7 BeamConstruct

7.1 Security

This application is designed to control laser equipment which may effect a person's health or may otherwise cause damage. Prior to installation and operation compliance with all relevant safety regulations including additional hardware-controlled safety measures has to be secured. Beside of that some laser equipment can be damaged in case it is controlled with wrong signals. Thus it is highly recommended to check the output generated by this plug in using e.g. an oscilloscope to avoid problems caused by wrong configurations. This should be done prior to putting a system into operation for the first time and whenever a software update was installed or whenever some of the relevant parameters have been modified.

Here “software update” not only means updates of the OpenAPC or BeamConstruct software but also modifications with dependent software like components or drivers for scanner controller cards.

7.2 Overview

BeamConstruct is a CAD application which is a bit similar to CNConstruct but specialised for creation and processing of laser marking data. These data can be used together with a laser scanner system to perform the material processing. Beside of that BeamConstruct is able to store the generated processing data in different formats that can be used by ControlRoom plug-ins directly. Thus the generated laser marking data can be used within a process control environment directly and without the need to deploy the editing software “BeamConstruct” on the target system. Comparing to CNConstruct this application is not only able to generate these data but – optionally – also to test it and to start laser marking and related motion processes directly out of the application.

7.3 Position within the system

BeamConstruct is not a vital part of the OpenAPC runtime environment. More than this OpenAPC not necessarily requires BeamConstruct main application for proper operation also in case a ControlRoom project is used for processing BeamConstruct-generated data. This application exists beside the ControlRoom environment and is an additional tool that primarily belongs to construction process, not to production.

So one possible usage cycle is as follows:

1. Processing data are created within BeamConstruct, that can be done apart the production place, e.g. in an construction office.
2. The constructed data are saved or exported.
3. The saved or exported data are transferred to the production where an ControlRoom project is running.
4. This ControlRoom projects loads the BeamConstruct-data and uses it as binary control data internally for processing materials in the desired way.

Optionally it is possible to perform some additional fine-tuning between step 2 and 3 with the generated project files using an other (or the same) installation of BeamConstruct at the production with the complete external hardware. Here the capability of BeamConstruct to mark directly out of the application can be used.

7.4 Quick Start into BeamConstruct

This section describes how to use BeamConstruct in direct operation mode where laser marking is done out of the application and without the use of a separate ControlRoom project. It gives a short overview about basic setup and usage of BeamConstruct and describes with some short steps how to get first results easily. So this section is a shortcut to get results with this software very fast but it ignores most of the useful features. These features are described in detail in following sections of the users manual, so it is recommended to use this quick start only to understand the very basic working principles of the software while going deeper into it afterwards.

1. **SECURITY CHECK**: The following steps describe how to set up BeamConstruct and how to control laser equipment out of it. Thus all laser safety rules and regulations need to be respected, all required technical security mechanisms need to be available and active prior to starting with this software.
2. **Main configuration**: First the scanner controller card that has to be used needs to be selected and configured. To do that select Menu “Project” menu item “Project settings...” and go to panel “Hardware” of the opening settings dialogue. Within the selection-list named with “Scanner Card” choose the scanner controller card you want to use. After selecting it, press the button “Configure” and set up the scanner controller card according to its specific needs (choose things like firmware file, correction table, working area size, number of controlled axes or what ever your card requires for proper operation) and according to your local hardware configuration.
3. **Save Configuration**: Leave all these settings dialogues by pressing “OK” once all parameters have been entered correctly and select menu “Project” menu item “Save as default configuration”. Now whenever you start BeamConstruct and as long as you do not load a project file with a different hardware set-up, these settings are used by the application.
4. **Create basic geometry**: Select the blue triangle-symbol within the tool bar and draw that triangle within the drawing area right below the tool bar. There you have to left-click your mouse three times at different positions to create the triangle, every of these mouse-clicks specifies an other corner of the triangle.
5. **Modify existing geometry interactively**: Once you have finished creation of the triangle this new element is selected and highlighted by a double-lined blue box surrounding it. This box can be used to modify the geometry. While picking and dragging one of the coloured squares that are contained in this surrounding, the triangles size can be changed (the grey squares) as well as its rotation (the red square). The cyan-coloured squares can be used to slant the geometry. When the triangle is dragged by clicking the selection frame between these coloured squares, its position can be changed.
   PLEASE NOTE: When modification of the geometry has finished it still has to be located completely within the working area that is symbolised by the grey rectangle. This working area is the maximum range your scanner can work within, so all geometry that is located outside of that range will be cropped.
6. **Modifying existing geometry manually**: The method described previously is a very quick way to change the geometry but it is also a very inaccurate one. Thus there exists an other possibility: As long as an element is selected, there is a configuration pane usable at the windows left hand side. The first configuration pane is always an element-specific one, in this example it contains several parameters and values that influence the creation of the triangles base geometry. On the same side of the main window there also exists an other tab-pane “Geometry” where the generic geometric data of an element can be changed by entering the desired numeric values. Using this way things like size, position and rotation can be modified in a very exact way. The related values are taken over and applied to the geometry as soon as the data input is confirmed by pressing “Return” or by leaving the input field.
   Several of these data depend on each other and will change automatically whenever one of them is modified. So in case you change the scale factor of your geometry, the position and size values of it will be changed too as soon as you hit your “Return”-key within the scale value input field.
7. **Apply laser parameters**: Required laser parameters can be applied to existing geometry via a

number of predefined and freely definable pens. Such an (existing) pen can be set via the tab-pane "Element" and the selection list named "Pen". Whenever a new pen is selected for an existing geometry it is applied to it automatically, which means the visual representation of that geometry within the drawing area changes its colour and the next laser marking cycle would use the parameters of this pen when this specific geometry is processed.
The different laser and scanner parameters that are assigned to such a pen can be modified by selecting menu "Project" menu item "Pen settings...". There a dialogue opens where you can select the pen that has to be modified (by using the selection list on the upper side of the dialogue). The tab-panes below this list give access to all relevant parameters that influence mark and jump speed, laser power and frequency, scanner delays and others more. When you change some of these parameters and leave the dialogue by pressing "OK" all the geometries that are assigned to this (now changed) pen will use the modified parameters during next laser marking process.

8. **Adding a hatch pattern**: Currently only the outline of the triangle is shown and only this outline would be processed during laser marking. To process the inner side of the triangle too, a fill pattern has to be added by using the Additional Geometry element "Hatch". It is symbolised by a violet tool bar icon that consists of several horizontal lines. When this icon is clicked as long as a Primary Geometry element (like the triangle) is selected, it is added to this element automatically. Now the appearance of the geometry and the appearance of the application changes:
   - the first pane on the main windows left hand side switches to show all the "Hatch" parameters
   - the Element Tree on the main windows right hand side now shows the new hierarchical structure of the element with the "Hatch" as sub-element of the primary "Triangle" geometry
   - the triangle within the drawing area is filled with some hatch lines
   This hatch pattern now can be changed by modifying the values within the property-pane "Hatch" on the main windows left hand side.
   PLEASE NOTE: after clicking the Hatch-button within the tool bar the new geometry of the now added hatch/fill pattern is selected instead of the triangle! That means all modifications to the selected geometry (as described previously) now would apply to the hatch geometry only but NOT to its parents triangle!

9. **Save data**: To avoid the currently generated geometry gets lost, the project has to be saved now. To do that select menu "Project" menu item "Save as..." and save these data at a suitable position using the .BEAMP format.
   PLEASE NOTE: this project contains all the hardware definitions that have been done during configuration of the software in first steps. Whenever you change this configuration and then load this project again, the hardware set-up of the project is used instead of the changed one of the application. To avoid that after loading such a project, the menu "Project" menu item "Load default configuration" can be chosen to replace the projects hardware set-up by the local, desired one.

10. **SECURITY CHECK**: Next the scanner controller card will be accessed for the first time. That means it is opened and initialised and all connected equipment may start working now. Thus it is very important to ensure all security regulations are met and nobody can be injured and no damage can be caused also in case laser output or other motion starts spontaneously and unexpectedly!

11. **Prepare for laser marking**: Now the created geometry has to be sent to the connected laser and scanner system for processing it on some material. To do that the menu "Process" menu item "Mark" has to be selected. It opens the marking dialogue and tries to access the connected hardware. In case it is not possible to access the scanner controller card, an error message is shown and none of the buttons of the mark dialogue are usable (except the "Cancel" button to leave the dialogue). In this case you have to go back to the project settings as described in step 2 and to correct the set-up of your scanner controller card.

12. **SECURITY CHECK**: Next the laser and scanner will be accessed. Since there are some (laser) controllers available that are VERY sensitive to wrong laser signals, it is recommended first to check the output your scanner controller card produces. This can be done e.g. by using an oscilloscope instead of the real hardware. The target equipment should be connected only in case all signals are checked, correct and acceptable by the hardware. More than this it is recommended to repeat this step whenever the something within the complete set-up changed; changes may be caused e.g. by modified parameters, by software or driver updates.

13. **Start marking**: Now marking can be started by pressing the big yellow button (the one with the laser warning sign) in the middle of the marking dialogue. This starts sending of all laser and scanner data to the scanner controller card so that it is able to output motion and laser control data synchronously.

Such a marking operation can be stopped by pressing the big red button (with the STOP-symbol) at the dialogues right hand side.
PLEASE NOTE: this stop-button is not a replacement for a real emergency stop, it will try to stop the currently running laser process only via software which – in worst case – may fail for an example due to an abnormal problem or in case of a hardware failure. Thus there must be independent and working emergency stop equipment available in every case!

7.5 Project Configuration

When starting with a new project it has to be configured first so that the editing environment of BeamConstruct reflects the real processing conditions within production.

This can be done in global settings, the related dialogue can be found in menu “Project” sub-menu “Project settings...”. There a dialogue opens which offers several configuration options within different tab panes. The following parameters can be set and modified within these panes:

In tab-pane “Drawing Area”:

- Grid Size – this is a helper grid that is used and visible within the working area as an array of of points with an distance in X and Y direction as specified here
- Snap to Grid – when this check box is selected all geometry that is drawn or re-positioned within the working area automatically snap to a position that is defined by the visual grid; this option gives the possibility to position elements very exact
- Background Colour – this option changes the visual representation of the editor and does not have any influence on the generated data, it specifies the colour of the background within BeamConstruct's drawing area
- Working Area Border – the previously defined working area is shown as rectangle within the drawing area of the application, here the colour of this rectangle can be changed; similar to the previous option this one also does not influence the generated data
- Expand / Move entity tree to tab pane – this option saves some space in X-direction; the entity tree that is shown on main windows right hand side normally will be moved to the left side and becomes a normal tabbed pane there; changes to this parameter require saving of the current configration as default one and a restart of the software in order to take effect

In tab-pane “Custom Dot” that is responsible for defining a style for a customised dot layout that is used by several geometric elements:

- Custom Dot Style – selects the type of geometry, here polygon (includes a circle) or spiral can be chosen to be used as replacement for simple dots
- Edges/Segments – specifies the number of the edges or segments the custom geometry has to consist of
- Outer Radius – sets the size of the custom geometry
- Inner Radius – this parameter is used only in case of a spiral, it specifies the inner size of it
- Slope – here the same is true, this parameter applies to a spiral only and can be used to set the steepness the spiral grows with
- Draw CCW – here the drawing direction of the custom geometry can be inverted
- Inside To Outside – when this option is set for a spiral it is drawn starting from its inner point

In tab-pane “Hardware” it is possible to configure several components like the scanner controller, laser and image capture device to be used out of BeamConstruct directly. In case these components are set up properly according to the used hardware environment (and in the same way like they would be used within a “real world” ControlRoom project) it is possible to start marking and motion operations directly from within BeamConstruct:

- Scanner Controller Selection – this combo box has to be used in multihead mode where BeamConstruct controls more than one scanner card at the same time. The selection with this combo box influences the settings of all following parameters. Please note: in multihead and singlehead mode the first scanner controller always has to be set, it is not possible to start e.g. with settings for the second scanner controller and leave the first one empty.
- Scanner Controller – here a scanner card can be chosen out of a list of available scanner controller types; this list makes use of the related plug-ins that belong to the ControlRoom environment. As soon as a scanner card is selected for usage within BeamConstruct it can be configured by pressing the button “Configure”. Although this configuration is done for the scanner controller card all the

parameters like the working area size and position are used to set up BeamConstruct too.

- Pilot Laser – this section is related to the configuration of a pilot laser that does not perform marking operation but points to the position where the main laser would influence the working piece (as some kind of preview-laser). This pilot laser can be used out of BeamConstruct's marking dialogue directly (please refer below for more details); the related parameters are enabled only in case a scanner controller card was chosen and configured properly
- Output Port – here a port can be chosen that has to be used to turn the pilot laser on and off
- Output Number – here the bit number at the previously chosen output port has to be selected which shall be used to toggle the pilot laser; please note: some scanner controller cards use some of their output bits for specific, reserved purposes, these bits should not be used for pilot laser to avoid any unwanted and undefined behaviour. As a second precondition it is necessary to connect the pilot lasers on/off input with the output that was selected here.
- Invert Output Logic – inverts the output value for the signal that should turn the pilot laser on, this option needs to be set for some specific pilot lasers to invert their behaviour
- Correction Factor / Correction Offset – pilot lasers normally have a different colour and therefore a different wavelength than the main laser. In case some optics are used within the scan head this may result in variances in the marked positions due to a different light refraction factor. Using these parameters such variances can be compensated. The correction factor is a factor that modifies the size of the pilot lasers output in X and Y direction while the correction offset modifies its absolute position
- Scanhead Selection – this combo box is dedicated to multihead configuration too, different to the preceding combo box it is assigned to a scan head. This differentiation is made because one scanner controller / one plug-in defined above may access several scan heads independently, therefore head-specific parameters have to be set separately. The selection made with this box belongs to the following parameter:
- Laser – here a laser controller plug-in can be selected that communicates with a laser independent from the scanner card. As soon as a laser controller is selected for usage within BeamConstruct it can be configured by pressing the button “Configure”.

All following parameters are unique and independent from any head or scanner controller selection:

- Video Controller – this gives the possibility to choose a source for a live background video which is displayed in drawing area behind all vector and bitmap data. This live image can be used to adjust the current marking project to the working piece that is shown by a connected camera.
  To have a background image just as pattern for a laser project, it is recommended not to use such a live image but to import a still image and use it as light-table background (please refer to description of import functionality).
- Position / Size – using these input fields the position and displayed size of the captured video can be specified, it expects the same coordinate system and orientation like it is used for definition of working area
- Display image on manual activation only – when this option is set the image is not shown all the time, it has to be enabled manually and can be disabled afterwards to continue without a live background image; this can be done via vision menu or via the image button in mark dialogue

In tab pane Motion Axes it is possible to configure up to two different motion controllers with up to three independent axes each. Both possible motion controllers are identified via names OUT2 and OUT3, which are identically to the outputs of the related BeamConstruct2Control plug-in. So when a BeamConstruct project is executed out of a ControlRoom environment using this plug-in the hardware settings given here are ignored and the motion data are emitted at these plug-ins outputs. When the motion controllers have to be driven by BeamConstruct directly (or by the BeamConstruct-HMI-plug-in) here a valid configuration is required for at least one of them

- Motion Controller OUT2 or OUT3 – this combo box can be used to select a motion controller that would be accessed whenever a motion control information is assigned to output OUT2 or OUT3 (please refer to the description of the Primary Element “Motion” and other motion-related functionalities below). This selection list makes use of the motion plug-ins of the ControlRoom environment, so for a description of the related plug-ins parameters please refer above. The parameters that are set for such a motion controller are NOT handed over to BeamConstruct fully, so

when some of the axes of a motion controller are not enabled here within its settings, they are still be usable and configurable within the related BeamConstruct elements. This is necessary to keep all options and possibilities for a user that wants to export a BeamConstruct project and use it within a ControlRoom project where more/other axes may be available.

- Reference axis on start-up – here these axes can be specified that have to be referenced on application-startup or on first opening of devices automatically
- Axis alias and orientation – here for the default axes A, B and C an own name can be set that is shown e.g. within mark dialogue to identify the axis; additionally for planar axes it can be specified in which direction movement is done, the setting made here influences what kind of arrows are shown for axis movements in mark dialogue

Tab pane “Limits” gives the possibility to configure allowed ranges and behaviour of some pen parameters, here the minimum and maximum value that can be specified within pen settings dialogue can be set. Beside of that the behaviour of the related slider can be changed, when check box “Logarithmic” is set, the sliders no longer act linear. Here allowed range and behaviour of following values can be configured:

- Pen Frequency
- Jump Speed
- Mark Speed

Beside of that some procecsing-related limits can be set:

- Parts Counter / Enable – enables the parts counter; this function counts how many parts already have been processed and informs the user when a limit was reached; in this case the user has to confirm this limit and needs to reset the counter to continue marking; confirmation and resetting can be done in mark dialouge
- Default part number – here a number of default parts can be specified that is used for the parts counter, it can be overwritten by the user in mark dialogue

Since the parameters that have been specified here have to fit to the production environment where the constructed data have to be used, it is important to use the same settings for all constructed data. These project parameters are stored within every project file. Thus it may happen a project file is loaded that contains different hardware settings and therefore is not compatible to the local system. To avoid such troubles two functions can be found in menu “Project” that handle the local default data:

- Save as default configuration – saves the current set up as default, whenever the application is started or a new project is generated, this configuration is used automatically; this not only includes the settings done within the project settings but also the number of pens and pen settings
- Load default configuration – loads a saved default configuration, overwrites the current project settings and appends the loaded pen definitions to the currently used ones

7.6 Pen Settings

Every element that is created within a BeamConstruct project has a pen assigned to its geometry (or for scanner bitmaps to its bitmap data). This pen contains all information the related element will be marked with: scanner speeds, delays, laser power and frequency and others more. These parameters can be set within the pen settings dialogue that opens when the menu “Project” menu item “Pen settings...” is selected.

On top of that dialogue the head can be selected this pen applies to. This is important for multihead configurations where more scanner controllers/more independent working areas are used. There will always exist the same number of pens for all heads but the same pen number can have different parameters for different heads.

Below of this a pen can be chosen for editing, the same combo box can be used to create a new pen, in this case the option “Append new pen...” has to be selected there. After selecting an existing or a new pen all its parameters can be changed within the lower part of the dialogue. It is separated into some sections that contain different categories of pen parameters.

All tab-panes that hold these categories have one common functionality for selected parameters: by pressing the button “To all pens” a parameters value can be applied to all pens that currently exists. So in case a specific pen parameter has to be changed globally, it is not necessary to edit it manually within every single pen.

PLEASE NOTE: there is no feedback from a possibly connected laser or scanner equipment to this dialogue, so the application can't know if a value is suitable for the connected equipment or not. Although there are some logical and range checks that try to avoid heavy mistakes it is up to the user to keep all parameters within valid and useful ranges.

7.6.1 General Pen Settings

This panel contains some basic pen parameters. On top of it an input field can be found that can be used to rename the current pen, there its name can be changed and the new name can be applied by pressing the return key.

Beside of that the following parameters can be edited here:

- Power – the output power in range 0..100% the laser has to be driven with
- Frequency – the frequency in unit Hz the laser has to be driven with; the allowed frequency range can be configured within project configuration dialogue
- Mark Speed – the speed of the scanner that is used during marking (motion while laser is turned on); the allowed speed range can be configured within project configuration dialogue
- Jump Speed – the scanners speed that is used during jumps (motion while laser is turned off); the allowed speed range can be configured within project configuration dialogue
- Spot Size – the diameter of the lasers spot on the surface, this value should be as exact as possible because it is used for different calculations
- Draw Off-Movements – this option is related to the visual representation of a project within BeamConstruct only; when this option is set not only these parts of the geometry are shown within the drawing area where the laser is turned on but also the jumps where the laser is turned off; this option can be helpful to optimise a project
- Use as default Pen – the pen where this option is set for is used as default pen for all newly created geometries. More than this, whenever a new pen is created the parameters of this pen will be set to the values specified for the default pen. Within a project only one pen can be default, so whenever this option is selected for a pen, it is disabled, resetting this option can be done only by choosing an other pen as default one.
- Use for Pilot-Laser – the parameters of this pen are used to control the pilot-laser. This means the speed and delay settings are used whenever the pilot laser is used. Since this laser can be turned on and off only, all values like power, frequency and some delays are disabled, they are not relevant for the pilot laser. Within a project only one pen can be used for the pilot laser, so whenever this option is selected for a pen, it is disabled, resetting this option can be done only by choosing an other pen for the pilot laser.
- Pen On-Colour – this colour is used within the drawing area for all geometries
- Pen Off-Colour – this colour is used when “Draw Off-Movements” are enabled to show the laser jumps within the drawing area

7.6.2 Scanner Pen Settings

This tab-pane contains all scanner-related pen parameters:

- Laser On Delay – the time that is set between start of a mark movement and the moment the laser is switched on; so this parameter specifies if and if yes how much the laser should be turned on

delayed in case a marking operation is started

- Laser Off Delay – the time that is set between the end of a mark operation and the moment the laser is turned off; so this parameter specifies how much turning the laser off has to be delayed in case a marking operation ends
- Jump Delay – time the scanner waits when a jump was executed; this delay applies at the end of a jump to let the scanner finish its movement
- Mark Delay – time the scanner waits when a marking operation was executed; this delay applies at the end of a marked line to let the scanner finish its movement
- In-Polygon Delay – the time the scanner has to wait for every corner within a polygon when the laser is turned on and stays turned on
- Calculate Delays – the delay values described above are essential to get high quality marking results also in case of an as high as possible marking speed. Since the evaluation of the correct values is a difficult and time-consuming process BeamConstruct offers a possibility to set some default values which can be used as starting point for optimising these delays. Every scan head vendor provides a value named “Time lag” (or something similar) within its technical documentation. This value describes the specific inertia of this scan head. After pressing this button this time-lag-value has to be entered within the related dialogue. When it is left by pressing “OK”, BeamConstruct calculates some basic delay parameters that fit to the scan heads mechanical properties and that can be used for further optimisations.
  For more details about the purpose of all these delays and their influence please refer to your scan heads or scanner controller manufacturers manual.
- Set Defaults for Bitmap-Marking – when marking scanner bitmaps instead of vector data some very specific pen parameters have to be used that follow different rules. In such cases it is recommended to use this button, it changes the current pen parameters including the scanner delays to values that are suitable for marking scanner bitmap elements.
- Wobble Frequency / Wobble Amplitude – when wobble is enabled the linear movement of the scanner during marking is distorted by an additional frequency that lets the scanner oscillate around the predefined position. This functionality can be used e.g. to warm up larger areas of a material, for welding or similar things. To enable wobble both parameters amplitude and frequency have to be greater than 0. The wobble frequency specifies how fast to oscillate and the wobble amplitude how much to vary over the original position. Wobble has to be supported by the used scanner controller card in order to have any effect during marking.

7.6.3 Laser Pen Parameters

This panel contains several parameters that belong to the used laser and the parameters/signals that are required to operate it. So depending on the laser type that was configured for the current project these options are enabled that contain useful parameters for proper laser operation. For a detailed description of these parameters and their meaning please refer to your laser vendors manual.

PLEASE NOTE: some laser types need to be operated using relatively tight parameter ranges. When they are controlled with wrong parameters the results may be an undefined behaviour or the laser hardware may be damaged in worst case. So when setting up new parameters or when changing them or after a software update was done, it is highly recommended to (re-)check these laser parameters and the output signals of the scanner controller in order to avoid problems with the laser. Here “software update” not only includes updates of the OpenAPC package or BeamConstruct. Also in case the software or drivers that for an example belong to the scanner controller card are modified, it is recommended to perform these checks.

7.7 Construction Of Geometry

Comparing to other CAD applications that offer basic primitives with huge amount of options and parameters the concept of BeamConstruct is different: It offers several basic primitives like lines, circles and others that

contain only as less parameters as necessary. To get a wide range of effects and complex geometries, these basic data can be combined with other elements that add new data to them or that modify and manipulate them. Thus several simple and easy to understand elements can be put together to complex geometries.

CNConstruct offers following element types that can be used for these combinations:

- Primary Geometry – such an element is always the starting point and offers a basic, primitive geometric element (like a rectangle, triangle, text or others like this); this element can be combined with several other elements like:
- Additional Geometry – this elements uses a previously defined geometry and adds some more geometry to it
- Post-processing Tool – this element modifies existing geometry
- Input Element – here a indirect influence to existing geometries is possible, this kind of element gets data from an external source and inputs it to Primary Geometry elements that can use these data for their own geometry (like the text or barcode element)

Following rules apply to these elements:

- a Primary Geometry element can have several child elements but none of type “Primary Geometry”
- Additional Geometry and Post-Processing Tools can exist several times as child of a Primary Geometry element, but they influence only the state of the geometry like it exists before their own position
- an Input Element can exist exactly once for a Primary Geometry element and only for such elements that really are able to handle input data)

The second rule can be made explained better with an example: as Primary Geometry a rectangle is drawn. It is modified with a “Sine Distortion” Post-processing Tool which changes the borders of the rectangle to have a sine waveform. Next an additional element “Hatch” is used with adds lines to the geometry that fill the rectangle

In this case the sine distortion is applied to the rectangle only (because it is located before the sine-element) but not to the hatching lines (because they are added after the sine distortion takes place. So the hatching lines stay straight.

The situation becomes different when the two sub-elements change their position. When the first child element below of the primary element is the hatcher the resulting hatch lines will be distorted by the following Post-processing Element too. They are no longer straight lines but have the same sine shape like the rectangles border because the sine distortion now applies to the hatcher too: that's caused by the fact that the sine distortion Post-Processing Tool stays after the hatcher.

PLEASE NOTE: for the example explained above the line styles for rectangle and hatch have to be switched to “Connected Lines”.

7.7.1 The Drawing Area

Within BeamConstruct's main window the drawing area for geometry is located in the middle. There new primary elements can be created or existing geometry can be modified. Whenever an element is selected, it is highlighted by a double-lined, blue border. This border can be used to manipulate the element. When pressing the left mouse button within this border and outside the coloured squares it contains, it can be moved and repositioned. Left-clicking it within one of the squares gives access to other manipulation functions:

- the dark-grey rectangle at the lower right corner provides a resizing-function where the aspect ratio between both visible directions is kept intact
- the medium grey rectangles at the lower or right border of the rectangle provide resizing functionality in one direction only
- the light-grey rectangles in upper right and lower left corner allow to rescale the element in every

direction and without keeping the current aspect ration between the two visible directions

- the cyan rectangles at the left and upper border can be used to slant the geometry in one of the visible directions
- the red rectangle in upper left corner can be used to rotate it

How and by which value the elements are changed can be seen within the panels on the main windows left hand side as described in following section.

PLEASE NOTE: The manipulation possibilities described above apply to the geometry that is currently selected. When a primary element is selected the changes apply to its geometry, possibly existing additional or Post-Processing Tools are re-calculated according to these changes. Whenever additional geometry within a Primary Element is selected and manipulated, this has no feedback to its parent Primary Element, in this case the Additional Geometry might be changed without any relation to the parents geometry and therefore in a way that is not desired.

The part of the current project that is visible within the drawing area can be changed too: when no element is selected the whole area can be moved by holding down the left mouse button and dragging it into the direction where the complete view has to be moved to. Beside of that there are zoom-buttons available within the tool-bar:

- Zoom In – zooms into the drawing area so that more details become visible
- Zoom Out – show a bigger area but less geometry details
- Zoom To Working Area – changes zoom and position of the current view so that the full working area is visible in the maximum size that is available in the drawing area
- Zoom To Selected – changes zoom and position of the current view so that the currently selected element is visible in the maximum size that is available in the drawing area

When one single element is selected that contains some geometry, a special point editing mode can be enabled to modify the single points this element consists of. This mode can be enabled by turning on the tool-bar button right beside the zoom-buttons. Once this button is enabled the appearance of the current element changes, now all editable points are surrounded by a rectangle. These points now can be dragged to other positions. This can be done for every point separately. To drag a group of points together please refer the description of the Geometry Tab Panes table “Coordinates” below.

7.7.1.1 2D and 3D Editing

Within most scanner controller parameters (please refer to the description of the project settings above) it is possible to choose between a 2D operation mode (two-axis mode) and a 3D operation mode (three axes controlled by the scanner controller). This option depends on the capabilities of the used scanner controller and influences the behaviour of BeamConstruct's drawing area. When a two-axis mode is selected, only the two axes X and Y can be modified within BeamConstruct and the drawing area offers manipulation possibilities for X (horizontal direction) and Y (vertical direction) only.

As soon as 3D mode is enabled, the drawing area is extended by some semi-transparent buttons that are shown directly within the drawing areas upper left corner. These buttons can be used to switch the current view and the axes that are visible within this view:

- top view – the default view for a laser marking system from top where the laser source is located above the working piece, here X/Y are shown in horizontal/vertical direction of the drawing area
- front view – view from front where X/Z are shown in horizontal/vertical direction of the drawing area
- right view – view from right side where Y/Z are shown in horizontal/vertical direction of the drawing area
- 3D view – here all three dimensions of the current project are visible at the same time within a three-dimensional, foreshortened view; comparing to the other views here no elements can be created and edited but it is possible to rotate the view by moving the mouse while holding down the right mouse button

- split view – when this view is enabled all four views described above are shown at the same time within a split view. This mode requires more hardware resources but makes editing easier because all three views can be edited here simultaneously.

7.7.2 The Property Tab-Panes

The main window of BeamConstruct contains some special tab-panes on its left hand side. These panes give access to different parameters and values, they can be used to influence geometries in an very exact way.

7.7.2.1 The Tab-Pane Of The Currently Selected Element

The very left tab-pane is a dynamic one, it changes its contents depending on the element that is currently selected. As long as no element is selected this pane is empty, no parameters can be changed here. These element-specific values that become visible as soon as something is selected within the drawing area or within the element tree on the windows right hand side are described in detail below together with the different elements.

In case more than one element or in case a simple group element is selected this tab-pane is empty too.

7.7.2.2 The Geometry Tab-Pane

This pane can be used only when an element is selected that contains some geometry. Thus it does not offer any functionality as long as no element or as long as a geometry-less Post-Processing Tools is selected.

Within this panel geometry-related values are displayed and can be changed. When 3D mode is enabled, the number of available and usable options and parameters depends on the currently selected view, in 2D mode only these values and options can be changed and used that belong to a flat, two-dimensional project that only extend in X and Y direction:

- Mirror X, Mirror Y and Mirror Z buttons – when pressing one of these buttons the currently selected geometry is mirrored in X, Y or Z direction; pressing the same button twice results in no changes
- Centre X, Centre Y and Centre Z buttons – these buttons reposition the selected geometry within the current working area, they centre it in X, Y or Z direction
- Scale – these input fields show the current scaling factor comparing to the original state of the geometry for X, Y and Z direction, a value of 1.0 means the geometry is not scaled, values smaller than 1.0 mean it is shrunk in this direction, vales greater than 1.0 mean it is bigger comparing to the original
- Top Left – the upper left coordinates of the selected element, whenever they are changed the element is repositioned without changing its size, resulting from that the following values are changed too:
- Bottom Right – the lower right coordinates of the selected element, whenever they are changed the element is repositioned without changing its size, resulting from that the previously described values for the top left corner are changed too
- Size – the total width, height and depth of the element, when it is changed the geometry is scaled in X-, Y- or Z-direction, the related values for scaling, the top left and the bottom right corner are changed too
- Rotation – the angle in unit degrees the element is rotated with, here the rotation can be changed which may result in changes of other parameters depending on the shape of the used geometry
- Coordinates – this list contains the coordinates of all points of the currently selected geometry, here

they can be changed to re-position a single point of it; selecting a point within this list also affects the highlighted element within the drawing area: there the selected point is surrounded by a separate, blue box which can be used to drag this point, thus the geometry can be edited using the mouse. Within this table of coordinates a single point or groups of points can be selected. This can be done by left-clicking into the row of the point that has to be selected. Additional points can be chosen by selecting additional rows of points while the shift or control key is held down. In case more elements are selected they can be modified within the drawing area by dragging them to other positions, here all highlighted points are moved together.
Comparing to this a point editing mode is available that gives the possibility to highlight and edit all points of an element separately. For more details about this mode please refer above.

For the parameters described here the same is true as described for the manipulation functionalities within the drawing panel: When the changes are applied to a primary element, they influence the subsequent elements too. When an additional element is selected there is no feedback to its parent primary element, the changes may override the parents geometry.

7.7.2.3 The Element Tab-Pane

Comparing to the Geometry-Pane this one contains more global parameters of the selected element. Depending on the type of selected element only some of the parameters are accessible:

- Type – this is an informational field and therefore read-only, it displays the type name of the element
- Name – here the name of the element is shown and can be changed; this name is auto-generated when the element is created and shown within this pane and within the element-tree on the main windows right hand side
- Layer – BeamConstruct supports several drawing and displaying layers that can be used to separate parts of the whole project from each other and to make it easier to manage complex projects. These layers can be hidden and shown depending on which has to be visible. Using the combo-box provided here the selected element can be assigned to one of the available layers .For more information please refer the section about the layer tab-pane below.
- Pen – a pen is a definition about how the related geometry has to be processed on the target system; here a pen can be assigned to the current geometry so that is is processed using these specific pen parameters; please refer above for a description of the pen parameters
- Process Geometry – this check-box decides if the related geometry has to be processed or not, when it is not checked the related element acts as some kind of help-drawing only, it is not used by the target system for processing the working piece
- Count X/Y/Z and Distance X/Y/Z – these four parameter fields belong to each other and can be used to create arrays of geometry without the need to duplicate them; here it can be defined how often they have to be repeated in X, Y and Z direction and which distance has to be set between them
- Number of vectors – this is an informational element and can't be changed directly, it displays the number of vector lines that are used to create the selected element
- Total line length – this field contains an information too, here the total length of the geometry is shown; this value takes the “on-”-lines into account only, “off”-lines (movements with the tool turned of to go to the beginning of the next “on”-line) are ignored here
- Process time – here the time is displayed that is needed to process the currently selected element; this value is calculated out of the length of “on”-lines, the length of “off”-lines between them and the speed and delay information of the pen that is assigned to this element

7.7.2.4 The Layer Tab-Pane

Every element can be assigned to exactly one layer. These layers are in no way related to the processing of the data within the target system, but they are a useful utility that makes it easier to handle complex projects.

Within this tab pane two things can be done: layers can be renamed according to their meaning and they can be turned on and off.

When the box in front of a layer is checked, all elements that are assigned to this layer are drawn within the drawing area. Layers that are not checked are not visible within the drawing area, they are hidden and therefore can't be selected or edited.

When a marking process is started out of BeamConstruct the layer visibility states do not have an influence on the marking result. Means also these layers that are currently hidden will be marked.

7.7.3 The Element-Tree

On the main windows right hand side a tree is shown that represents the current projects structure. It consists of a list of primary elements and their (optional) child elements. During processing on the target system the elements are processed in the same order as they are listed there from top to bottom (including their children).

Every primary element may contain several Additional Geometry elements and several Post-Processing Tools. They are listed as child nodes of their Primary Geometry parents within this tree.

All these primary and child nodes can be edited within this tree via a context menu. This menu can be opened by selecting a node within the tree and clicking the right mouse button. Then following functions can be chosen:

- Group Elements – while holding down the Shift- or Ctrl-key it is possible to select a range of elements within the entity tree; in case more than one Primary Geometry element is selected it is possible to put them into a group using this function
- UnGroup Elements – this item can be used when a group element is selected, it resolves the group, pulls all element out of it into the hierarchical level where the group existed before
- Delete Element(s) – deletes an element completely; in case this is applied to a primary element all its sub-elements are removed too
- Duplicate – the currently selected Primary Geometry element is copied and inserted at a position that is slightly shifted according to the original element
- Move To Top – the selected element is moved to the top position within its same hierarchically level (means a child of a primary element will stay a child of it but it will become the first one)
- Move Up – the selected element is moved one position up but also within the same hierarchically level
- Move Down – the selected element is moved one position down within the same hierarchically level
- Move To Bottom – the selected element is moved to the bottom position within its same hierarchically level (means a child of a primary element will stay a child of it but it will become the last one)

7.7.4 Primary Geometry Elements

To create a new primary element following steps have to be performed:

1. select the related button within the tool-bar, all primary elements use blue tool-bar symbols
2. click into the working area to position the element; depending on the geometry that is created by the related function it can be drawn now with some additional clicks into this area
3. now the new element is selected and its parameters are shown within the first, element-specific tab-pane on the main windows left hand side

When the parameters of such an element are changed within its tab-pane, all following elements of the same type use exactly these parameters as default values.

Following the available elements, the steps to create them within the working area and their parameters are described.

7.7.4.1 Dot

This is the most simple element that is possible. When it is selected for drawing within the tool-bar, the first click into the drawing area creates a single point at the left-clicked position.

This element does not offer any parameters, so there are no input fields available within the element-specific tab pane as soon as such a dot is selected.

Within the options the dot can be configured:

- Style – specifies the style of the created point, here Dot is a simple one that consists of a single coordinate and has no size or Custom for a dot as configured within the global parameters

7.7.4.2 Line

When drawing a line two clicks are necessary within the drawing area: the first click specifies the starting position of the line, the second one the end position. It is not necessary to keep the mouse pressed between these two clicks.

After drawing or selecting such a line following parameters are available to manipulate them:

- Line Style – the style the line is created with, here following options exist:
  Continuous: the geometry consists of exactly one starting and one end point where one single line is drawn between
  Connected Lines: the geometry consists of several short lines including additional points between the start and end point, all these lines are connected
  Dashed: the geometry consists of several short lines including additional points between the start and end point, every second line is drawn that results in a dashed line style
  Dotted: no lines are drawn, the geometry consists of a set of not connected dots
  Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the parameter settings
- Distance – whenever a non-continuous line style is selected this distance value specifies the length of the additional points that form the selected line style
- Expand By Dot – expands the line according to the chosen distance-value by one dot (or one line segment)
- Remove Last Dot – removes the last dot or line segment

7.7.4.3 Triangle

To draw a triangle all three corners have to be specified separately by single left mouse clicks for each. First the starting point is defined, with the next click an other corner of the triangle is specified and the last one completes the triangle by setting the third corner of it.

Within the triangles property tab-pane following options are available:

- Line Style – the style the triangles lines are created with, here following options exist:
  Continuous: the geometry consists of exactly tree points that are connected by three completed lines
  Connected Lines: the geometry consists of several short lines connecting the three corners including additional points, all these lines are connected and therefore form a closed shape
  Dashed: the geometry consists of several short lines including additional points between the three corners, every second line is drawn that results in a dashed line style

Dotted: no lines are drawn, the geometry consists of a set of not connected dots
Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the parameter settings

- Distance – whenever a non-continuous line style is selected this distance value specifies the length of the additional points that form the selected line style

7.7.4.4 Rectangle

When drawing a rectangle the upper left and the lower right corner of it are specified by two separate mouse clicks. The resulting rectangle will always be parallel to the currently shown coordinate axis.

Within the rectangles property tab-pane following options are available:

- Line Style – the style the rectangles lines are created with, here following options exist:
  Continuous: the geometry consists of exactly four points that are connected by four completed lines which form a rectangle
  Connected Lines: the geometry consists of several short lines connecting the four corners including additional points, all these lines are connected and therefore form a closed, rectangular shape
  Dashed: the geometry consists of several short lines including additional points between the four corners, every second line is drawn so that it results in a dashed line style
  Dotted: no lines are drawn, the geometry consists of a set of not connected dots
  Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the parameter settings
- Distance – whenever a non-continuous line style is selected this distance value specifies the length of the additional points that form the selected line style

7.7.4.5 Circle

This primary element can be used to create circles and arcs. Starting point is always a circle that is drawn in two steps: the first left mouse click into the drawing area specifies the centre point of it, the second one specifies the radius (via its distance from the first point).

Next the circle can be modified further:

- Line Style – the style the circle is created with, here following options exist:
  Continuous: the geometry consists of several short, fully connected lines that form a closed circle; for this mode the parameter “Segments” specifies how much of these short lines are used to create this circle, the more lines are used the more smooth the circle becomes
  Connected Lines: the geometry consists of several short lines that form the circle, comparing to the previous option here the parameter “Distance” influences the length of these lines and therefore the resolution; here the shorter the lines are the more segments this circle consists of and the more smooth it becomes
  Dashed (Arcs): the circle consists of dashes where the dashes are not straight lines but follow the shape of the circle and therefore are round
  Dashed (Straights): the circle consists of dashes where the dashes do not follow the shape of the circle but are straight lines
  Dotted: no lines are drawn, the geometry consists of a set of not connected dots
  Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the parameter settings
- Distance – this parameter decides how long the resulting lines of the chosen line style have to be, it is not valid for the continuous line style where the length would be always equal to the circumference
- Radius – the radius of the circle
- Segments – here it can be chosen how much segments the circle has to consist of, this parameter influences the accuracy of the resulting circle; for the line style “Dashed (Arcs)” it influences the

smoothness of the resulting arcs while the “Distance”-parameter influences their length

- Start Angle and End Angle – these two parameters can be used to change the circles starting and end angle, it can be used to draw arcs (in case the resulting total angle is smaller than 360 degrees) or to let a circle be drawn several times (in case the resulting total angle is a multiple of 360 degrees)
- Grow: this parameter is valid in 3D mode only; it defines how much the circle shall grow in the third direction per every rotation of it. Here “third direction” does not necessarily mean Z-direction, this depends on the view the circle is drawn in. So in case the right side view is enabled the circle extends in Y and Z direction, resulting from that the third direction where the grow parameter applies to is the X direction.
- Layered Sphere: in 3D mode this option can be used to create a sphere that consists of circles of different diameters that form a sphere; to use this option the Grow value has to be set which specifies the distance between the circles that form the sphere
- Draw CCW – normally the circle has an clockwise orientation, means it is drawn to right direction; when this check box is set, the drawing direction is reversed

7.7.4.6 Star

This element is a special variant of a circle, it consists of two radii where every second point the element consists of, belongs to an other radius. Resulting from that stars can be drawn and modified by its parameters. Such a star is drawn in two steps: the first left mouse click into the drawing area specifies the centre point of it, the second one specifies the first radius. While drawing the star the second radius is set automatically to value smaller than the first radius.

After the star is drawn it still can be modified interactively. Here every second point (the ones that belong to the second radius) is marked by a small, blue cross. This cross can be dragged with the mouse in order to change the second radius independent from the first one and in order to apply an offset to the angle of these points.

Next the star can be modified via its options:

- Line Style – the style the circle is created with, here following options exist:
  Continuous: the geometry consists of single, continuous lines
  Connected Lines: the geometry consists of several short lines including additional points, all these lines are connected
  Dashed: the geometry consists of several short lines including additional points, every second line is drawn that results in a dashed line style
  Dotted: no lines are drawn, the geometry consists of a set of not connected dots
  Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the parameter settings
- Distance – this parameter decides how long the resulting lines of the chosen line style have to be, it is not valid for the continuous line style
- Radius 1 – the first radius that is valid for all odd-numbered points
- Radius 2 – the second radius that is valid for all even-numbered points
- Spikes – here it can be chosen how much spikes (or rays) the star shall have,
- Angle offset – here an offset can be specified for the points that are assigned to the second radius in order to create non-regular spikes
- Draw CCW – normally the star has an clockwise orientation, means it is drawn to right direction; when this check box is set, the drawing direction is reversed

7.7.4.7 Spiral

This primary element can be used to create spirals. Starting point is always a spiral that is drawn in two steps: the first left mouse click into the drawing area specifies the centre point of it, the second one specifies the outer radius.

Next the spiral can be modified via its options:

- Line Style – the style the spiral is created with, here following options exist:
  Continuous: the geometry consists of several short, fully connected lines that form a continuous spiral; for this mode the parameter “Segments” specifies how much of these short lines are used to create this spiral, the more lines are used the more smooth the resulting spiral becomes
  Connected Lines: the geometry consists of several short lines that form the spiral, comparing to the previous option here the parameter “Distance” influences the length of these lines and therefore the resolution; here the shorter the lines are the more segments this spiral consists of and the more smooth it becomes
  Dashed (Arcs): the spiral consists of dashes where the dashes are not straight lines but follow the shape of the spiral and therefore are round
  Dashed (Straights): the spiral consists of dashes where the dashes do not follow the shape of the spiral but are straight lines
  Dotted: no lines are drawn, the geometry consists of a set of not connected dots
  Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the parameter settings
- Distance – this parameter decides how long the resulting lines of the chosen line style have to be, it is not valid for the continuous line style where the length would be always equal to the circumference
- Inner Radius – the inner, minimum radius of the spiral
- Outer Radius – the outer, maximum radius of the spiral
- Slope – this value defines the steepness of the spiral, its value influences how strong it rises per rotation
- Segments – here it can be chosen how much segments the outer part of the spiral has to consist of, this parameter influences the accuracy of the result; for the line style “Dashed (Arcs)” it influences the smoothness of the resulting arcs while the “Distance”-parameter influences their length
- Smoothing Factor – normally a spiral is generated out of short lines where the length is calculated out of the number of segments and the current radius. This leads to an adaptive line length with as less as much data and an as fast as possible, resulting process time. But in some cases this may lead to spirals that are not very smooth but angular at their inner radius. Here the number of segments could be increased (what would lead to a much higher amount of data used because of smoother corners also at curves where it would not be possible) or the smoothing factor can be set to values greater 1.0: this changes the calculation of a spiral in a way where the inner line length becomes shorter and therefore more smooth while not using more data than necessary. So the more smoothing factor is taken for the calculation the smaller the radius becomes.
- Start Angle – this parameters can be used to change the spirals starting angle
- Grow: this parameter is valid in 3D mode only; it defines how much the spiral shall grow in the third direction per every segment. Here “third direction” does not necessarily mean Z-direction, this depends on the view the spiral is drawn in. So in case the front side view is enabled the spiral extends in X and Z direction, resulting from that the third direction where the grow parameter applies to is the Y direction.
- Draw CCW – normally a spiral has an clockwise orientation, means it is drawn from its starting point to right direction; when this check box is set, the drawing direction is reversed
- Inside To Outside – this option influences the growing direction, when the check box is set, drawing of the spiral starts at the inner side and ends outside; in case it is not set it starts at the outer side and ends at the inner

7.7.4.8 Polygon

A polygon consists of a undefined number of edges (but requires at least three). Drawing it can be done by

left clicking at the position where a corner between the connecting lines has to be positioned. This can be done several times, the process of drawing this polygon can be finished by right-clicking the mouse. Then the last corner and the first position where the user left-clicked are connected by a line.

Following options are available to modify the parameters of the polygon:

- Line Style – the style the polygons lines is created with, here following options exist:
  Continuous: the geometry consists of lines that use exactly one starting and one end point where one single line is drawn between
  Connected Lines: the geometry consists of several short lines including additional points, all these lines are connected
  Dashed: the geometry consists of several short lines including additional points, every second line is drawn that results in a dashed line style
  Dotted: no lines are drawn, the geometry consists of a set of not connected dots
  Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the parameter settings
- Distance – whenever a non-continuous line style is selected this distance value specifies the length of the additional points that form the selected line style
- Polygon Style – here it can be chosen if the last polygon point and the first one are connected by a line (style “Closed”) or not (style “Open”)

7.7.4.9 Bezier Curve

Creation and parameters of this element are very similar to the polygon described above but it does not generate direct connections between the specified base points. Using this element a smooth, round Bezier curve is generated. This curve uses the given base points as creation hint but does not necessarily cross them.

Such a Bezier curve consists of a undefined number of base points but requires at least three of them. Specifying the position of these base points can be done by left clicking within the drawing area. This can be done several times, the process of drawing the related curve has to be finished by right-clicking the mouse.

After that the positions of the base points still can be modified interactively. As long as this element is selected the real position of the base points are marked by blue crosses. These crosses can be dragged with the mouse. Changing the position of the base points also changes the appearance of the resulting Bezier curve.

Following parameters are available to modify the parameters of the Bezier curve:

- Line Style – the style the polygons lines is created with, here following options exist:
  Continuous: the geometry consists of continuous lines that consist of a number of sub-segments which are specified by the parameter “Resolution”
  Connected Lines: the geometry consists of several short lines of a defined length including additional points, all these lines are connected
  Dashed: the geometry consists of several short lines of a defined length including additional points, every second line is drawn that results in a dashed line style
  Dotted: no lines are drawn, the geometry consists of a set of not connected dots
  Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the parameter settings
- Distance – whenever a non-continuous line style is selected this distance value specifies the length of the additional points that form the selected line style
- Bezier Style – here it can be chosen if the last polygon point and the first one are connected by a line (style “Closed”) or not (style “Open”)
- Resolution: this parameter specifies the smoothness of the Bezier line, the bigger it is the more sub-lines are used to create such a curve, the more smooth it becomes and the more resources are used for it

7.7.4.10 Text

This primary geometry can be used to draw some text using an existing true type font. This element accepts static texts or dynamic values that can be set via an Input Element. When such a project is moved from one computer to an other or from one operating system to an other it has to be made sure a used font is available on the other system too. Otherwise the application tries to find a similar font which might be only somehow similar, but exact positions, sizes and outlines may be got lost in such a case.

Drawing such a text is quite easy: only one single click into the drawing area is necessary to specify the position of the text, there a new geometry is set using a default text. This text can be changed together with some other parameters:

- Line Style – the style the lines the text consists of is created with, here following options exist:
  Continuous: the geometry consists of closed, connected lines with as less as possible points
  Connected Lines: the geometry consists of several short lines including additional points, all these lines are connected
  Dashed: the geometry consists of several short lines including additional points, every second line is drawn that results in a dashed line style
  Dotted: no lines are drawn, the geometry consists of a set of not connected dots
  Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the parameter settings
- Distance – whenever a non-continuous line style is selected this distance value specifies the length of the additional points that form the selected line style
- Text – here the text can be specified that has to be drawn
- Font Type – here the type of font that has to be used for this text element can be chosen, following options are available to select from:
  TrueType: the standard fonts that are installed on the system can be used, when this option is selected the combo box directly below of this one is enabled to select a font out of it; all these fonts are in no way optimised for output via a laser scanner system, their intended target is publishing, therefore their lines and paths are optimised for quality which may result in a slow output
  Laser Vector: this special type of fonts is optimised for laser marking operations. They consist of as less as possible lines and are designed for single-lined outputs like they are done with lasers. Using these fonts marking of texts is much faster than with the TrueType fonts. When this font type is selected the font list below of this combo box is modified to show the available laser fonts to choose from.
- Font – this list of available fonts can be used to select a specific font and style for the text. Depending on the font type chosen above, here a specific font can be selected. In TrueType mode the number and types of available fonts depends on the operation system and which ones are installed there. In Laser Vector mode the internal laser fonts are listed here, these fonts are delivered with BeamConstruct and do not depend on the fonts installed on the system.
- Alignment – the text is always drawn from a fixed position that is specified by the left mouse click when setting the text initially; using this list it can be chosen how the text has to be aligned to this position (left, centred or right)
- Orientation – this list specifies the direction the single characters of the text have to be drawn
- Spacing – this value can be used to modify the distance between the characters; here a value of 100% is the distance that is specified by the used font, smaller values set the characters closer to each other, larger ones stretch it to a bigger distance
- Kerning – this value can be used to influence the kerning distance for fonts that support it, here 100% is equal to the kerning value that it specified by the font, bigger values set the characters with a kerning value closer to each other, values smaller than 100% set a bigger distance between them; this parameter is different to the “Spacing”-value, it only influences character-combinations where kerning is defined for
- Arc Length – when creating geometry out of the available font information depending on the style of the chosen font different round parts have to be created (like the two arcs that are needed for creating a letter “B”). This parameter specifies the segment length for these round parts, the smaller it is the more accurate the result is but the more data are used to hold it.

- Set Monospaced – when this option is checked equal distance is set between all characters independent from their shape and independent from the distance information of the used font

To create radial text this element can be combined with the Curve Post-Processing Tool (please refer below)

7.7.4.11 Barcode

Using this function several types of 1D and 2D barcodes can be created. This element accepts static data for creating a barcode or dynamic values that can be set via an Input Element. The size of the created barcode can be defined freely, when creating this element a rectangle is drawn exactly in the same way like it is done for the Rectangle Primary Element. This rectangle describes the outline of the barcode. For some barcode types that use a fixed aspect ratio between width and height the predefined outline is modified automatically.

The complete layout and structure of the barcode is defined via the parameters that can be set within the elements tab-pane:

- Data – the text or numeric data that are encoded within the barcode, here it depends on the chosen barcode type if and which characters, numbers or combinations of them are allowed and will result in a valid barcode
- Type – here the type of barcode can be chosen, depending on this type several of the following options are available and can be used for further definitions that are necessary for this type
- Mode – this is a barcode-type-specific option, here an encoding mode can be chosen for some of the barcodes
- Error Correction – this is a barcode-type-specific option, here an error-correction level can be set
- Size – this is a barcode-type-specific option, here the resulting size can be specified (which not influences the dimension of the barcode but the encoded data size)
- Bar Width – this parameter influences 1D barcodes only, here the size of the resulting bar lines can be modified; this value might be changed depending on the method of material processing in order to get a readable barcode
- Segments – this parameter is used only for the Maxicode barcode, it specifies the number of segments and therefore the smoothness of its circles
- Fade In Size – this parameter is used for inverted barcodes, it defines the size of the additional frame that is drawn around the barcode to get an inverted representation
- Force to Square – this option applies to DataMatrix barcodes only, in case it is set the resulting barcode is always a square and never a rectangle
- Merge Cells – several barcode types may consist of cells (rectangles or squares) that are located directly beside each other; this option merges such cells wherever that is possible without destroying the barcode information, it can be used to save vector data
- Draw Cells as Dots – when this option is enabled the cells some barcode types consist of are replaced by plain dots
- Draw Cells as Custom Dots – when this option is enabled the cells some barcode types consist of are replaced by the custom dot geometry as defined within the settings
- Invert – barcodes created by this element consist only of the outlines, together with the Hatching Additional Geometry element these outlines can be filled. Depending on the used material processing method these filled areas may result in lighter or darker areas. In case the result is not readable by barcode scanners the light and dark areas can be exchanged by this option, here an additional border is drawn around the barcode so that the hatching function generates an inverted fill pattern

7.7.4.12 Delay

This element does not have a visual representation, it does not accept any additional data or post-processing but it can be used to influence the material processing. The elements of a project are processed in the order they appear within the Element Tree. At the position where this element is added, the full process is delayed for the given time. Thus this element can be used whenever a delay is necessary e.g. to let material become dry, let material become colder or whatever.

This element expects exactly one parameter:

- Delay – the delay (in unit seconds) the full process has to stop

7.7.4.13 Motion

This element does not have a visual representation, it does not accept any additional data or post-processing elements but it can be used to influence the material processing in general. The elements of a project are processed in the order they appear within the entity tree. At the position where this element is placed additional motion axes (apart from the axes of the used scanner) can be driven. These axes have to be connected with the two additional CTRL-outputs of the “BeamConstruct to Control”-plug-in within an ControlRoom project that makes use of this BEAMP-file.

The motion can be influenced by the parameters that have to be set for this element. First of all up to three axes can be controlled by the element using following parameters:

- Enable – specifies if an axis has to be changed by the following parameters or if it has to be left untouched, axes that are not enabled stay at their current position
- Position – the new position to move the axis to
- Speed – the speed for the movement to the given position
- Relative – defines a non-absolute movement, means the axis does not drive to the given position but changes it current position by the given distance
- Stop Axis – the motion of an axis is stopped immediately, this option is available only for motion controllers that support this function and ignores the given position and speed values
- Move axes to home-position – the axis is moved to its home / reference position, this option is available only for motion controllers that support this function and ignores the given position and speed values

All other parameters influence the whole motion element:

- Pre-Motion Delay – this delay is done before the motion is triggered
- Use Control Output – the “BeamConstruct to Control”-plug-in provides two CTRL-outputs where motion control data can be emitted, this option gives the possibility to define which of both outputs OUT2 or OUT3 have to emit the motion information defined for this element

7.7.4.14 Custom Output

Most scanner controller cards provide several analogue and/or digital outputs. As soon as a scanner controller card is configured within the project settings this element can be used to send values to these outputs. This Primary Element does not contain any geometry so clicking the related tool-bar button immediately adds it to the current project.

The exact layout of the related property pane highly depends on the capabilities of the used scanner controller card. There options are shown depending on the outputs the used card provides.

So it is possible that following types of outputs can be enabled for modification and set within this element:

- Laserport – a numerical value according to the valid range of the laserport (e.g. 0..255) can be entered, this value is sent to the card during processing in case the related check box is enabled
- Digital – several buttons are shown that influence the related output ports bits and can be toggled

into different states: “X” means this bit is left unchanged, “1” sets a bit to HIGH and “0” clears it; here the first button is the highest bit while the last button is always bit 0

- Analogue – a numerical value according to the resolution of the analogue output (e.g. 0..1023) can be entered, this value is sent to the card during processing in case the related check box is enabled
- Pulse Output – when this option is not set the output(s) simply is/are set according to the settings that are done above. In case this option is enabled and a time in unit milliseconds is given, the output it switched to the defined state only for this time, after that it is set back to its previous state. So this option can be used to emit only pulsed signals instead of a permanent output value.

PLEASE NOTE: The scanner controller hard has to be set up and configured BEFORE this element is used for the first time. This is necessary because the capabilities of the scanner controller card need to be known for this element so that it can show the correct output options that belong to the card. When a completely different scanner controller card is selected for a project it is necessary to save this project, close and restart the application to force a re-initialisation, load the project again and then check if all Custom Output elements still use the correct ports and values.

7.7.4.15 External Trigger

This element does not contain geometry and does not offer any options. So after clicking the related tool-bar symbol it is added to the project immediately. Whenever the project reaches this position during execution, all output is stopped until an external trigger signal is detected. Here the external trigger according to the used scanner controller cards capability is used.

PLEASE NOTE: starting the geometry after a trigger is received is done by the scanner controller, the time between detection of the external trigger signal and output of the next geometry depends on the used scanner card and typically is less than some microseconds.
Waiting for a trigger after the last geometry has been sent (or after the last Primary Element was processed completely) is controlled by the application. Here the reaction time highly depends on the used operating system and the available computing power. So it is recommended to ensure a gap of of at least 20 milliseconds after the last element was processed until the external trigger may appear.

7.7.4.16 Z-Shifter

This element does not have a visual representation but is somehow similar to the motion primary element. It does not accept any additional data or post-processing elements but it can be used to influence the material processing in general by changing the lasers focus. The elements of a project are processed in the order they appear within the entity tree. At the position where this element is placed, a focus shifter or beam expander is accessed. These axes have to be connected with the two additional CTRL-outputs of the “BeamConstruct to Control”-plug-in within an ControlRoom project that makes use of this BEAMP-file. In case only BeamConstruct is used, the related Z-Shifter plug-in has to be configured in projects hardware settings.

The focus/z-position can be influenced by the parameters that have to be set for this element:

- Position – the new position to move the z-position to
- Speed – the speed for the movement to the given position
- Relative – defines a non-absolute movement, means the axis does not drive to the given position but changes it current position by the given distance
- Move axes to home-position – the axis is moved to its home / reference position, this option is available only for motion controllers that support this function and ignores the given position and speed values

All other parameters influence the whole motion element:

- Pre-Motion Delay – this delay is done before the motion is triggered

7.7.5 Additional Geometry Elements

Additional Geometry elements add new geometry based on the already available geometry of the primary element it belongs to. Here the additional element only takes care of the primary one, it ignores possibly existing, other additional elements that might exist for the same primary element.

To add an Additional Geometry element to a existing Primary Geometry the drawing area doesn't has to be used, here the desired primary element has to be selected within the element tree, then the additional element has to be clicked within the tool-bar. There the Additional Geometry elements are shown in violet colour and are added to the Primary Geometry element as soon as the tool-bar item is clicked.

7.7.5.1 Hatcher

Hatching is the process of filling a closed polygon with a specific line pattern. This can be used to process a bigger area. It can be useful e.g. combined with texts to get characters that consist not only of its outline.

Hatching will work only with closed polygons and might fail on specific geometries that do not describe a closed area non-ambiguous. In such cases the resulting hatch pattern may be incomplete or may be located outside of the polygon.

In general only two-dimensional geometry can be hatched, lines and dots are not extended by this element. As an other condition a polygon can be hatched only at positions where the outline has a closed line style, geometry with dotted lines can't be hatched, geometry with a dashed outline is hatched only at positions where a line is drawn.

Also in case 3D mode or 3D geometry is used the hatcher offers a 2D-functionality only but it can be applied to 3D elements. In such cases the hatcher always uses the geometry in X and Y direction (similar to the top view) and ignores the Z-value to create the hatch pattern. After this pattern is generated the Z-information out of the lines they start from/end at are used to modify the hatch lines. This results in perfect 3D hatch patterns in most cases but may have unexpected results when complex geometries are combined with more advanced hatch options (like beam compensation or inner hatch lines).

The hatcher offers following parameters:

- Line Style – the style the lines the text consists of is created with, here following options exist:
  Continuous: the geometry consists of closed, connected lines with as less as possible points
  Connected Lines: the geometry consists of several short lines including additional points, all these lines are connected
  Dashed (simple): the geometry consists of several short lines including additional points, every second line is drawn that results in a dashed line style; this mode starts with a line at every beginning of a hatch line
  Dashed (interleaved): the geometry consists of several short lines including additional points, every second line is drawn that results in a dashed line style; this mode starts with a line and a space alternative at every new beginning of a hatch line
  Dashed (continuous): the geometry consists of several short lines including additional points, every second line is drawn that results in a dashed line style; this mode starts with a line or a space at the next beginning of a hatch line depending on the previous hatch line, the pattern is kept continuous
  Dotted: no lines are drawn, the geometry consists of a set of not connected dots
  Dotted (Custom): no lines are drawn, the geometry consists of a set of not connected points in custom dot style as configured within the parameter settings
- Distance – whenever a non-continuous line style is selected this distance value specifies the length of the additional points that form the selected line style
- Hatch Style – here the hatching mode is defined, depending on the selection made here a different pattern is used to fill a polygon
  Lines, forward – filling is done with parallel lines that go all into the same direction
  Lines, forward/backward – the polygon is filled with parallel lines that change their direction

Connected lines – this mode extends the previous one, here the parallel lines are connected and form some kind of waved lines
Zig-zag – these lines are no longer parallel, they exchange their direction alternative and are connected at their ends directly
Inner lines – this mode repeats the outline of the hatched polygon in its inner side as often as it fits with the chosen hatch distance

- Hatch Angle – this angle specifies the orientation of the hatch lines according to the coordinate system
- Angle Offset – this parameter applies only in case the hatcher is set as sub-element of a group that contains more than one geometric element to be hatched; in this case only the first primary element within that group is hatched with the original hatch angle, for all following elements the hatch angle is modified by this offset. So this parameter can be used to have some kind of rotating hatch angle for several elements that are concatenated together within a group.
- Hatch Distance – this is the distance that is kept between the hatching lines, for the zig-zag hatching mode it applies to the ends of the lines
- Hatch Offset – normally hatching starts at the border of a polygon; this parameter allows to specify an offset (in positive and negative direction) to modify the position where hatching really starts
- Beam Compensation – the laser beam that is used to process a working piece itself has an own size that results in the width of the lines that are processed by it; for the hatcher it might be necessary to compensate this lasers spot size to avoid parts of the working piece to be processed more than once by the overlapping beam, this compensation can be chosen here:
  Use spotsize from pen – here the tool compensation sizes are calculated automatically out of the spot sizes of the used pens
  Custom –when this option is used a custom value for compensation can be entered

7.7.6 Post-processing Tool Elements

The Post-Processing Tools influence all geometric elements that are located on an earlier position within the Element Tree on the windows right hand side. So the manipulation of geometry that is done by such a tool is always applied to the Primary Geometry element it belongs to and to all previously applied Additional Geometry elements of this primary one. Additional elements that follow a tool are not changed, they apply their additional geometry to the modified geometry.

Post-Processing Tools are symbolised by red tool-bar buttons and can be added to a primary element simply by clicking this tool-bar button. To do that the related Primary Geometry element has to be selected within the Element Tree.

Post-Processing Tools do not add any new points or lines to existing geometry, thus it requires an outline that consists of lines that are short enough to let the tool apply its function, elsewhere the result would not look like expected. So within the parameters of the elements that have to be modified the line-.style has to be set to a non-continuous mode (for an example connected lines, dashed lines or dots with a small distance should be used here).

7.7.6.1 Sine Distortion

This Post-processing Tool applies a sine waveform to existing geometry. This tool does not add any new points or lines to existing geometry, thus it requires an outline that consists of lines that are much shorter than the wavelength. Elsewhere the result would not look like a real sine waveform.

Following parameters can be set for this tool:

- Direction – the direction the waveform has to be applied to, beside the two values that are relevant for 2D data (“Horizontal” sets a sine parallel to X-axis, “Vertical” sets a waveform parallel to Y-axis) four additional options are available that are relevant for 3D data only. These options can be used to specify the direction of the amplitude and the direction the wave grows into

- Wavelength – the length of a single wave
- Amplitude – the amplitude of the sine wave
- Offset – an offset that defines at which position within the wave the sine calculation has to be started, this offset can be used to shift the waveform

7.7.6.2 Curve Distortion

Using this tool an existing geometry can be bent around a defined centre point to get a radial, round shape. It is useful e.g. in combination with the Text Primary Geometry element to define radial texts. Curve distortion is available for 2D elements only, it can be applied to three-dimensional geometry too but its distortion is always done in X and Y direction with an axis around Z (similar to the top view)

This tool does not add any new points or lines to existing geometry, thus it requires an outline that consists of lines that are short enough for a result that looks like an bent outline.

Following parameters can be used to influence the result:

- Alignment – this field specifies where the centre point is located relative to the geometry that has to be processed
- Radius – the radius of the circle the geometry is bent to, this is the distance from the middle of the geometry to the radial centre point
- Angle Offset – an offset for the bending angle starting point, using this value the geometry can be shifted

7.7.7 Data Input Elements

This type of element influences geometry only in a very indirect way, it provides data that can be used by Primary Geometry elements to create their geometry. So all types of Primary Geometry elements that accept such input data can be combined with all types of Data Input elements. Of course it is not possible to have more than one Data Input element per Primary Geometry element.

To add such a Data Input element the Primary Geometry element has to be selected within the Entity Tree. Next the green tool-bar symbol of the Data Input has to be clicked to assign it to the Primary Geometry element.

7.7.7.1 OpenAPC Data Input

This input can't be previewed within the editor of BeamConstruct. It expects input data when the BeamConstruct project file is running within an ControlRoom project. This can be done by using the “BeamConstruct to Control” plug-in. This plug-in provides three Char-inputs IN2, IN3 and IN4. Data that are set at this input are used by this Data Input element to modify the assigned Primary Geometry element. This way a BeamConstruct-project can be changed dynamically directly within an ControlRoom project.

Because the data are provided by the ControlRoom project here, only the input has to be defined that has to be used for setting data into the BeamConstruct project. Whenever new Char-data arrive at this input within a ControlRoom environment they are used to re-create the assigned Primary Geometry element for the next marking cycle.

7.7.7.2 Serial/Date/Time

This is a very complex Data Input element that can be used to generate numbers, date or time informations or combinations of them. The result can be used to create e.g. serial numbers, “best-before” information or others within a text or a bar code – depending on the Primary Geometry element where this input is assigned to.

The Data itself are updated before the next material processing cycle is started. Depending on the used configuration this update increments/decrements the serial number and/or updates the date or time information to represent the current time.

Following parameters can be used to influence the resulting data and their behaviour:

- Start Value – the starting value where the serial number has to count from when the project is loaded initially
- Reset At – here a number can be defined that is used as limit for the serial number, as soon as the current serial number is equal to the value given here the serial number is reset to the start value defined above
- Increment – the value the serial number has to be incremented by for every update; this value can be negative which results in a decrement for every cycle
- Beat Count – this number specifies for the number of cycles a serial number has to be left unchanged until it is updated, here a value of three – as an example – would mean, a serial number is updated and incremented only at every third marking cycle
- Beat Offset – this parameter corresponds to the preceding one, it adds an offset to the beat count, means it defines at which number it has to be started to count for the number of Beat Counts
- Numeric Base – by default a serial number consists of numeral values in range 0..9 which means the numeric base is 10; this parameter can be used to define any other numeric base so that less numeral values are used (Numeric Base < 10) or in a way where letters in range A..Z are added for counting the serial number (Numeric Base >10)
- Minimum Digits – this parameter specifies the number of digits a serial number has to consist of at minimum – independent from their real value; in case a number would have less digits than specified here, it would be filled with one or more preceding zeros
- Time Offset – here an offset can be specified using freely selectable numbers of years, days, hours and minutes, this offset is added to the time information that can be incorporated into the resulting data and can be used e.g. to define a best-before date counted from the current date/time
- Format String – this format string defines the layout and contents of the resulting data which are handed over to the assigned Primary Geometry element. Here any desired text can be added and combined with some place-holders which are replaced by serial number or date or time information. Here following place-holders are possible:
  - $S – this string is replaced by the serial number as defined with the parameters above
  - %A – is replaced by national representation of the full weekday name
  - %a – is replaced by national representation of the abbreviated weekday name
  - %B – is replaced by national representation of the full month name
  - %b and %h – are replaced by national representation of the abbreviated month name
  - %C – is replaced by the year divided by 100
  - %c – is replaced by national representation of time and date
  - %D – is equivalent to "%m/%d/%y"
  - %d – is replaced by the day of the month as a decimal number (01..31)
  - %e – is replaced by the day of month as a decimal number (1..31); single digits are preceded by a blank
  - %F – is equivalent to "%Y-%m-%d"
  - %G – is replaced by a year as a decimal number with century. This year is the one that contains the greater part of the week (Monday as the first day of the week)
  - %g – is replaced by the same year as in "%G", but as a decimal number without century (00..99)
  - %H – is replaced by the hour (24-hour clock) as a decimal number (00..23)
  - %I – is replaced by the hour (12-hour clock) as a decimal number (01..12)
  - %j – is replaced by the day of the year as a decimal number (001..366)
  - %k – is replaced by the hour (24-hour clock) as a decimal number (0..23); single digits are preceded by a blank
  - %l – is replaced by the hour (12-hour clock) as a decimal number (1..12); single digits are preceded

by a blank
- %M – is replaced by the minute as a decimal number (00..59)
- %m – is replaced by the month as a decimal number (01..12)
- %p – is replaced by national representation of either "ante meridiem" ("AM") or "post meridiem" ("PM") as appropriate
- %R – is equivalent to "%H:%M"
- %r – is equivalent to "%I:%M:%S %p"
- %S – is replaced by the second as a decimal number (00..60)
- %s – is replaced by the number of seconds since January 1st, 1970, 00:00 o'clock, UTC
- %T – is equivalent to "%H:%M:%S"
- %U – is replaced by the week number of the year (Sunday as the first day of the week) as a decimal number (00..53)
- %u – is replaced by the weekday (Monday as the first day of the week) as a decimal number (1..7)
- %V – is replaced by the week number of the year (Monday as the first day of the week) as a decimal number (01..53). If the week containing January 1st has four or more days in the new year, then it is week 1; otherwise it is the last week of the previous year, and the next week is week 1.
- %v – is equivalent to "%e-%b-%Y"
- %W – is replaced by the week number of the year (Monday as the first day of the week) as a decimal number (00..53)
- %w – is replaced by the weekday (Sunday as the first day of the week) as a decimal number (0..6)
- %X – is replaced by national representation of the time
- %x – is replaced by national representation of the date
- %Y – is replaced by the year with century as a decimal number
- %y – is replaced by the year without century as a decimal number (00..99)
- %Z – is replaced by the time zone name
- %z – is replaced by the time zone offset from UTC; a leading plus sign stands for east of UTC, a minus sign for west of UTC, hours and minutes follow with two digits each and no delimiter between them
- %+ – is replaced by national representation of the date and time

– Locale – some of the date/time place holders are replaced by information that depend on a language and or on local specialities; using this parameter the locale can be chosen that has to be used for these time information

7.8 Edit Geometry

Geometries are mainly generated by Primary Geometry elements. Whenever the parameters of such an element are changed the geometry is re-created and all assigned Additional and Post-Processing Elements are executed again to apply their modifications to this new geometry. Thus modifications that are done for single vectors get lost as soon as such modifications are done. Nevertheless it is possible to perform such modifications in case one of the two conditions are met:

– the parameters of the elements that create a geometry are not touched

– a geometry is converted to a static one where no Primary Geometry element with variable parameters is available and where no Additional Geometry or no Post-Processing Element is assigned

Functions to edit geometries can be found at two places: in menu “Edit” and its sub-menus “Non-Destructive” and “Destructive” within the main window and within the context menu of the drawing area that opens when an element is selected and the right mouse button is clicked.

7.8.1 Edit Vectors

Editing of one or more separate vectors requires selection of these vectors. This can be done within the Coordinates-list of the Geometry-tab-pane when an element is selected. Here following functions are available:

- Delete selected Points – all selected points are deleted, resulting from that the lines between them are removed too
- Delete selected Lines – all lines between the selected points are removed, the points itself are left untouched
- Insert point before – a new point is added in the middle between the currently selected point ant its preceding one
- Insert point after – a new point is added in the middle between the currently selected point ant its subsequent one

7.8.2 Edit Non-Destructive

The non-destructive editing functions perform modifications that leave the geometries and the elements they are created from untouched. Some of them are available also from within the context menu of the Element Tree. Alternatively they can be found in Menu “Edit” sub-menu “Non-Destructive” and require at least one element to be selected:

- Group – several selected Primary Geometry elements are concatenated together within a group
- Group to Active Split – using this function geometries that are larger than the available working area can be cut into smaller pieces and processed step by step using an additional drive; for more information please refer the related section below
- Group to Active Move – here full geometries can be processed repeatedly and combined with movements so that the same geometry is arranged in tiles or at the circumference of a ring several times; for more information please refer the related section below
- UnGroup – an existing group of elements is removed, the contents of the group are put out of it
- Duplicate – a copy of the currently selected element is created, the copy is 100% identically to its original (except its position, it is placed a bit above the original element)

7.8.2.1 Active Split Group

This is a special kind of group that concatenates several elements into one group. Due to the kind of this group it is recommended to use only geometries and scanner bitmaps and not to put other ones like motion elements into it.

An Active Split Group is able to handle geometries and bitmaps that are larger than the available working space. It cuts them into smaller pieces and combines them with motion control information so that these large and cut geometries and bitmaps can be put together during processing. So this functionality can be used to handle big working pieces that e.g. are moved by a XY-table. The cutting operation only applies to X-Y-direction (equal to top view).

An other application is processing on the surface of rings, here a special radial mode is supported. This mode gives the possibility to cut geometries into segments and to process the whole ring (inner or outer side).

As soon as some geometric elements are grouped together within such an Active Split Group it's behaviour can be modified using the parameters that are available within the property panel of this group:

- Split horizontal – splits the grouped geometry along X axis, this option can be combined with “Split vertical” to define two-dimensional movements
- Split distance – the split size in horizontal direction
- Split vertical – splits the grouped geometry along Y axis, this option can be combined with “Split horizontal” to define two-dimensional movements
- Split distance – the split size in vertical direction

- Split radial – defines a splitting operation onto a ring, this option can not be combined with one of the previous splitting direction modes
- Direction – specifies the direction for the rotational splitting, here it can be chosen between “Horizontal” and “Vertical”, the axis that is assigned to this direction has to be aligned properly
- Diameter – the total diameter of the ring where the split pieces have to be marked at
- Split angle – the movement angle for every split, the size of the single split pieces result out of this angle and the diameter of the ring
- Keystone correction – when marking the inner side of a ring the laser beam has to be slanted in order to hit only the lower inner side of the ring and not the upper outer side too. Resulting from that the length of the beam varies dependent on the X/Y position of the geometry which results in a distortion when no special optic is used.
  Using the keystone correction this distortion can be suppressed so that the marking result will look like expected. This correction is done by setting an as a percentage correction factor and by defining the side of the geometry this factor may apply to. The correction factor specifies how much the geometry shall grow or shrink according to its original size at the outer position where the full distortion has to be expected.
- Invert motion direction – this option has to be used in case the inner side of a ring needs to be processed, there an inverted motion direction is required to concatenate the pieces in correct order
- Process order – this order applies to the planar splitting modes and defines in which order the pieces have to be processed:
  Left to right – horizontal direction always starts from left
  Right to left – horizontal direction always starts from right
  Zig-zag from left – horizontal direction starts from left and performs zig-zag movements
  Zig-zag from right - horizontaldirection starts from right and performs zig-zag movements
  Top to bottom – vertical movement starts from top
  Bottom to top – vertical movement starts from bottom
  In case two-dimensional motion is defined both process order selections are combined with each other to describe the 2D motion.
- Motion speed: the movement speed in unit mm/sec or degrees/sec that is applied to the motion between the splits.
- Overlap splits: here an as a percentage value can be set that specifies how much the pieces should overlap, means how much of the geometry should exists twice so that it is processed two times at the areas of intersection
- Try split between pieces – here the splitting algorithm tries to find empty spaces between geometries to avoid cutting of lines; in case this option is set the specified split distance or split angle is used as maximum value: a cut is set wherever space between geometries is found or latest after the given split distance/split angle. In last case cutting of lines is still done. So in this mode split distance/split angle define the absolute maximum size of a resulting piece while the distances where the geometry are cut really can be smaller than this.
- Axis mapping: at the lower end of the property panel a matrix of radio buttons exists where the axes can be mapped to the related movements, there it can be specified which of the axes A, B or C of the two possible outputs OUT2 and OUT3 have to provide the related planar movements in horizontal or vertical direction or the angular movement.
  Later, when such a project has to be used within a ControlRoom project, is has to be made sure the outputs OUT2 and OUT3 of the “BeamConstruct to Control” plug-in are connected with the correct motion plug-in. Within these motion plug-ins the related axes have to be configured correctly (planar or rotational mode) and they have to access the correct axes that belong to the defined motion modes

After such a splitting group has been created and after the correct parameters have been set, the appearance of the related geometry changes: now it is overlapped by horizontal and/or vertical lines. These lines specify the cutting positions and can be modified manually. They can be dragged with the mouse in horizontal or vertical direction exclusively to change the position where the geometry has to be cut. The related modifications are done as soon as such a cutting line is released.

Please note: the positions of the cutting lines do not influence the parameters given within the property panel

but as soon as the parameters within the property panel are modified, the position of the cutting lines are reset to their default. Thus their positions should be changed only in case all other parameters do fit perfectly.

7.8.2.2 Active Move Group

This is a special kind of group that concatenates several elements into one group. Due to the kind of this group it is recommended to use only geometries and not to put other ones like motion elements into it.

An Active Move Group is able to repeat a grouped geometry several times and to combine it with movements so that e.g. a ring can be processed with a repeated pattern on its surface or to repeat the current geometry on a large working piece that itself is re-positioned by using an XY-table. The active movement functionality only applies in 2D mode or in X-Y-direction (equal to top view). Comparing to the Active Split Group here the contents of such a group are not cut or somehow else modified, they are marked all in once repeatedly.

As soon as some geometric elements are grouped together within such an Active Move Group the groups behaviour can be modified using the parameters that are available within the property panel of this group:

- Move horizontal – moves the grouped geometry along X axis, this option can be combined with “Move vertical” to define two-dimensional movements
- Move distance – the distance a movement has to be done in horizontal direction between two processing cycles
- Move steps – specifies how often processing of the geometry has to be repeated in horizontal direction
- Move vertical – moves the grouped geometry along Y axis, this option can be combined with “Move horizontal” to define two-dimensional movements
- Move distance – the distance a movement has to be done in vertical direction between two processing cycles
- Move steps – specifies how often processing of the geometry has to be repeated in vertical direction
- Move radial – defines a movement operation onto a ring, this option can not be combined with one of the previous splitting direction modes
- Diameter – the total diameter of the ring where the geometry has to be marked at
- Move angle – the movement angle for every split, the size of the single split pieces result out of this angle and the diameter of the ring
- Move steps – specifies how often processing of the geometry has to be repeated on the ring
- Keystone correction – when marking the inner side of a ring the laser beam has to be slanted in order to hit only the lower inner side of the ring and not the upper outer side too. Resulting from that the length of the beam varies dependent on the X/Y position of the geometry which results in a distortion when no special optic is used.
  Using the keystone correction this distortion can be suppressed so that the marking result will look like expected. This correction is done by setting an as a percentage correction factor and by defining the side of the geometry this factor may apply to. The correction factor specifies how much the geometry shall grow or shrink according to its original size at the outer position where the full distortion has to be expected.
- Process order – this order applies to the planar movement modes and defines in which order the grouped geometry have to be repeated:
  <u>Left to right</u> – horizontal direction always starts from left
  <u>Right to left</u> – horizontal direction always starts from right
  <u>Zig-zag from left</u> - horizontal direction starts from left and performs zig-zag movements
  <u>Zig-zag from right</u> - horizontal direction starts from right and performs zig-zag movements
  <u>Top to bottom</u> – vertical movement starts from top
  <u>Bottom to top</u> – vertical movement starts from bottom
  In case two-dimensional motion is defined both process order selections are combined with each other to describe the 2D motion.

- Motion speed: the movement speed in unit mm/sec or degrees/sec that is applied to the motion
- Axis mapping: at the lower end of the property panel a matrix of radio buttons exists where the axes can be mapped to the related movements, there it can be specified which of the axes A, B or C of the two possible outputs OUT2 and OUT3 have to provide the related planar movements in horizontal or vertical direction or the angular movement.
  Later, when such a project has to be used within a ControlRoom project, is has to be made sure the outputs OUT2 and OUT3 of the “BeamConstruct to Control” plug-in are connected with the correct motion plug-in. Within these motion plug-ins the related axes have to be configured correctly (planar or rotational mode) and they have to access the correct axes that belong to the defined motion modes

After such a splitting group has been created and after the correct parameters have been set, the appearance of the related geometry does not change but within the entity list a different symbol for the group is shown in order to point to the fact a special kind of group is used here.

7.8.3 Edit Destructive

The functions of this category perform irreversible modifications to the input geometry. That means only the resulting geometry is used for further processing and all source elements that have been used to create this geometry get lost.

Resulting from that there is much less computing time and memory used to hold such geometry and editing on a per-vector-level is much less difficult because the data no longer can't be overwritten by a re-creation caused by some parameter changes. On the other hand the conversion to static geometry means that no more dynamic changes are possible like they can be performed when Data Input elements are used – as soon as these elements have been modified by such a destructive modification, all the (sub)elements it consisted of are lost. But afterwards is is possible to assign Additional Geometry and Post-processing elements to this static geometry again.

Following functions exist that perform such destructive modifications:

- Merge – the geometries of the selected elements are merged together, the result is one static element with all geometries included into it; this function can also be applied to one single Primary Geometry element and its sub-elements to reduce its memory usage to the absolute minimum so that only the resulting static data of it are stored
- Split – tries to split the geometry of an element into several pieces, here splitting is done at positions where a geometry ends (e.g. at the end of a logic element or the end of a polygon). There are several levels of splitting so that it is possible to perform a splitting operation up to two times at the same data. As an example: when the splitting-function is applied to a geometry that represents the string “Text” for the first time, the result are four elements containing the geometries for the letters “T”, “e”, “x” and “t”. In a second step the splitting function can be applied to the geometry of the letter “e” again. Now it is split based on the contained poly-lines, the result are two elements that contain the two polygons the letter “e” consisted of (one with the outline and one with the small part within the head of the “e”).
- Optimize – this function checks geometry for inefficient structures and optimizes them. Here the visual representation of a geometry is not changed but the number of vectors and vertices is reduced if possible.
- Reduce Geometry – here the data a geometry consists of can be reduced. As parameter this function expects the minimum size a vector may have within a geometry or a minimum angle a point may define. Lines that are shorter than the given distance or points that are located between two other ones and describe a smaller angle than the specified one are removed and merged with their predecessor. The result is a geometry that may use less data and therefore can be processed faster but also may have changed in its visual representation.

7.9 Process 3D Data

There are two ways to process 3D data in BeamConstruct: one possibility is to use their 3D information including the Z (=depth) information to drive a 3D scanner and to mark them exactly as they appear. Alternatively a solid 3D model can be imported and cut into horizontal pieces (so called slices) which can be processed separately and optionally without the need to involve a 3D scanner system.

The first variant does not require any more than a scanner controller card that is configured for 3 axis operation. Resulting from such a configuration the user interface of BeamConstruct is switched into 3D mode too, now it is possible to edit Z-values within all property panels, to switch the drawing area to profile views or to a real 3D view and to draw and edit elements also in depth-direction.

7.9.1 Slicing 3D Data

The second processing method does not necessarily requires a 3D scanner, here a 2D system can be used too, the third dimension can be handled by external hardware (like a drive that moves the position of the working piece in Z-direction via a lift table). As a precondition to use this operation mode a ready-to use 3D model has to be imported. Currently BeamConstruct supports the RenderWare RWX format and the Surface Tessellation Language STL in binary and ASCII format. Beside of that the Common Layer Interface CLI format is supported too, since this is a file format that already contains sliced data it can be used for processing but is not a real 3D format where a slicing operation can be applied to.

More directly supported 3D file formats will follow in future. In case 3D data are available using a different file format than the ones described above, a converter application can be used. Here we recommend AccuTrans 3D which is available at http://www.micromouse.ca/ and supports nearly every 3D file format that exists. AccuTrans 3D itself is available for an extremely low price.

After selecting a 3D file for import, a configuration dialogue opens where some initial slicing parameters can be configured. All the slicing parameters can be changed later within the application:

- Import Scale Factor – a factor that can be used to scale the whole 3D object during loading
- Slice Distance – the distance between every slice
- Slice Offset – specifies an offset from top/bottom of the 3D model where slicing has to start; in case this value is set to 0.0 it may result in a first slice that contains nearly no relevant data (dependent on the used 3D model)
- Slice Direction – here the slice direction for the 3D model can be selected, “Top To Bottom” may be used e.g. for depth-engraving where operation starts on top of the model and moves into the material, “Bottom To Top” can be used e.g. for rapid prototyping applications where processing starts from bottom and builds up a model slice by slice
- Slice Mode – here it can be selected if the depth-information has to be handled by the Z-axis of a scanner or by usage of external equipment; when mode “Real 3D” is selected all the slices are located at their true Z-position according to the origin model. This mode is for usage with a 3D scanner.
  In case mode “Flat (Z externally driven)” is selected, all slices are located at Z-position 0 and the movement in depth-direction has to be done with a separate device. Control elements for this device can be added to a slice group later. In case the scanner card is configured for two-axis-operations, only the second option is available, in this case “Real 3D” is disabled and can't be selected

When this configuration dialogue is left by pressing the “OK” button the 3D model is loaded and sliced according to the specified parameters. Dependent on the size of the model, the number of slices that result out of this size, the slice distance and the complexity of the models geometry this operation may take a while. When the slicing operation is finished a “Sliced 3D Mesh” group element is added to the current project that contains the 3D model and the slices.

7.9.2 Sliced 3D Mesh Group

This is a very specific group that contains a 3D model that will not be marked and several slices which are generated out of this model. Such a group has to be combined with other elements carefully since it performs operations in Z-direction that have to fit to other elements or groups that are located before or after it within the current project.

When the group is selected a special property panel opens on the windows left hand side. There several parameters can be changed. Some of these parameter changes lead to a recalculation of the slices which means the currently existing slices, their sub-elements and possibly added motion-elements are removed from this group. So it is recommended first to optimise all the slicing parameters and then add more data and elements to such a group.

- Slice Distance – the distance between every slice; when this value is changed all slices and possibly existing additional elements are removed and the slices are generated again
- Slice Offset – specifies an offset from top/bottom of the 3D model where slicing has to start; in case this value is set to 0.0 it may result in a first slice that contains nearly no relevant data; when this value is changed all slices and possibly existing additional elements are removed and the slices are generated again
- Slice Direction – here the slice direction for the the 3D model can be selected, “Top To Bottom” may be used e.g. for depth-engraving where operation starts on top of the model and moves into the material, “Bottom To Top” can be used e.g. for rapid prototyping applications where processing starts from bottom and builds up a model slice by slice; when this value is changed all slices and possibly existing additional elements are removed and the slices are generated again
- Slice Mode – here it can be selected if the depth-information has to be handled by the Z-axis of a scanner or by usage of external equipment; when mode “Real 3D” is selected all the slices are located at their exact Z-position according to the origin model, this mode is for usage with a 3D scanner; in case mode “Flat (Z externally driven)” is selected, all slices are located at Z-position 0 and the movement in depth-direction has to be done with a separate device. Control elements for this device can be added to a slice group later. In case the scanner card is configured for two-axis-operations only the second option is available, in this case “Real 3D” is disabled and can't be selected; when this value is changed all slices and possibly existing additional elements are removed and the slices are generated again
- Slice Pens – this table can be used to define patterns for the pens that have to be assigned to every slice. There separate pens can be specified for contour and hatch of a slice. First of all the check box in front of a row of the list has to be selected to enable this entry. Then the pens can be selected via the combo box. Here the list rows have different meanings: “First Slice” is used for the very first slice only (that can be on top or bottom of the model dependent on the slice direction) and “Last Slice” is used for the very last slice only (that can be on top or bottom of the model dependent on the slice direction). All other rows within that list define an order of pens that is repeated until the last slice is reached. Here patterns of up to 5 different pen combinations can be defined.
  Since the pen-definitions for sliced geometry have to be done here the related option within the “Element” tab-pane is disabled, pens can be assigned only via this pen mapping table.
- Show All Slices – in case this check box is selected all slices that belong to a 3D model are shown within the drawing area of BeamConstruct. This function has to be handled with care since a large amount of slices can slow down the application dramatically, here it is recommended to use “Display reduced” parameter to show only every nth number of slice
- Show 3D Mesh – draws the 3D model the slices result from; it is necessary to enable this option in case the model has to be edited: all functions like rotating, scaling, moving and others more that are available within the drawing area can be accessed and applied to the 3D model only in case this option is selected.
  PLEASE NOTE: as soon as something was changed at the 3D model all currently existing slices are dropped and a new slicing operation is started in order to get slices that reflect the modified 3D models shape.
- Display Reduced – reduces the number of slices that are shown in case option “Show All Slices” is selected, the bigger this number becomes the less slices are shown within the drawing area

Beside of that there is a slider available on the property panels left hand side: there the currently shown and used slice can be selected and it can be used to scroll through the sliced model. The same is true for the input field below of that slider: there a number of the current slice can be entered or chosen.

Such a Sliced 3D Mesh Group is shown as a group element with one sub-element for every slice within the element tree on the windows right hand side. Comparing to other groups it behaves a bit different. So it is possible to put new elements (like a motion control element or I/O elements) into that group directly. To do that, either the group node itself or one of its slices has to be selected and the Primary Element to be added has to be chosen within the tool bar. Now a dialogue is opened where the user can select if that element has to be added as a single one only, below of every slice or for a range of slices. This way it is possible to set motion controlling elements for every slice easily. More than this: all elements that are added via such a range will belong together afterwards: whenever a parameter of one of the elements is changed, the parameters of all others that belong to the same range (and therefore have the same number in its name) are modified too.

The same is true for Additional Elements: when there is a hatch added to a single slice the user can choose to apply it to a range of slices or to all slices. When the parameter of one of these hatches is changed the change is applied to all the other hatches that have been created together with this first one.

Using this way the same operations and parameters can be applied to all slices easily.

7.10 Vision

BeamConstruct provides an integrated Vision system for automatic adjustment and correction of marking data. Using this vision system special markers – so called fiducials – can be teached. Later the Vision system is able to recognise such a fiducial on a working piece and adjust position and rotation of the current marking data according to the fiducials measured position. Vision functions can be found in menu “Edit” submenu “Vision” and in mark dialogue.

To use the vision system it is mandatory to connect a camera and to configure a Video Controller in hardware settings. This enabled the Vision menu entries and functionalities.

7.10.1 Vision Functions

Menu Vision → Start Video

When image capture is configured to be started manually this menu item can be used to start (menu item checked) and stop capturing (menu item unchecked)

Menu Vision → Freeze Video:

As soon as a Video Controller is configured, a live image is shown in background of the working area. This image changes permanently and can be freezed using this menu. This is a toggle menu, selecting it turns freeze mode on, selecting it a second time turns this mode off and enables the live-image again.

Menu Vision → Calibrate Camera:

This functionality can be used to calibrate a camera and to adjust and correct distortions caused by the lens of the camera. This function does NOT correct camera angle/perspective distortions. When selecting this menu item, a calibration dialogue opens. For camera calibration following steps have to be performed:

1. A black/white checkerboard has to be placed in cameras view. Such a board can be found e.g. at http://www.beamconstruct.com/checkerboard.png. Here the board must be visible in cameras live image fully, none oft the squares have to be cutted.
2. The camera calibration dialogue has to be opened and the boards parameters have to be entered: here the number of crossing points between squares (the chessboards inner corners, not the number of squares itself!) have to be entered for horizontal and vertical direction.
3. The button “Try calibration” has to be pressed. It starts a calibration run where the checkerboards

inner corners are searched. If this is successful all these crossing points are marked by blue circles and the “OK”-button of the dialogue is enabled.

4. The dialogue has to be left with “OK” in order to take over the calibration data. Now they can be saved by selecting menu “Project” → “Save as default configuration”.

Menu Vision → Drop Calibration:

The current calibration data are dropped, afterwards the shown camera image is uncalibrated

Menu Vision → Teach Fiducial

Here one or more fiducials can be taught that have to be recognised later. This can be done in fiducial teaching dialogue which opens after selecting this menu item.
This dialogue shows the current – probably calibrated – image. There an area can be marked by drawing a rectangle directly into that image. After releasing the left mouse button a fiducial detection is performed within that area. The result of this operation is a list of keypoints which are marked by circles within the image and listed on the dialogues left hand side. Now within that list all these keypoints have to be removed (by pressing the “Delete” key or by using the related button) that do not belong to a fiducial (e.g. because marking of the area within the image was inaccurate or because they are located between desired positions when more than one fiducial is marked). During all that time a fiducial detection is performed with the same image to get a rough recognition quality value. This value is shown on lower left side of the dialogue. It should be as close as possible to 100%. When too much keypoints are removed, this values decreases – and the expected detection accuracy decreases as well.
As soon as this dialogue is left by pressing the “OK”-button, a fiducial is taught and can be used. This fiducial can be saved in a separate file and can be loaded as needed with the following menu items.

Menu Vision → Load Fiducial

This menu can be used to load an already existing, saved fiducial definition. Currently used fiducial(s) is/are replaced by this function.

Menu Vision → Save Fiducial

This menu can be used to save the current fiducial definitions for later usage.

Menu Vision → Drop Fiducial

The current fiducial definitions are dropped, no more fiducial recognition is possible until new fiducial(s) is/are taught or loaded.

As soon as there is a fiducial definition active and valid, it is used for marking operations. When the marking dialogue is opened, a fiducial recognition is performed automatically. When the fiducial(s) can be detected in current live image, the orientation and position of the actual marking project is changed according to the fiducial(s) orientation and position. This procedure is repeated after every marking process automatically. Additionally it can be triggered again in mark dialogue by pressing button “Auto”, it starts a new cycle of recognition and correction.

7.10.2 Vision Cookbook

To get a Vision system that is working well and that produces exact results is not an easy thing and requires a lot of adjustment and experience. As a starting point and to get some basic information to make own experiences with, following some hints are given to get better results. The steps listed below should be performed as accurate as possible:

1. Use a camera with a high resolution. The fiducial(s) should be visible very clear and quite large so that all relevant details of it/them can be seen in cameras image.
2. Adjust the lighting. As first step a working piece should be placed in cameras view. Now adjust the light so that the fiducial(s) on that working piece can be seen clear and has/have a good contrast comparing to its underground and comparing to other markers on this working piece. Think about using coloured light which could result in better contrast between fiducial and background.

3. Adjust the camera parameters in BeamConstructs hardware settings. First of all a monochrome image should be used. The Vision system does not make use of colours and would convert the image to monochrome representation in every case. So enable grayscale mode in camera plug-in and check the points 1) and 2) again.
4. Calibrate the camera as described above. Please note: in case your camera has a really good lens and does not distort the image, this step should be dropped. The camera calibration always results in a loss of information and quality and therefore should be avoided when possible. Nevertheless: a lens distortion is much more worse than this loss of information, so this should be dropped only in case of a really good camera!
5. Teach the fiducials as described above. It is not possible to make any forecast which of the fiducial recognition keypoints has which influence on the recognition result. Thus several iterations are necessary here: select the fiducial(s) in teach dialogue, remove the unused keypoints, accept the result and try recognition with a changed position of the working piece. And depending on the results: start from the beginning with fiducial selection and keypoint removal.

7.11 Processing Operation

To manipulate a loaded project related to the processing operation several functions can be found in menu “Process” of the main window:

- Simulate – a full process cycle is simulated, means the complete project is updated, all serial numbers, date and time objects are triggered, the process time of geometries is calculated, delays are measured and movements are (partially) simulated. The resulting total process time is displayed to the user. This time is nearly the same time such a process would need within the target environment. It differs only in case motion elements are used that perform absolute movements, here the real processing time can't be calculated because the starting position of an driven axis is not known.
- Mark: this option requires at least a scanner card to be configured within the global project settings and gives the possibility to start a real marking process instead of simulating it. In case the current project uses motion elements the related motion controllers should be configured too within the project settings.
  After selecting this menu item a marking dialogue opens, for more information about its functionalities please refer below.
- Increment – all serial number elements of the current project are incremented, the date and time elements are updated
- Decrement – all serial number elements of the current project are decremented, the date and time elements are updated
- Reset – all serial number elements of the current project are reset to its starting value, the date and time elements are updated

7.12 Marking

The mark dialogue can be opened via menu “Process” menu item “Mark”. When this dialogue is opened for the first time or in case the hardware settings have been changed after it was used the last time, as first operation the scanner controller cards and the – optionally configured – motion devices are opened. This operation may take some time dependent on the connected hardware.

In case this operation could be completed successfully, the dialogues mark-buttons can be used afterwards. This dialogue provides a button for starting the pilot laser (requires fully configured pilot laser outputs in project settings) on the left side of the dialogue, a mark-button in the middle that starts the main laser and a stop-button on the right side that stops the main or pilot laser. Below of them some options can be found that influence the marking operation:

- Mark repeatedly – starts an infinite loop, as soon as the mark-button is pressed the current geometry is marked again and again until the stop-button is pressed
- Mark selected elements – when this option is set only these parts of a project are marked that are selected within the Entity-Tree and highlighted within the drawing area
- Pilot laser – the following options can be used to control a pilot laser. The combo box gives the possibility to choose the pilot laser marking mode, “Off” disables usage of the pilot laser “Manual” expects that the user starts the pilot laser manually by pressing the big pilot-laser-button on the windows upper left hand side and “Auto” re-starts the pilot laser after every marking process automatically. Also in mode “Auto” the pilot laser has to be started manually for the first time because of security reasons.
  The radio buttons below this combo box can be chosen to select what the pilot laser shall show in its preview, “Use total projects outline” draws a simple rectangle that includes the whole project, “Use individual elements outline” draws a simple rectangle for every element within the current project (except dots, lines and triangles which are shown fully) and “Use real element shapes” draws the full shape of all elements except hatches.
  The pen – and therefore the related speed and delay values – that is used for the pilot laser can be defined within the pen settings dialogue (please refer above).

There are some more functionalities available in mark dialogue that offer useful features related to marking. These functions are grouped logically into separate tabbed panes. In tab pane Geometry the current projects vector data can be manipulated:

- Arrows left/right/up/down – using these arrows the whole geometry of the project can be shifted into the given direction (in top view for 3D mode); the shift step size in unit mm is taken out of the input field below of these arrows
- Arrows rotation left/right – using these arrows the whole geometry of the project can be rotated into the given direction (in top view for 3D mode); the rotation step size in unit degrees is taken out of the input field below of these arrows
- Button Auto – this button can be used only when a live image is captured and when fiducials are teached using the integrated vision system, it tries to detect the teached fiducials in current image and aligns and rotates the current geometry automatically according to the position and orientation of these fiducials
- Button Reset – when this button is pressed all changes in position and rotation of the current projects geometry are taken back, it is reset to its default values

In tab pane Motion Axes it is possible to drive configured motion axes manually and independent from any motion elements in marking project. Please note: when there are some marking elements used directly within the project, it has to be taken into account that the user may have changed the position of the axes via these manual functions. Thus at least the first motion element should perform a movement to an absolute position or should reference its position. Within the mark dialogue following motion functions are available:

- OUT2 / OUT3 – specifies which of the two possible motion controllers has to be used
- Speed – specifies the speed a manual motion operation can be performed with; please note: the value entered within this field is not clipped to the maximum possible speed immediately, since every axis can have a different maximum speed it is decided on motion start which of these limits has to be used; thus it may be possible an axis moves with a lower speed than specified within this field simply because is maximum speed is limited
- Camera – this button an be used to toggle the background image on and of in case manual image capture enabling is configured within project settings; this button has the same functionality like the related vision menu item
- Double arrows – these buttons cause a movement as long as the button is pressed
- Single arrows – these buttons cause a single movement via the distance or angle specified with the number input field in the middle, here the time the button is pressed does not influence the motion
- Ref – start referencing of the related axis

For planar movement axes the images of the buttons can be changed within the motion axis configuration panel of the general project settings. Depending on the real movement direction (left/right, up/down, in/out) a different symbol can be shown here in order to make it easier for the operator to decide which direction a

motion will use. The same is true for the axis names, they can be configured via the axis alias value in general project settings.

The third tab pane Parts is related to part counting, its buttons and functionality will be enabled only when part counting is enabled for the current project (can be done in general project settings dialogue). When part counting mode is enabled the large counter shows the current number of parts already marked. When the limit specified in project settings and in input field “To produce” is reached, no more marking operations are possible until the user presses button “Reset Counter”.

7.12.1 Exporting Data

To use the created data on the target system for processing work pieces they have to be stored in a usable format. Here following possibilities exist:

BeamConstruct “.BEAMP” project files:

This is the project file format of BeamConstruct, here all information about used elements and sub-elements, modified geometry, scanner and laser parameters are contained, no information are lost when this format is used.

CSV format:

The “comma separated values” format is more a simple list of parameters that are comma-separated. This format includes all geometry and some pen information and can be used e.g. by the CSV to Control plug-in of the ControlRoom software to extract the processing information out of it. Here no dynamic information are contained, only static geometry can be marked when this format is used.

HPGL format:

This is a vector graphics format that contains only geometry information, the pen (and thus the processing data) are not part of this format. So it should be used for data exchange with other applications only. This format can be used with the HPGL to Control plug-in. Because of the missing pen information they have to be entered within the plug-ins settings manually. Here no dynamic information are contained, only static geometry can be marked when this format is used.

7.13 Multihead Operations

In many cases BeamConstruct will use one scanner card that uses exactly one rectangular working area. In this configuration there will be one scan head performing movements for this working area.
In some special cases this so called singlehead operation mode can make use of a second working area and a second scan head where both heads perform the same movement. This mode is often called “secondary head”, it simply doubles the output but does not allow to mark different, independent geometries with these two heads.

Full independence of all used heads is possible only with a real multihead mode. In this mode BeamConstruct knows about more working areas that can overlap each other or that can exist beside each other. But all these working areas are completely independent, every area is assigned to an own scan head that performs separate movements.

This multihead mode can be used to:

- mark geometries that are larger than a single working area (in this case it is recommended to let the working areas overlap to profit from vector data optimisations BeamConstruct performs automatically)

- mark large, complex geometries faster (in this case big overlapping areas have to be configured to let both heads work on same area in parallel)
- mark independent geometries faster (in this case working areas do not need to overlap)

In last case it is recommended to use scan heads with the same performance and lasers with same power, elsewhere it may happen one marking area slows down the full marking process.

In first two cases different lasers and scan heads can be used but it is recommended to have the more powerful lasers and the faster scan heads configured at the first position.

Setting up of a multihead configuration is quite easy and can be done in general project settings (please refer to detailled description of settings above). There in tab-pane “Hardware” two combo boxes can be found. One is for selecting a scanner controller and one for selecting a scan head. Both can be separate things but don't have to, this depends on the used scanner controller / the used scanner controller plug-in. The difference between both:

- the scanner controller is a piece of hardware / a plug-in that accesses this scanner controller device, where more than one scan head can be connected to.
- the scan head is assigned to a single working area and a single laser that is used for this working area, it is possible to have more than one scan head connected to a scanner controller.

In many cases there will be a 1:1 relation where scanner controller selection is equal to scan head selection, but in case one scanner controller plug-in is able to control more scan heads independently, this separation between “controller” and “head” is necessary.

The same can be found in pen settings (please refer to description above). There the scan head can be selected, means different pen parameters can be set for every working area – independent from the fact which scanner controller plug-in really controls this head.

7.14 Customise BeamConstruct

BeamConstruct can be modified in a way so that it can be delivered together with machinery or additional equipment using an own brand. Here following attributes can be changed:

- the applications name, this value replaces the name BeamConstruct completely
- the homepage which is shown in “About”-dialogue
- the splash image shown during application start-up and in “About”-dialogue
- the application icon shown in taskbar and main window (not supported on all operating systems)
- the copyright as shown in “About”-dialogue; this custom copyright does not replace the default one but is added to it
- the images shown in toolbar and entity-tree

To customise the application in this way a plain text file with the name `beam.oem` has to be created in UTF-8 format. To become active it has to be placed in installation directory of the application for Windows operating systems (typically C:\Program Files\OpenAPC) or in /usr/local/openapc for Linux systems. Within this file every single line contains one customisation definition:

1. the name of the application
2. the homepage URL to be shown in “About”-dialogue
3. path to the splash image in PNG format
4. path to the icon image in PNG format
5. copyright text to be shown in “About”-dialogue

As an example:

```
Beamy Raymanipulator
```

```
http://www.beamconstruct.com
beamoem.png
beamoem_icon.png
Copyright (c) 2012 by LaserFreak
```

This file (in UTF-8 encoding) placed within the directory described above renames BeamConstruct to “Beamy Raymanipulator”, shows http://www.beamconstruct.com within the “About”-dialouge (instead of http://www.lasermarkingsoftware.com) as well as the additional copyright information. As splash image for the startup-screen the image out of file beamoem.png is used. When this files name is given without a absolute path the application tries to find it in installation directory (Windows) or in directory /usr/local/openapc (Linux). The same is true for beamoem_icon.png which is used as image for the applicattions icon.

The images that are shown within toolbar and entity tree can be replaced by own ones too. Here two different methods have to be used to replace all of them.

To replace the toolbar- and entity-tree images replacement images in PNG-format have to be put into to the plug-ins location but with different names. The base name is always the name of the plug in without extension. For the toolbar image a “1.png” has to be added to this base name, for the entity-tree image a “2.png” has to be added. As an example: The images of the barcode plug-in have to be replaced. It can be found in folder “priplugins” with the file name “libio_pri_barcode.dll” or “libio_pri_barcode.so”. Here two images “libio_pri_barcode1.png” with a size of 25x25 pixels and “libio_pri_barcode2.png” with a size of 15x15 pixels have to be put into the same folder. After next software start the barcode appears with the new images.

To replace all other images PNG files with special names have to be placed in folder “icons”:

- “newprj.png” for the “New”-symbol
- “openprj.png” for the “Load project”-symbol
- “saveprj.png” for the “Save project”-symbol
- “saveprjas.png” for the “Save project as”-symbol
- “quit.png” for the “Quit application”-symbol
- “zoomin.png” for the “Zoom in”-symbol
- “zoomout.png” for the “Zoom out”-symbol
- “zoomworkarea.png” for the “Zoom full working area”-symbol
- “zoomselected.png” for the “Zoom selected entity”-symbol
- “pointdrag.png” for the “Point drag mode”-symbol

8 CorrCorrect

This section describes CorrCorrect, a tool to create and modify scanhead correction tables.

8.1 Overview

When a scanhead – a system with two mirrors that deflect a laser in X and Y direction – is used, the resulting movement on the working area is distorted. There two major distortion can be found: 1. a pincushion distortion that is caused by the mirrors and the used optics and 2. a 3D focal distortion that happens because the distance between last mirror and working area differs dependent on the position where the laser hits it – the distance is shorter in the middle directly below of the mirror and longer on the borders of the working area, resulting in a loss of focus for some of the positions.
To correct such distortions special correction tables are used. In most cases these correction tables are specific to and delivered together with a scanhead. They use a vendor-specific file format that has to be converted depending on the used software/the used scanner controller plug-in. In other cases no such correction file exist and has to be generated from scratch. As a third case for some very high accuracy applications existing correction files have to be modified so that they fit to the used hardware exactly.

All these three tasks can be done with CorrCorrect correction file tool that is described here. The resulting correction table afterwards can be saved in BeamConstruct HD (.bcorr) correction file format – a special format that provides much better accuracy than most other formats. Such a correction file can be used for some of the scanner controller plug-ins of OpenAPC package directly (like the ETH6608 plug-in).

8.2 Usage

To start with generation of a new correction file the “New”-toolbar button or the menu Project → New has to be selected. This opens a dialogue where parameters for focal and pincushion distortion can be set. Additionally it can be specified which of both corrections have to be applied to the correction table. So for plain 2D applications or hardware set-ups where no third axis or no possibility to change the focus exists, only pincushion distortion parameters can be set. For a real 3D set-up focal correction parameters can be applied too.

Alternatively it is possible to load an already existing correction file via menu Project → Open or by using toolbar button “Load Project”.

Next this correction table can be modified by specifying one or more nominal and actual positions. To get the values required for this, the current correction file has to be used for marking. During the marking operation one or more single points have to be marked. These points should be located at positions where the accuracy has to be increased or at positions spread over the whole working area. After marking the positions it has to be measured where the points have been marked really. The resulting values have to be entered in single or multiple point correction dialogue that can be opened via menu Edit → Correct Single Point or menu Edit → Correct Multiple Points. After entering the nominal coordinate(s) – the coordinates of the points within BeamConstruct – and the actual coordinate(s) – the real coordinates as measured after marking – the current correction table is modified at the given position(s) in order to reflect the deviation(s) at this/these point(s). This operation has to be repeated with the same or varied point coordinates until the resulting correction table offers the required accuracy.
Please note: these correction operations influence the correction table only in X- and Y-direction. A possibly existing focal correction is damaged by these operations. Because of that for full 3D correction the focal correction has to be applied again after this: By selecting menu Edit → Recalc Focal Correction the related correction is re-calculated according to the changed positions of 2D correction coordinates.

Additionally the CorrCorrect tool provides the same “Geometry”-panel like it is known from BeamConstruct. So when the current correction table – that is shown in the middle of the application – is selected, here several operations can be performed. It can be scaled, mirrored, centred, rotated, the total position can be

changed and other things more.

8.3 Correction Definition Dialogue

When menu Project → New or toolbar button “New Project” is selected, a dialogue opens, where focal and pincushion distortion parameters can be set. There exists an other dialogue that provides only focal correction parameters and that can be selected via menu Edit → Recalc Focal Correction. This dialogues parameters are a subset of the parameters of the correction definition dialogue and therefore are not described separately.

This dialogue provides following general parameters:

- Z-Distance – the shortest distance between last mirror and working area

The correction dialogue provides following parameters for pincushion distortion:

- Checkbox Pincushion Distortion – the 2D / pincushion distortion parameters are applied to the newly generated correction table only when this checkbox is set
- X-angle – the distortion strength/angle in X direction
- Y-angle – the distortion strength/angle in Y direction

This dialogue provides following parameters for focal correction:

- Checkbox Focal Correction – the depth / focal distortion parameters are applied to the newly generated correction table only when this checkbox is set
- Working Area Size – the size of the working area; independent from its real shape here always a squared size is assumed and the biggest used size has to be entered here

8.4 Correct Single and Multiple Points Dialogue

Both, the single and the multiple point dialogues expect the same values and behave the same except the following:

- the single point dialogue expects exactly one nominal and one actual coordinate value pair
- the multiple point dialogue asks for a CSV file that contains pairs of nominal and actual coordinate values and shows an editable list of them within the dialogue;
  The CSV-file contains comma-separated values in format
  `nominal x, nominal y, actual x, actual y,`
  using dot-separated floating point numbers

The dialogues offer the following fields and input values:

- Nominal Position X, Nominal Position Y – the nominal coordinate(s) in unit mm
- Actual Position X, Actual Position Y – the actual, measured coordinate(s) in unit mm
- Working Area Position X and Y – the top left position of the working area in unit mm
- Working Area Size – the size of the working area in unit mm, here a squared working area is assumed

When the dialogue is left with “OK” the current correction table is modified according to the given nominal and actual value(s).

Index

3

3D....184f.
3D view....184
3rdEye(R) PSC140P....76

A

access state....146
AccuTrans 3D....206
Active Move....168, 202
Active Move Group....170, 204
Active Split....168, 202
Active Split Group....168, 202
ADD....136
Add Element....27
Additional Geometry....151, 163, 183, 197
Additional Pane....24
Allow modification....27
Analogue Clock....35
analogue output....196
AND....135
Angle Offset....164, 198
Angular Meter....22, 34
Angular Regulator....22, 30
APCG....28
AS-i Serial Interface....63
Auto....211
Averaging....57
AVR Net-IO (Ethernet)....64
AVR Net-IO (serial)....64
axis alias....212
Axis alias....180

B

Background Colour....17, 20, 178
Barcode....161, 194
bcorr....215
Beam Compensation....198
BeamConstruct....11, 30, 37, 44, 174
BeamConstruct HD....215
BeamConstruct to Control....37, 44, 195f., 199, 203, 205
BeamConstruct2Control....179
BEAMP....44, 176, 212
Bezier Curve....160, 192
BINARY....25
Binary Data Counter....57
Binary Gate....62
Binary NOP....52
Binary Shift Register....53
Binary to CMD/Value-Pair....43
Binary Triggered Gate....61
BOOL....137, 142
Bottom To Top....206f.

C

CAL....138
CALC....138
CALCN....139

Calculate Delays....182
Calibrate Camera....208
Capture Image....65
Centre X....153, 185
Centre Y....153, 185
Centre Z....185
Character Counter....56
Character Gate....61
Character NOP....52
Character Shift Register....52
Character Triggered Gate....61
Characters to CMD/Value-Pair....43
Characters to Digital....42
Characters to Mixed....45
Characters to Number....42
CHARS....25
Check-box....22
checkerboard....208
chessboard....208
circle....150, 178
Circle....157, 189
CLI....206
Clock....35, 109
CMD/Value-Pair to Binary....43
CMD/Value-Pair to Characters....43
CMD/Value-Pair to Digital....40
CMD/Value-Pair to Numeric....42
CNConstruct....11, 37, 45
CNConstruct to Control....37, 45, 162f., 165, 169f.
CNCP....45, 172
Coherent(R) Avia Ethernet Laser Controller....78
Common Layer Interface....206
Compare Characters....56
Compare Digital....54
Compare Numbers....55
Compress Data....48
Connectors....26
Container....22f.
Control....21f.
Control Flow Time-Out....17
Control To Number....46
Control To Tool....47
ControlRoom....11f.
CorrCorrect....215
Correct Multiple Points....215
Correct Single Point....215
correction factor....179
Correction Factor....179
correction offset....179
Correction Offset....179
correction table....215
COS....137
Count X/Y....154
Count X/Y/Z....186
CSV....37
CSV to Characters....47
CSV to Control....37, 111, 172, 212
CSV to Number....47
Curve Distortion....165, 199
Custom Dot....178
Custom Dot Style....150, 178

Custom Output....195
Custom Pen Settings....151
cut....19
cyan....25

D

Data....27, 109
Data Conversion....26
Data Dummy....65
data flow....17
Data Input....165, 199
data types....25
Delay....60, 162, 194
Delete Element(s)....155, 187
Destructive....167, 201
Dialogue....62
DIGITAL....25
Digital (N)AND....49
Digital (N)OR....49
Digital (NOT) XOR....49
Digital Counter....54
Digital Gate....60
Digital NOP....48
Digital NOT....48
digital output....195
Digital Shift Register....49
Digital to Characters....40
Digital to CMD/Value-Pair....40
Digital to Number....39
Digital Triggered Gate....60
DINT....138, 142
disabled....22, 146
Display....21f.
Display image on manual activation only....179
Display reduced....207
Display Reduced....207
DIV....136
Dot....156, 188
Double arrows....211
Draw CCW....150, 158f., 178, 190f.
Draw Off-Movements....151, 181
Drawing Area....178
Drop Calibration....209
Drop Fiducial....209
Duplicate....155, 168, 187

E

E-Mail Notification....112
Edges/Segments....150, 178
Element Tab-Pane....154, 186
Element Tree....164, 198
Ellipsis....23
enabled....146
END_FUNCTION....138f., 141
END_MAP....140f.
END_VAR....139
endless....17
endless loop....28
EQ....136
ETH6608....98, 215
EXE....120

Execute Program....120
EXIT....137
Exit Application....60
Expand By Dot....156, 188
External Application....17
External Trigger....196

F

fiducials....208
Filedialogue....62
First Slice....207
Flat (Z externally driven)....206f.
Floating Number Field....22, 30
Flow Control....26
Flow Editor....16, 24
Flow Indicator....35
focal correction....215f.
Focal Correction....216
focal distortion....215
Font....20
Font Type....193
Foreground Colour....20
format string....41, 44f.
Frame....23
Freeze Video....208
Frequency....150, 181
front view....184
FUNCTION_BLOCK....138f., 141

G

GE....136
General Pen Settings....150, 181
Generic Laser Controller....78
Geometry....211
Geometry Tab-Pane....153, 185
GPS....66, 74
GPSd....66
Grid Size....149, 178
group....28f.
Group Elements....155, 187
groups....26ff.
Grow....190f.
GSV-2 Measurement Amplifier....66
GT....136

H

Hardware....178
Hatch Angle....164, 198
Hatch Distance....164, 198
Hatch Offset....164, 198
Hatcher....163, 197
HMI....11f., 16
HMI editor....18
HMI Editor....16
Horizontal Gauge....22, 34
Horizontal Slider....22, 30
HPGL....37, 113
HPGL to Control....37, 113, 172, 212
HTTP Client....114
human machine interfaces....12
Human-Machine-Interface....16

I

ID....20
IEC 61131....134f.
ignore....146
IL....134, 137
iIPLC....134
Image....23, 38
Image Button....22, 29
IMS....99
In-Polygon Delay....151, 182
IN0....19f., 29
Initial Flow Start....59
Inner Radius....150, 178
Input Element....152, 183
Input/Output....26
insert....19
Insert....19
Inside To Outside....150, 159, 178, 191
Instruction Language....134
Instruction List....15, 134
INT....138, 142
integrated user management....145
interlock....125, 145
Interlock Server....12, 14ff., 20, 27, 118, 121, 125, 144
Interlock Server Connection....118
Interlock Server Connection Flow Element....145
Invert Output Logic....179
invisible....146
Isel....6, 101
isX_cb_char_data....139ff.
isX_cb_digi_data....139ff.
isX_cb_num_data....139ff.
ISxC....140
ISxD....140
ISxRA....140
IWH Robot....101
IWH Robot Controller....107
IWH Robot Plug In....107

J

JCZ(R) LMC1....79
JMP....136
JMPC....136
JMPCN....136
JoyWarrior Accelerometer....66
Jump Delay....182
Jump Speed....180f.

K

Kerning....161, 193
Keyboard font....18
Keyboard size factor....18
Keystone correction....203f.

L

Laser....27, 179
Laser Off Delay....182
Laser On Delay....181
Laserport....195
Last Slice....207
layer....155, 186

Layer....154, 186
Layer Tab-Pane....155, 186
Layered Sphere....190
LC Numeric Display....23, 34
LCDproc Client....67
LD....135
LDISx....140
LDN....135
LE....136
libwlocate....74
Limits....180
Line....23, 156, 188
Linear Meter....35
Linear Regulator....33
LINT....138, 142
LN....137
Load default configuration....180
Load Fiducial....209
Load Image....114
Load Text....115
LOG....137
Log Output....21, 118f.
Log Recorder....20, 119
Log-In User....119
Logging....20
Logic Operations....26
loop....17
LREAL....138, 142
LT....136
LUA....15, 131
luaPLC....131

M

macros....27, 29
Map outputs to server....27
MAP_ISx....140ff.
Mark....210
Mark Delay....182
mark dialogue....210
Mark dialogue....79
Mark repeatedly....211
Mark selected elements....211
Mark Speed....180f.
Marking....210
Math Calculation 1....57
Mathematical....26
Merge....171, 205
Min / Max....20
Mirror X....153, 185
Mirror Y....153, 185
Mirror Z....185
mirrors....215
Miscellaneous....27, 118, 120
Miscellaneous Pen Settings....151
Mixed to Characters....44
MOD....137
Modbus Addressable RTU Master....68
Modbus RTU Master....68, 69, 75
Modbus TCP Master....69, 75
Modbus TCP Slave....70
motion....196

Motion....26, 99, 106, 162, 195
Motion Axes....179, 211
Motion Controller....179
Move Down....155, 187
Move entity tree to tab pane....178
Move To Bottom....155, 187
Move To Top....155, 187
Move Up....155, 187
MUL....136
Multihead....212
Mutual Exclusion....53
MySQL Access....116

N

Name....20, 27
NE....136
Network Client....70
Network Receiver....71
Network Server....71
Network Transmitter....72
NMEA....66
Non-Destructive....167, 201
NOT....136
Number Field....22, 30
Number of vectors....154, 186
Number to Bits....41
Number to Characters....41
Number to CMD/Value-Pair....41
Number to Digital....40
NUMERIC....25
Numeric Gate....61
Numeric Shift Register....52
Numeric Triggered Gate....61
Numerical (N)AND....51
Numerical (N)OR....51
Numerical (NOT) XOR....51
Numerical Addition....54
Numerical Counter....56
Numerical Division....55
Numerical Multiplication....55
Numerical NOP....51
Numerical NOT....51
Numerical Subtraction....55

O

OAPC_CMDERR_DOESNT_EXISTS....132
oapc_ispace_connect()....132f.
oapc_ispace_disconnect()....132, 134
oapc_ispace_get_value()....132, 134
oapc_ispace_recv_callback()....132f.
oapc_ispace_request_all_data()....132f.
oapc_ispace_request_data()....132f.
oapc_ispace_set_data()....132f.
oapc_ispace_set_value()....132f.
oapc_thread_sleep()....132ff.
oapc_util_thread_sleep()....134
off delay....47, 101, 104, 106
Off Delay....111, 113
off speed....112
Off Speed....111, 113, 150
on delay....47, 101, 104, 106

On Delay....111, 113
on speed....112
On Speed....111, 113, 150
on-screen....18
on-screen-keyboard....18
on-screen-numpad....18
OpenAPC Data Input....165, 199
OpenDebugger....12, 16f., 28, 59f., 121ff.
OpenEditor....12, 16
OpenHPlayer....12, 125
OpenIServer....12, 17, 125
OpenPlayer....12, 14ff., 59f., 121, 123f.
OpenPlugger....12, 14, 16, 121, 124, 144
Optimize....171, 205
OR....135
ORN....135
OUT0....29
OUT2....179
OUT3....179
Outer Radius....150, 178
Output Number....179
Output Port....179
Override Control Parameters....58

P

Panasonic Minas....102
Parallel Interface....72
Parts....212
Parts Counter....180
Password Field....22, 30, 119
Pen....154, 186
Pen Frequency....180
Pen Off-Colour....151, 181
Pen On-Colour....151, 181
pen settings....180
Pen Settings....150, 180
PID....58
PID Controller....58
Pilot laser....211
Pilot Laser....179
pincushion distortion....215f.
Pincushion Distortion....216
Pinpad....33
Pipes....38
place holder....41
PLC....134
Plot2D....36
PLT....113
plug-in....12
Plugged Devices....16f., 120f., 145
point editing....153f., 184, 186
polygon....150, 178
Polygon....159, 191
Position....20
Position Correction....33
Position Correction to Number....50
Post-processing Tool....152, 183
PostgreSQL Access....116
POW....137
Power....150, 181
Primary Geometry....151f., 155, 183, 187

PRINT....137
Process Geometry....154, 186
Process time....154, 186
properties dialogue....19
PSC140P....76
Pulse Output....196
purple....25
Put Control....26

R

Radio Button....22
Random Generator....116
Raylase(R) SP-ICE2....81
read only....22
REAL....138, 142
Real 3D....206f.
Recalc Focal Correction....215f.
Rectangle....23, 157, 189
Reduce Geometry....171, 205
Ref....211
Reference axis on start-up....180
Remove Last Dot....156, 188
RenderWare....206
Reset....211
Reset Counter....212
RET....138f.
RETC....138f.
RETCN....138f.
right view....184
Rising/Falling Edge....53
Rotate Control Parameters....58
Rotation....185
rtbak....146, 148
rtdat....146, 148
RWX....206

S

S....135
SAMLight CCI Controller....95
SAMLight(R) CCI....82
Save as default configuration....180
Save Fiducial....209
Save Image....116
Save Text....117
Scale....153, 185
Scale/Translate Control Parameters....59
scan head....213
Scanhead Selection....179
SCANLAB(R) RTC ScanAlone....85
SCANLAB(R) RTC3....86
SCANLAB(R) RTC4....88
SCANLAB(R) RTC5....90
scanner bitmap....182
scanner controller....213
Scanner Controller....178
Scanner Controller Selection....178
Scanner Pen Settings....181
SCAPS FEB Controller....96
SCAPS(R) FEB....92
SCAPS(R) USC-1/2....93
Schneider/IMS MDrive+....99

Schneider/IMS MDrive+ Controller....106
Sequencer....15
Serial Interface....72
Serial/Date/Time....166, 199
Set Defaults for Bitmap-Marking....182
Show 3D Mesh....207
Show All Slices....207
Sill(R) Focus Ethernet....101
Simple Button....22, 29
SIN....137
Sine Distortion....165, 198
Single arrows....211
Single Panel....24, 38
SINT....137, 142
Sintec(R) ETH6608....98
SIRF....66
Size....20
Slice Direction....206f.
Slice Distance....206f.
Slice Mode....206f.
Slice Offset....206f.
Slope....150, 159, 178, 191
Smoothing Factor....159, 191
Snap to Grid....17, 149, 178
software interlocks....125, 145
SP-ICE2....81
Speak....73
Speed....211
Spikes....158, 190
spiral....150, 178
Spiral....158, 190
Split....168, 171, 205
split view....185
spot size....198
Spot Size....181
SQRT....137
SR-FlipFlop....50
ST....135
Stacked Pane....23, 38
Star....158, 190
Start Angle....191
Start Video....208
State....20
Static....21, 23
Stepper Motor Driver (Parport)....103
Stepper Motor Driver (Scannercard)....105
Steppermotor Controller....108
STISx....140
STL....206
STN....135
STP....137
STRING....142
SUB....136
Surface Tessellation Language....206
Symbol Button....33

T

Tabbed Pane....23, 38
Teach Fiducial....209
Text....20, 160, 165, 193, 199
Text Field....22, 30

Text Label....23, 37
Text Listbox....34
Timer....59
Timer Resolution....17
To produce....212
Toggle Button....22, 29
Toggle-FlipFlop....50
Tool....164, 198
Tool Compensation....164
Tool Off Delay....151
Tool On Delay....151
Tool Size....151
Top To Bottom....206f.
top view....184
Touch-screen support....18
Triangle....156, 188

U

ucf....94
UDINT....138, 142
UINT....138, 142
UIRTeach....74
ULINT....138, 142
UnGroup....168
UnGroup Elements....155, 187
USB-UIRT....74
Use as default Pen....151, 181
Use for Pilot-Laser....181
Use individual elements outline....211
Use real element shapes....211
Use total projects outline....211
user management....18, 21, 39, 119, 145ff.
User Management....145
User Management Panel....39
User Privilege....21
User Privilege Settings....18
User Settings....18
USINT....137, 142

V

VAR_GLOBAL....139, 142
VAR_LOCAL....139, 142
Vector2D....37
Vertical Gauge....22, 34
Vertical Slider....22, 30
Video Controller....179, 208
visibility....146
Visual Grid Size....17
Visual Size....17

W

watch....123
Weecoboard 4M IO....75
Weecoboard LCD IO....76
white....25
WLAN-Position....74
Wobble Amplitude....182
Wobble Frequency....182
working area....149, 179
Working Area....149, 178
Working Area Size....216

Working Area Upper Left.....149

X
XOR.....135
XORN.....135

Y
yellow.....25

Z
Z-Distance.....216
Z-Shifter.....196
Zoom In.....153, 184
Zoom Out.....153, 184
Zoom To Selected.....153, 184
Zoom To Working Area.....153, 184
.....23

.....40, 48f., 51f., 69f., 75

!
!.....136

(
(De)Compress Data.....48

%
%.....41, 44
%d.....44
%d1.....41
%f.....44f.
%f4.....41
%s.....44
%s5.....45