: #RFT 60

```
switch1    on off title safeFlag autoFlag #SW1
switch2    on off title safeFlag autoFlag #SW2
switch3    on off title safeFlag autoFlag #SW3
switch4    on off title safeFlag autoFlag #SW4
```

Entries for the actions of up to ten switches in the switch-block of the CAM Control-Panel (see Chapter 3.6.5).
Example: #SW2 "OS4,1;" "OS4,0;" "Title" 1 0
The switch entries expect the following parameters:

1. Command for switching ON

2. Command for switching OFF

3. Title of the switch, or "" to leave the default values.

4. Flag: 1 = switch can be switched during output, 0 = switch is inactive during output.

5. Flag (optional, >= v4.1):
   1 = The CAM Control-Panel displays a row of switches with the Title "A" =
   Automatic.
   The corresponding switch can be set before or during output. If an auto-switch
   is set, the corresponding OFF-command is send before a tool change and Stop
   (including Alert Panel). The ON-Command is send after a tool exchange and
   "Continue".
   0 = inactive (Default). The switch in the auto column is not operational.

```
return value for ok                           #RET
```

Any action performed flawless by the CNC controller is prompted by sending a reply
to Cenon. This reply can be entered here as a decimal value for most controllers.
The vhf CNC controllers of the 550, 950, 1050 series, return several characters as
reply. In this case two strings are expected here: first the entire reply string, second
the initials of optional error codes.
If you don't enter a value here, no return values are checked.
Example for a return value of '0': #RET 48
Example for the CNC 550: #RET "0;" "E"

```
separate thread for return values (1=Yes) #THR
```

If you activate an extra thread, then the return values during output are collected
asynchronous by a separate thread. This improves the output performance.
This option can only be used with controllers, which support the wait command
(#WAI) like the CNC550 and CNC950. The option Look Ahead (#AHE) is ignored,
if you activate the thread.

```
wait until all data is processed         #WAI
```

The command is send after sending all data to the controller to wait until the con-
troller has finished operation. Cenon waits until the controller sends a '!' to signal
that all data has been processed.
Example: "!H1;"

```
delay                                    #DEL
```

Delay command to wait until the spindle achieved its revolution. The time value
#TIM can be used here by providing a variable (%d).
Example: "D%d;"

```
set speed draw (v)                       #VDR
set speed move (v)                       #VMV
```

Commands to set the working speed (speed inside the working part) and the position-
ing speed (move). The commands can be different for draw and move. If #VMV is
missing the entry of #VDR is used. If you are using special move commands (#G1D,
#G2D, #G3D), no move speed is needed.
Example: "VS%.0f;"

```
move absolute (x,y,z)                    #G3D
```

Command to move in x, y, and z direction. No speed is set, before issuing this
command. If this command is missing, Cenon will interpolate it with #MOV and
#MVZ.
Example: "GA%.0f,%.0f,%.0f;"

```
move absolute (x,y)                      #G2D
```

Command to move in x and y direction. No speed is set before issuing this command.
If the command is missing, the corresponding draw/move command is used (#MOV).
Example: "GA%0.f,%0.f;"

```
move absolute (z)                        #G1D
```

Command to move in the z-direction. No speed is set before issuing this command.
If the command is missing, the corresponding draw/move command is used (#MVZ).
Example: "GA,,%0.f;"

```
draw/move absolute (x,y,z)                #M3D
```

Command to move in x, y, and z direction. If this command is missing, Cenon will interpolate it with #MOV and #MVZ. The speed will be set before issuing this command.
Example: #M3D "A3%.0f,%.0f,%.0f;"

```
draw/move absolute (x,y)                  #MOV
```

Command to move in x and y direction. The speed will be set before issuing this command.
Example: #MOV "PA%0.f,%0.f;"

```
draw/move absolute (z)                     #MVZ
```

Command to move in the z-direction. The speed will be set before issuing this command.
Example: #MVZ "ZA%0.f;"

```
arc (x-center,y-center,angle)             #ARC
```

Code to draw a circle segment (arc) in the HPGL style. If all arc commands are missing Cenon will interpolate arcs. The flatness entry (#FLT) is also used to interpolate arcs.
Example: #ARC "AA%0.f,%0.f,%0.f;"

```
arc cw  X Y A B (ctr X, Y, ang beg, end)  #G02
arc ccw X Y A B (ctr X, Y, ang beg, end)  #G03
arc cw  R A B   (radius R, ang beg, end)  #G02
arc ccw R A B   (radius R, ang beg, end)  #G03
arc cw  X Y R   (end X, Y, radius R)      #G02
arc ccw X Y R   (end X, Y, radius R)      #G03
arc cw  X Y I J (end X, Y, offset x, y)   #G02
arc ccw X Y I J (end X, Y, offset x, y)   #G03
```

Code to draw an arc in different G-Code / NC derivates. G-Codes (also DIN) needs two arc commands, one for clockwise and one for counter clockwise arcs. Additionally, there are several alternatives of the commands with different sets of parameters. Cenon determines the derivative from the number of parameters and the use of the tags" X, Y, A, B, I, J.
Example: #G02 "G2 X%.3f Y%.3f I%.3f J%.3f\n"

```
curve (x2,y2,x3,y3,x4,y4)                 #CRV
curve (x2,y2,z2,x3,y3,z3,x4,y4,z4)        #CV3
```

Code to draw a 2 or 3 dimensional curve. If this command is missing, Cenon will interpolate the curves. In this case the value given for the flatness (#FLT) is used.

```
helix (x-center, y-center, angle, z)      #HEL
```

Code to draw a helix. If this command is missing, Cenon will interpolate the helix using arcs or lines.

```
tool up                                   #TUP
tool down                                 #TDN
```

If you are using a switch-axis with lift magnet instead of a freely positionable z-axis, you can enter the code for lifting and lowering here.
Example: #TUP "PU;"

```
select tool (n)                           #TOL
```

If you have an automatic tool selection, insert the command to change the tool here. If this command is missing, Cenon will ask you to change the tool.
Example: #TOL "SP%d,1;"

```
safe manual tool change (default = 1)     #TOS (>= v4.1)
```

Flag to turn off safe manual tool exchange (#TOS)
During a manual tool exchange, the Z axis will be lifted completely before every
start and will always ask to insert a tool, even if the tool is selected already. This safe
behaviour can make work slower.
If you set #TOS = 0, Cenon will not ask for a tool, if the tool is selected already.
Warning: make sure, that the same tool magazine is used for all output jobs !
Warning: make sure, that you didn't change the tool without Cenon being informed.

```
    tool start index (default = 1)              #TSI
```

This entry sets the start index of the tool exchange (#TOL).

```
    set spindle (rev/min)                       #REV
    spindle off                                 #RV0
    spindle range (min, max)                    #RVR
    spindle on at origin (default = 0)          #RVU (>= v4.1)
```

If you have a spindle which can be automatic driven, insert the commands here. You
have to provide a command to switch on the spindle, and set the revolution (#REV).
The second command switches off the spindle (#RV0). The third entry (#RVR) tells
Cenon the range of revolution the spindle can achieve. If the commands are missing,
Cenon will ask you to switch on the spindle. The optional fourth entry decides,
weather the spindle is turned on at the Z origin (1) or at flight level (0 = Default).
Example:
```
#REV "RVS%d;"
#RV0 "RVS0;"
#RVR 5000 60000
#RVU 1
```

```
    get position                                #GPA
```

This entry allows reading the machine position into Cenon. If the entry is available,
the corresponding button inside the Control-Panel of Cenon is activated. You can

make use of this feature to set the starting position directly at the machine with a
hardware control panel.
The reply to this command from the controller is expected in the form "PA=x,y,z,...".
The Z position is used as the surface position.
Example for CNC950:
```
#GPA "?PA;" "PA="
```

```
        get serial number                              #GPA
```

This entry queries the serial number form the CNC controller. The command needs
two or three parameters, depending on the return value.
1. Command to query the serial number
2. Prefix: characters before the serial number
3. Suffix: characters following the serial number (if not the terminator)
Example:
```
Serial Number (CNC950-Series) #GSN "?V;" "SN " " "
```

Automatic Tool Change (>= v4.1)

This section describes setting up an automatic tool change, which is coordinated by
Cenon. Additionally, it is still possible to let the CNC-Controller / Plotter coordinate
the tool change.

```
        select tool (n)                                 #TOL
```

If you have an automatic tool selection, insert the command to change the tool here.
If this command is missing, Cenon will ask you to change the tool.
Example: "#TOL SP%d,1;"

```
    #T01 "Get Tool" "Remove Tool"
    #T02 "Get Tool" "Remove Tool" ...
```

The content of your #T01-n commands, depends on your CNC-Controller. Please contact your machine manufacturer for documentation. You have to configure the moves to the tool changer, the Opening/Closing of the chuck, and the moves away from the tool changer. Example:

```
#T01 "TK0;GV,,0;RVS0;OS2,0;GV50000,10000;OS3,1;!D1000;GV,,3000;VS20000;PV,,6000;OS3,0;!D2000;PV,,4000;GV,,0;"
     "TK0;GV,,0;RVS0;OS2,0;GV50000,10000;GV,,3000;VS20000;PV,,6000;OS3,1;!D2000;GV,,0;!D500;"
#T02 "TK0;GV,,0;RVS0;OS2,0;GV75000,10000;OS3,1;!D1000;GV,,3000;VS20000;PV,,6000;OS3,0;!D2000;PV,,4000;GV,,0;"
     "TK0;GV,,0;RVS0;OS2,0;GV75000,10000;GV,,3000;VS20000;PV,,6000;OS3,1;!D2000;GV,,0;!D500;"
#T03 "TK0;GV,,0;RVS0;OS2,0;GV100000,10000;OS3,1;!D1000;GV,,3000;VS20000;PV,,6000;OS3,0;!D2000;PV,,4000;GV,,0;"
     "TK0;GV,,0;RVS0;OS2,0;GV100000,10000;GV,,3000;VS20000;PV,,6000;OS3,1;!D2000;GV,,0;!D500;"
```

Tool Gauging (managed by Cenon)

```
#TMZ "Gauging" "Return Format"
```

The #TMZ command has to be configured, if the #T01-X commands doesn't contain tool gauging by the CNC-Controller.

The tool gauging can also be used with a manual tool exchange (TOL inactive). You can find the commands in the CNC manual provided by your machine manufacturer.

The tool gauging needs a physical switch connected to an input of the CNC electronics.
The gauging commands have to include the moves to the gauging switch, the gauging itself, and the moves away from the gauging switch.
The Return Format has to decribe the entire reply from the CNC Controller, using a wildcard for the variable value holding the length of the tool. (%f = decimal, %d = integer). Example:
```
#TMZ "GV17550,30;GV,,3000;ME3,1,5,1,5000;GV,,0;" "ME3=%f"
```

Surface Measurement

```
measure surface position                        #SFM
get surface position (CNC750)                    #SFG
sensor height [mm]                               #SFH
```

These commands may be used to determine a tool offset relative to the surface of a working piece. The gauging process lowers the Z axis until a switch (e.g. contact plate) is triggered. Also see Adjust-Z in section 3.6.5. The switch can have a X/Y offset from the tool using the entry #MOF.

The position can either be returned directly (ex. CNC950) or queried by a separate command (ex. CNC750).

The height of the sensor itself may be provided. It will be added to the measured distance. Example:

```
#SFM "WMZ;"
#SFG "?V40;!H0;"
#SFH 10.0
```

Leveling

```
    Leveling CNC750  (x, y, nx, ny)          #LEV
    Leveling Default (nx, ny, deltaX, deltaY)  #LEV
    Leveling, keep tool (1 = keep tool)      #LEVT 1
```

If your controller provides a command to measure the surface of a given area, you can insert it here. Cenon supports two variants of this command, one for the CNC750 controller and a default one. Examples:

```
Leveling CNC750 #LEV "SH3, %f, %f, %d, %d;"
Leveling CNC950 #LEV "SH2, %d, %d, %f, %f;"
```

Asynchronous Commands

```
    halt                                      #HLT
    continue                                  #CNT
    break                                     #BRK
```

If your controller provides priority commands to stop, continue and break execution, you can insert them here. Examples:
```
#HLT "!S;"
```

```
#CNT "!C;"
#BRK "!B;"
```

After canceling the output the synchronisation between Cenon and the CNC controller is lost. To restore synchronisation Cenon proceeds as follows: If a synchronisation command (entry #WAI) is available, it will be send and waited for the return sign '!'. Without a synchronisation command Cenon clears the input stream for 5 seconds.

```
    alter speed       (0 - 200%)                #AVS
    alter revolution (0 - 200%)                 #ARV
```

These entries allow changing the speed and revolution during output. If the entries are available to Cenon, the sliders inside the Control-Panel of Cenon are activated during output. Example for the CNC950 series:
```
#AVS "OVA%d;"
#ARV "ORVA%d;"
```

Tangential knife

The entries #TAN, #TAM and #MVT are used to drive a tangential knife. Cenon controls the rotation of the knife in this case.

```
    /*
     * tangential knife
     */
    range (mm), res mechanic (points/inch)    #TAN 720 352.778
      range = 2 * 360 deg
      res = 5000 pts/U / 360 deg * 25.4
    max angle (deg), max vector (mm)          #TAM 20.0 1.0
    move + rotate knife (x, y, t)             #MVT "PA%.0f,%.0f,,%.0f;"
    knife offset relative spindle (X Y) [mm] #KOF -10.0 -10.0
```

#TAN   provides the range and resolution of the T-axis. The values can be calculated by the given formula. The example values are the defaults. The values in the example are the defaults.

#TAM   provides the maximum angle to rotate the knife within the material (in degree of arc), and the maximum vector length to rotate the knife while moving the vector (in mm). The values in the example are the defaults. For angles larger the maximum angle, the Z axis is lifted to rotate the knife.

              For segments longer than the maximum vector length, the knife is rotated at the end of the vector. This allows a smooth continuous rotation for curves and arcs (small vectors), while long straight lines are cutted without rotating the knife.

#MVT   provides the command to move the T axis.

#KOF   optional knife offset (>= v5.0) (Multi-Head Option)

Camera-Positioning (>= v5.0)

```
camera position mode (0 = off, 1 = on)  #CPM 0
camera offset        (X Y Angle)        #COF 90.0 -21.8 0
```

#CPM   sets the camera-positioning-mode. If this is active, the machine will move automatically to the tool position during output, and camera-position otherwise.

              If disabled (Default), you have to use the set button of the Camera-View to confirm the new starting point.

#COF   The camera offset is the same for Camera-Positioning and Camera+Targeting, and is explained above with the other offsets

Note: the internal computer camera is only recognized with the Camera+Targeting feature (for testing purposes only).

Camera Light (>= v5.0)

```
camera light on                         #LON "OS3,1;"
camera light off                        #LOF "OS3,0;"
```

#LON   Command to turn on the camera light. The camera light ist turned on
            and off together with the camera.

#LOF   Command to turn off the camera light.

Output-Loop with external Trigger (>= v5.0)

The entry #LOP allows to start the output repeatedly by an external trigger (taster
connected to input-port). The taster then mimics the Start-Button of the CAM Control-
Panel of Cenon.

```
output loop command (vhf CNC 950) #LOP "WI5,0,0,2;WI5,1,0,2;"
output loop command (NC M-Code)   #LOP "M66 P5 L1 Q3600"
```


Vacuum Matrix (>= v5.0)

The entry #VAC together with the optional translation tables #VXA and #VXP allow
the configuration of a vacuum table matrix. The matrix is displayed in the Machine-
View of the CAM Control Panel (section 3.6.5).
Example configuration for a single vacuum table, and a matrix of 8 vaccum tables.

```
/* vacuum tables (matrix)
 * command allows 1 (value), 2 (port+value) or 3 (addr+port+value) parameters
 * matrix to layout the vacuum matrix:
 *   X = number of vacuum tables in x (0 = Left) 2, 3
 *   Y = number of vacuum tables in y (0 = Low)  0, 1
 *   vMin, vMax, vInc define the range of the values
 */
// single vacuum table (On/Off)        VAC "    val" X Y min max inc
vacuum table ("CMD" X Y vMin vMax vInc) #VAC "OS2,%d;" 1 1 0 1 1
// vhf Sign X vacuum matrix             VAC "add prt val" X Y min max inc
vacuum table ("CMD" X Y vMin vMax vInc) #VAC "!V%dP%d=%d;" 2 4 0 100 100
// matrix translation tables for address and ports (defaults = 0)
// index = y * cntX + x (row by row, LL to UR)
// example (x = 2, y = 2): 2, 3
```

```
//                        0, 1
vacuum matrix addr ... (default = 0)    #VXA 1 1 1 1 2 2 2 2
vacuum matrix port ... (default = 0)    #VXP 15 35 55 75 15 35 55 75
```

#VAC   CNC command to switch a vacuum table matrix (output ports) with one, two, or three integer parameters (%d):
1 Parameter: value
2 Parameter: port, value
3 Parameter: address, port, value
The two entries after the command provide the number of vacuum tables in X and Y direction .
The three entries after the matrix, define the range of the values: Minimum-Value, Maximum-Value, Increment.
In the example above, the value of 100 for max as well as increment configures an On/Off behavior (0 or 100%).

#VXA   Address-Table. For each index position of the matrix, you can provide a dedicated Address. The example above puts the first four tables on address 1 and the second four tables on address 2, in a 2 x 4 matrix.

#VXP   Port-Table. For each index position of the matrix, you can provide a dedicated port.

Index   Index-Position of a 2 x 4 matrix (row by row from lower/left corner to upper/right corner):
6 7
4 5
2 3
0 1

Stopper (>= v5.0)

The entry #STP together with the translation table #SXP, allows the configuration of switchable stoppers. The stoppers are displayed in the Machine-View of the CAM

Control Panel of Cenonl (section 3.6.5).

Example configuration for 5 stoppers (2 along the X axis, 3 along the inverted Y axis):

```
/* Stoppers
 * command supports two values only (port, status)
 *   X = number of stoppers along x axis
 *   Y = number of stoppers along Y axis (negative: display stoppers at top)
 * translation table is a list of ports along x axis, then y axis (start counting at LL)
 */
//                                        STP " prt val" X Y
stopper ("CMD" X Y)                       #STP "OS%d,%d;" 2 -3
stopper x ports, y ports (default = 0) #SXP 6 7  3 4 5
```

#STP   CNC command to switch a port with two parameters for the port and the value (usually 0 and 1), followed by the number of stoppers along the x and y axis.

A negative number inverts the location in the machine view. "-3" places the stoppers at the top instead of bottom in the machine view.

#SXP   A translation table to assign port numbers to locations in the machine view.

The first number in the list is the lower left position in the machine view. First all stoppers of the x-axis are listed, then all stoppers of the y-axis. From the example above: SXP X1 X2 Y1 Y2 Y3

Safety Scanner (>= v5.0)

A Safety-Scanner can be installed (instead of an enclosure) to make operation of a machine more safe.

Example Configuration (.dev):

```
/* laser queries and reset */
//                                  LQS "Query1" "Answer1" "Query2" "Answer2"
laser check 1+2 (<= I14=0/1)        #LQS "?IA14;" "I14=" "?IA15;" "I15="
//                                  LRS "Reset1"  "Reset2"
laser reset                         #LRS "OA13,1;" "OA13,0;"
```

#LQS   This line configures two queries of CNC port, each command has it's return string configurable by a prefix.
        The 1. query is active during normal operation (Machine working, scanner area not violated)
        The 2. query is activ while the scanner area is violated until reset.

#LRS   Commands to release the safety scanner after a violation. Both commands will be send to the CNC controller, with a delay of about 0.3s in between.

Example of operation:
The machine is operating normally, and Query1 is send repeatedly. If there is a violation of the scanner area, a port (here 14) changes it's state from 0 to 1. and the machine stops.
Cenon will display an Alert box, that the scanner area has been violated. Cenon now sends Query2 repeatedly, until the port (here 15) drops back (from 1 = violation) to 0).
To continue after a violation, the violation condition has to be released manually (reset). This is done in Cenon by two confirmations (security laws):
First, you have to confirm that the area has been violated.
Once, the violation itself has been cleared (here: port 15 changes to 0), there will be a second Alert, announcing this. Only after confirming this with OK, the machine will continue it's work (Cenon will send the commands from the entry LRS to allow the CNC controller to resume it's work).

Lock Magazine Range (>= v5.0)

It is possible to lock a range of tools from user modification by excluding this range, using the device file. This is useful with the multi-head option, in cases where the tool heads don't allow inter-changing their tools. If, for example, one of the tool-heads is a tangential knife, then it's knife is tied to the knife head and must stay at it's tool position (within the shared tool magazine). In this case you can lock a tool or range of tools, which then can't be modified by the user.

Note: Cenon allows a single tool magazine for a project, that's why multiple tool heads have this issue.

```
tool magazine locked positions (from to) #TML 3 5
```

The example will lock the positions 3 to 5 in the tool magazine. The locked positions are marked in the CAM Magazine Panel (see section 3.6.3) with a leading "x" inside the tool Pop-Up.
Locked tools can't be moved, or deleted. Additionally, their Name and Type can't be modified.
If you need to make changes to a locked range of tools, you have to disable the lock in the device file to allow the necessary changes.
Values which can't be modified are disabled (gray).

Note:

The values in parenthesis () on the left side of many commands (left to the key #KEY), list the parameters your command has to provide, and are inserted by Cenon. For each parameter, the command has to provide a type identifier (e.g. %f for a float value; see section 4.1.2 for details).

Chapter 5

Appendix

5.1 What you should know about tools

### 5.1.1 Reasons for more cutting edges ...

The cutting edge is the working part of the tool. The more cutting edges a tool has, the more cutting edges share the tool erosion, thus the life of the tool is longer.

- A cutter which has two or more cutting edges runs more true than a milling cutter with just one cutting edge.

- Due to the larger cross section of the multiple teeth cutter, more heat is transported to the collet chuck. This is especially helpful if there is no other way of cooling.

- The more cutting edges there are, the smaller the chips become, so you will get smoother surfaces. A double tooth cutter is suitable especially for working on very hard synthetic material and harder aluminum types. We recommend triple tooth cutters especially for very hard non-iron metals and iron workpieces.

5.1.2   Reasons for few cutting edges...

The main problem that may occur during the milling process is the possibility that chips may choke the tool. If a milling cutter is finally choked, it cannot carry out chips any more and the feeding force of the spindle will break it. This happens - depending on the material - in most cases long before the cutting edges are worn out. So the main question is where to put the chips. "To the top or to the back" is usually the answer (except left-hand twist cutters). However, a certain space is necessary to move the chips along the "body" of the cutter. A comparison of the cross section of different types shows clearly that the single tooth cutter offers the largest open space (size of the grove for chips) and that this space is reduced with increasing number of cutting edges. It is easier for a milling cutter with few cutting edges to dip into the material. For working on material which is used mainly for sign making like synthetic material, wood and non-iron metals, the single tooth cutter has certain advantages. The danger that the cutting edges may erode is not as serious as the problem that the cutter may get choked.

5.1.3   Cross Section:
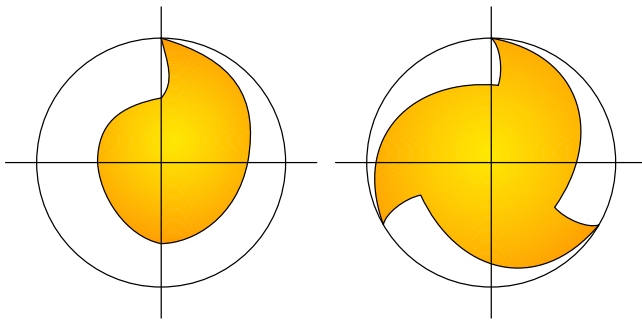
A Single tooth cutter offers a wide open space (left image).
Three cutting edges need much more space (right image).

5.1.4 Working Parameters

General rules:

1. The higher you set the cutting speed (vc = pi * ØS * n), the smoother the surface will be. At the same time the erosion of the tool increases.

2. Recommended cutting speeds vc for carbide milling cutters:

   - Aluminium: 100 - 300 m/min;
   - other non-iron material (brass, bronze, copper, zinc): 100 - 200 m/min;
   - stainless steel (VA): 80 - 120 m/min;
   - thermoplastic: 50 - 150 m/min;
   - duroplastic with filling material: 100 - 150 m/min;
   - carbon fiber compound material: 150 - 300 m/min.

3. Recommended feed fz per cutting edge and revolution for carbide milling cutters:

   - Aluminium and other non-iron metals:
     ØS 2 - 4 mm: 0.04 mm/U
     ØS 5 - 8 mm: 0.05 mm/U
     ØS 9 - 12 mm: 0.10 mm/U
   - Thermoplastic:
     ØS 2 - 4 mm: 0.05 mm/U
     ØS 5 - 8 mm: 0.06 mm/U
     ØS 9 - 12 mm: 0.07 mm/U
   - Duroplastic, GFK:
     ØS 2 - 4 mm: 0.04 mm/U
     ØS 5 - 8 mm: 0.08 mm/U
     ØS 9 - 12 mm: 0.10 mm/U

4. Formulas:

   revolution n: n [rev/min] = (vc [m/min] *1000) / (3.14 * ØS [mm].
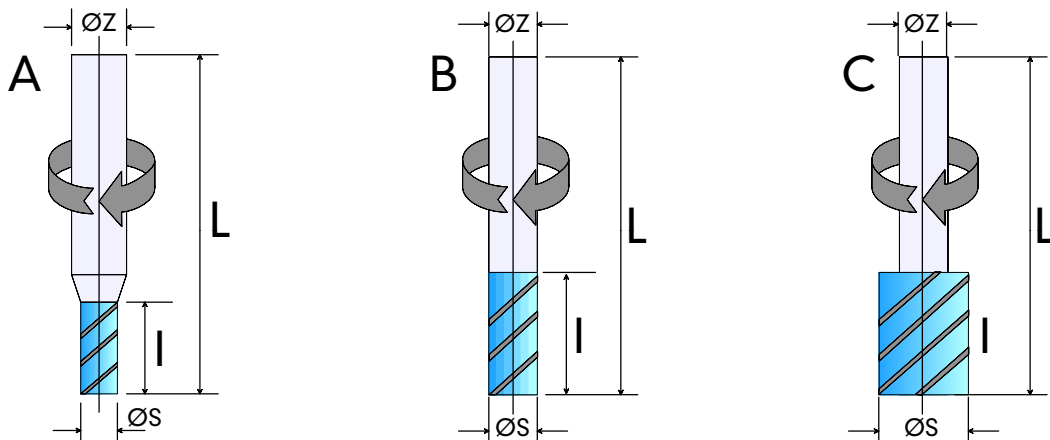
   feed f: f [mm/min] = n * fz * z

Example:

You want to mill aluminum with a double tooth cutter ØS = 3 mm (given above:
max. vc = 200 m/min).

max. revolution n:

```
n = (200 * 1000) / (3.14 * 3) = 200.000 / 9.42 = 21230 rev/min
```
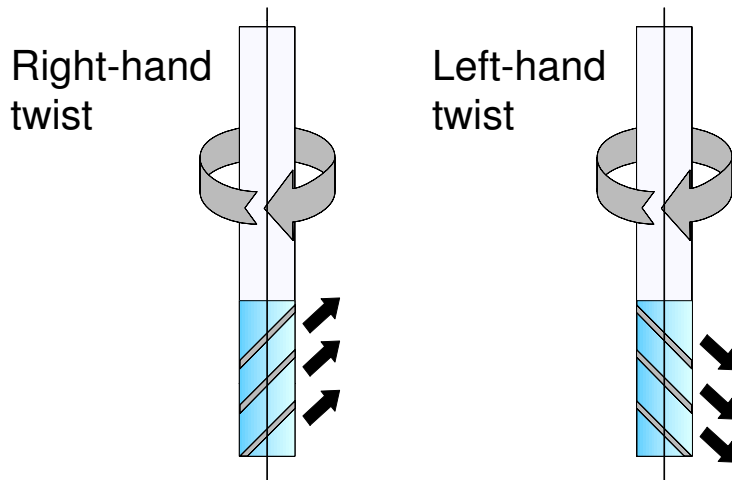
feed f:

```
f = 21230 * 0.04 * 2 = 1698 mm/min
```

5.1.5   Geometry and Dimensions

Shape A: diminished cutting diameter ØS < ØZ.

Shape B: cutting diameter equals staff diameter ØS = ØZ

Shape C: extended cutting diameter ØS > ØZ (only for drills)

Right-hand twist cutters:

The chips are transported to the top. The milling cutter tendends to lift up the workpiece (corkscrew effect).

Left-hand twist cutters (custom shape):

The chips are pushed down, resp. moved to the back, i. e. to the already milled channel. The milling cutter pushes the workpiece down on the table (reversed corkscrew effect).

5.1.6   More Information on Tools

Online Tool Parameters   Online service to calculate the parameters for your tool
                           and material. Please visit our web site ([http://www.](http://www.Cenon.com)
                           [Cenon.com](http://www.Cenon.com)) to find a link to the tool.

5.2   Files and directories

5.2.1   Cenon program

The program file of Cenon is located in the application directory of your computer
system:

Apple: /Applications/Cenon.app

GNUstep: /usr/GNUstep/Local/Applications/Cenon.app

OpenStep: /LocalApps/Cenon.app

5.2.2   Library

In the Library path of Cenon you can find examples, projects and all the things which
are intended to be customized (configurations, data files, etc.). Cenon has a global
Library path shared between al users, which is not writable to a user, and a local
Library path inside the home directory (here HOME) of the user:

Apple: /Library/Application Support/Cenon
             HOME/Library/Cenon

GNUstep: /usr/GNUstep/Local/Library/Cenon
             HOME/GNUstep/Library/Cenon

OpenStep: /LocalLibrary/Cenon

HOME/Library/Cenon

Files can appear in both Library paths (the global library path and the home library path). In this case the file in the home library path has priority. This allows a user to modify a configuration file without changing the installation of Cenon.

In the following we describe the most important files and directories. All located in the HOME-Library of Cenon:

File / Folder	Description
Projects	Your Cenon projects and examples
Examples	Some examples of import formats
Devices/din/*.dev	Configuration files for the drill data import
Devices/gerber/*.dev	Configuration files for the Gerber import
Devices/hpgl/*.dev	Configuration files for the HPGL import
Devices/xyz/*.dev	The device configuration files
CAM	Folder for special configurations
CAM/Jobs	Your CAM projects and example projects
CAM/positions	ASCII file holding the position memory
CAM/magazine	ASCII file holding the tool magazine

Cenon provides two folders for projects (Projects and CAM-Jobs). There is no technical differences between the file format.

5.2.3 Lock Tool-Magazine (>= v4.1)

You can protect a tool magazine from certain modifications, like creating and removing tools. In a locked magazine, only the parameters of already existing tools can be modified.

A locked magazine cannot be deleted, no tools in the magazine can be created or removed, and you can't rename tools, or change their order.

A magazine can't be locked from within Cenon. To lock a magazine, you have to edit the magazine file with a text editor as follows:

```
...
),
(
    MagazineName,
    lock,
    {
        cuttingSpeed = 3.00;
        diameter = 1.00;
        ...
```

The "lock" entry has to be added to the file "magazine" inside the User-Library. The lock entry has to be added to a new line, right behind the name of the magazine.

"/USER/Library/Application Support/Cenon/CAM/ magazine"

5.3   Error and Warning Messages

- **Select two objects for joining!**

  You have to select two objects to be able to join them and create a path object.

- **Can't create backup file. File not saved!**

  Check if you have write permission to the directory and the Cenon file you tried to write.

- **Could not open file FILENAME.**

  Check the read permissions on the file FILENAME, and on the directory it is located in. You need read permissions on a file to open it. Another possibility is that the file is corrupted or of a format Cenon is not capable to read. Check for other messages in the Console.

- **Could not open file FILENAME. Using Default.**

  Here Cenon tells you that it can't read FILENAME, and uses default values instead.

- **You have unsaved documents!**

  If you quit Cenon and have unsaved documents, this message appears to give you a chance to save the files. You can review the unsaved files or quit anyway.

- **Can't write file.**

  Check the write permissions on the directory you try to save in. Also check if there is already a file which you are not allowed to overwrite.

- **FILENAME has changes. Save ?**

  This warning message appears if you try to close a window of a document which hasn't been saved yet. You have the choice to save the file or close it anyway.

- **Do you want to revert to: FILENAME ?**

  This is a safety message giving you a chance to cancel your request to reload a file and loose all your changes.

- **This Operation will force a recalculation of the graphic!**

  Cenon gives you a chance to cancel the operation or will start a recalculation.

- **This Operation can take a while!**

  You are warned that the following operation will take some time and you have to wait until has been finished. This message does not appear in expert mode.

- **The contour will be calculated know! You may want to stop this operation to calculate on a later time.**

  You are warned that the output tracks needs recalculation and you are given a chance to calculate them on a later time. This message does not appear in expert mode.

- **Layer LAYERNAME needs recalculation!**

  If you start the output and the output tracks of some layers are not calculated yet, Cenon gives you a chance to cancel and take a look at the tracks before you start output. Otherwise the output is calculated and executed directly.

- **No data to process!**

  You started the output without any data to process.

- **Couldn't locate tool name TOOLNAME in magazine! You may have removed the tool since your last session.**

  You have tools assigned to a layer of your job which is not in the active magazine. Check the magazines for the needed tool or select a new tool from the pop up menu.

- **Name 'NAME' already in use!**

  If you add or rename a layer or position this message can appear. You should rename the existing layer or choose a different name for the new one if possible.

- **You need to install the Cenon Library!**

  Some Library files are missing. On OpenStep the Library of Cenon has an extra package. Most likely you haven't installed it.

- **Only one layer of this kind allowed!**

  Cenon allows only one layer of the kinds: Fitting-Layer, Clipping-Layer, or Levelling-Layer.

- **Only one position for parking allowed!**

  This shouldn't happen at all, but somehow you tried to add a second layer for the parking position. This is not possible.

- **Only a single rectangle allowed on leveling layer!**

  You created graphic objects on the leveling layer which are not allowed there. Delete everything but a single rectangle.

- **This Operation will remove the fill layer attached to the Pick Out!**

  The Pick-Out owns a second layer. If you leave the correction for a Pick-Out this layer is removed.

- **Automatic adjust! Be sure to have placed the surface sensor correctly, before pressing 'Start'.**

  If your machine allows automatic measuring of the tool offset, this message gives you a chance to place the switch under the tool before it starts the operation.

- **Do you really want to remove the current magazine?**

  A warning message telling you that you are about to remove an entire magazine.

- **Set Magazine: This operation will remove all tools from layers!**

  A warning message telling you that you have to assign a new tool to all your layers, if you select a new magazine. You have the chance to cancel your request.

- **Stop work?**

  A warning message. It appears when you click on Stop while the output is running. The Z axis is lifted and you have a chance to check things, before you continue or stop the output.

- **Graphic out of range!**

  Your graphic is located outside of the machine table. Be sure that the graphic you want to process is completely inside the gray lines, representing the machine table. You have a chance to continue, but this can lead to an incomplete output of your graphic.

- **Please log in as root!**

  Licensing only works as user root.

More messages can appear in the Console window (or system log file). Especially messages during calculation of the output path are listed there.

On Linux this file can be found in the menu of the Window Manager under *Info* ▷ *System* Consol*e*. On OpenStep it can be found in *Tools* ▷ *Console* of the Workspace Manager.

5.4   Keyboard Commands

Control-Panel:

Within the CAM control panel you have the following key commands available:

arrow up (8)	moves the y-axis in positive direction
arrow down (2)	moves the y-axis in negative direction
arrow right (6)	moves the x-axis in positive direction
arrow left (4)	moves the x-axis in negative direction
arrow up (9)	lift the z-axis
arrow down (3)	lower the z-axis
Ctrl (keep pressed)	move in 1.0 mm steps

Editing, Selecting

The keys Alt, Shift, and Ctrl can be used in combination with the mouse. The meaning of these combinations can be found in the description of each mouse action (see Cenon Manual).

Menu keys:

On Linux, the Command key usually is the Alt (Alternate) key.

Command	Key word	Description
Cmd-a	all	Select all
Cmd-A	Area	Show Working Area panel
Cmd-b	bold	Change selected text to bold
Cmd-B	Batch	Batch Production
Cmd-c	copy	Copy selected objects into buffer
Cmd-C	Color	Show Color-Panel
Cmd-d	direction	Revert direction

Cmd-D	Direction	Display directions of objects
Cmd-e	equal	Select equal objects
Cmd-F	Form	Show Transform-Panel
Cmd-g	group	Group selected objects
Cmd-G	unGroup	Ungroup selected groups
Cmd-h	hide	Hide program
Cmd-i	iItalic	Change selected text to italic
Cmd-I	Inspector	Show Inspector-Panel
Cmd-j	join	Join selected objects
Cmd-J	unJoin	Split joined objects (Path, Textpath, clipped Image)
Cmd-m	mirror	Mirror selected objects
Cmd-M	Moves	Show output tracks
Cmd-n	new	Create new document
Cmd-o	open	Open (Load) document
Cmd-O	Optimize	Optimize moves
Cmd-p	print	Print document
Cmd-P	Page	Show Page-Layout panel
Cmd-q	quit	Quit program
Cmd-r	rotate	Rotate selected objects by 90°
Cmd-R	Ruler	Toggle text ruler
Cmd-s	save	Save document
Cmd-S	Save as	Save document with new name
Cmd-t	text	Show Font-Panel
Cmd-T	Tool	Display tool diameter
Cmd-u	unsave	Revert to saved document
Cmd-U	pUnch	Punch selected objects
Cmd-v	view	Paste buffer into document
Cmd-w	window	Close window
Cmd-x		Cut selected objects into buffer
Cmd-z		Undo
Cmd-Z		Redo
Cmd-?	?	Help

Cmd-1		Graphic-Inspector, when editing text: Copy ruler
Cmd-2		Width-Inspector, when editing text: Paste ruler
Cmd-3		Fill-Inspector, when editing text: Copy font
Cmd-4		Texttype-Inspector, when editing text: Paste font
Cmd-5		Layer-Inspector
Cmd-8		Bring to front
Cmd-(		Bring one object further to the front
Cmd-9		Send to back
Cmd-)		Send one object further to the back
Cmd-#		Toggle grid
Cmd-Shift-#		Show Grid Panel
Cmd-<		align text to the left
Cmd–		center text
Cmd->		align text to the right

5.5   Frequently asked Questions

For an up-to-date version of the questions and answers visit the internet pages of
Cenon www.Cenon.info.

5.5.1   CAM

The tool radius is corrected more than expected

Newer versions of Cenon include the stroke width when correcting the tool radius.
You can set the stroke width of an object to 0 using the Inspector.

The tool radius isn't corrected

You have to fill your graphic objects to allow a tool radius correction.

Some characters have ugly sparcs in their output path

Your data contains lines or curves which are smaller than the tool radius. You should remove these elements from your graphic. As an alternative you can switch to the bitmap (raster) algorithm of Cenon (preferences option).

For my newly generated tool, the tool correction does the wrong thing or nothing at all

Check the type of the tool (the pop up menu in the tool parameter panel). If you want to cut you shouldn't set the type of a drill for example!

5.5.2 CAM Production

The wrong configuration file is used

Probably your configuration file was found on a second place with the same name. Device configuration files basically can reside in two places in the file system:

1. HOME/Library/Cenon/Devices/xyz (HOME is your home directory)

2. /Library/Application Support/Cenon/Devices/xyz

   or for Linux:

   /usr/GNUstep/Local/Library/Cenon/Devices/xyz

Configuration files in the first directory have priority and will be used if a file with the same name resides in the second directory. This allows a user to modify a configuration file without changing the installation of Cenon.

The spindle doesn't start automatically or isn't controlled by the application at all

Check the preferences of Cenon, if the correct machine type with support of your spindle is used.

After updating Cenon, the machine doesn't work any more

Check the preferences of Cenon to use the right type of machine.

The machine jerks sometimes and give bad results.

If you get an offset in your output (sometimes always at the same position), then probably the positioning speed is too high and has to be lowered.

Not everything is send to the machine, even with all the eyes open in the CAM-Panel

Go to the Control-Panel (CAM-Panel, Control) and set the radio button from "Selection" to "All".

The machine stops in the middle of the output (there appear messages in the console window of the Workspace), or the machine moves to wrong positions

Probably you experience an EMV problem of the PC, and disturbances come in over the serial interface. You should use a shielded serial cable (please use the cable coming with your machine). Connect your PC with a separate wall-plug than for example the vacuum cleaner. Also the use of a seperate serial card may help. Usually a small company don't have to buy an expensive industry PC to get rid of those problems.

CNC 450: If I stop during output, the machine stops with delay

Cenon has to send some vectors in advance to the controller, so the machine can't stop before processing those vectors. To shorten the delay, you can modify the maximum size of lines in the layer details section of the CAM-Panel.

Apple: the output is frozen and Cenon too

Plug out the serial adaptor from the USB interface for a short time. This will bring back the controls. You are using a device configuration which uses a tty device (entry #DEV) and you haven't connected a device (or have connected a device which doesn't fit the configuration). To prevent future freezing, you can change the device entry of your device configuration to use a cu device. To do this open the device configuration in a text editor and change the device entry (#DEV) from tty to cu (see section 4.2).

5.6 Serial Cable

To connect your machine or plotter to the computer you may still need a serial cable. If possible you should use the cable you get with your machine.
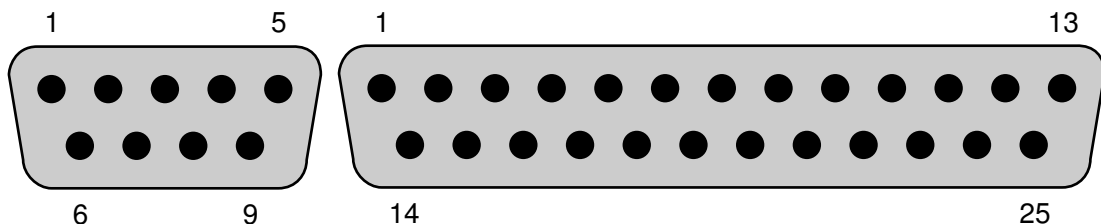
The images show the pin numbering for male SUB-D connectors. You find them on the PC side of the connection as well as on a serial adaptor (Apple). The female connectors are numbered in reverse order.

This is the general pin layout of the serial connectors on PCs and most serial devices (this is true for male and female connectors):

9 pin	25 pin	Pin Name	Pin Description
1	8	DCD	Data Carrier Detect
2	3	RXD	Receive Data
3	2	TXD	Transmit Data
4	20	DTR	Data Terminal Ready
5	7	GND	Signal Ground
6	6	DSR	Data Set Ready
7	4	RTS	Ready To Send
8	5	CTS	Clear To Send

The cable for connecting a plotter and some CNC controllers needs the following connections to work with all handshakes. See the manual for your specific device for further information.

PC	Plotter
RXD	TXD
TXD	RXD
RTS	CTS
CTS	RTS
GND	GND
DCD	DTR
DTR	DCD
DCD	DSR

5.7   Glossary

"What does this mean?" is sometimes the question. This glossary should help you to better understand technical terms and also give you a short explanation to important terms from A (aperture table) to Z (Cenon). If more information is available in the manual we will refer to the appropriate section of the manual.

Aperture Table   A aperture table is necessary for importing Gerber files. This file contains all the necessary D-code information

to assign the aperture of the photo-plotter (soldering point shape, sizes and conductor path thickness) to the different layout elements of your CAD-program. The aperture table used for export has to be used for importing as well. The extended Gerber format doesn't need an aperture table any more.

Blow Up   Special kind of isolation tracks for producing PCB prototypes. A blow up is used to increase the isolation paths for easier soldering.

CNC-Controller   The CNC controller is the link between your computer unit and the engraving unit. The controller converts the signals send by Cenon to signals of higher electrical current, so that they are able to power the different axes of the engraving unit.

Configuration file In your configuration file (extension .dev) control commands and other parameter for the output device are defined or different commands of the different import formats are translated for Cenon.Default A default is an entry preset by an application.

Conical   Conical describes a shape which goes from wide to narrow.

Inlay   Inlays are a special way of cutting material, so that one part exactly fits into another.

Excellon Format   Excellon is a data format used by industrial drilling machines for drilling holes in circuit boards. Many of the CAD programs can export these data and enable you to import all the drilling information. The format is imported using the DIN import.

Extended Gerber	This is an improved Gerber format without the need of a separated Aperture file. The format also allows complex ground planes, which is very important for a clean import of the data.
Gerber-Format	Gerber is a data format for exporting layout data. In general, photo-plotter use this file format. Because this file format is very common, most of the CAD-programs are able to create files in this format.
HPGL	This abbreviation is an acronym for "Hewlett Packard Graphics Language" and is one of the well know and mostly used command set for accessing pen plotter.
Inner Contour	The inner contour is mainly used for calculating the engraving path of filled areas. The appropriate tool is labeled engraving tool.
Insulation engraving	Special kind of tool radius correction used to create prototypes of printed circuit boards (PCBs). The insulation is engraved around the tracks.
Outer Contour	The calculation of the outer contour of components is necessary, if the elements have to be cut-out totally and the cut out should comply exactly with the layout of the element. These cut-outs are normally done with a milling tool.
Outline-Algorithm	The outline-algorithm is responsible for creating a contour around graphic objects.
Pick-Out	The pick out is a special method of creating output for detailed engraving purposes. It is used with a conical tool.

PostScript	PostScript is a vector based page description, which is mainly used in the DTP area. This format is normally used to drive photo-type-setters to create inexpensive film layouts.
Project	A project in Cenon is your document file. It is saved with the extension '.cenon'. In CAM applications a Cenon project can also be called a job.
Rub-Out	Rub-out area (especially PCB prototyping) indicates areas were analog to the chemical process the conduction copper material is completely removed (important for HF-applications). The actual tool diameter is used for calculation of the appropriate path to completely remove all the copper.
Sieb & Meyer	Sieb & Meyer ist a industrial drill data format. The two Sieb & Meyer formats (1000 and 3000) can be imported using the DIN import.
Spindle	Also called HF- or SF-spindle. Using high frequent three-phase current, extremely high revolutions per minute (RPM) can be generated, to achieve a precise output and a high feeding speed.
Cenon	Universal construction and production software.

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