8 Registering Images and Vector Data

This chapter describes the Register utility and all the related features. Register is used to geometrically correct images or vector data to a given coordinate system by warping them to fit a reference or base document. The base document can be an image, a vector file, a drawing, a map sheet, or a list of known points (from a GPS system, for example).

Warping Images with Register

In Chapter 7 (Transforming Images), you learned how to warp an image with the Warp Image tool from the Image Transform tool box. This tool uses control points, like Register, but it is used only for simple, straightforward transformations.

Register permits more control on establishing the transformation models and gives access to more sophisticated features, such as:

- Dynamic warping which overlays existing vector data over the uncorrected image, so you can verify the actual transformation model and decide whether it is good enough for running the resampling of the image.
- More flexibility for entering and managing control points. Any control point can be moved or deleted.
- Polynomials models which can be used for more severe distortion.
- A No-Residual Transformation model for precision in control points.
- Any number of control points. When there are more Dynamic Warping in Views Displaying Uncorrected Data than the minimum required, residuals can be used for inspecting and analyzing the actual model.
- Transformation of vector data through the same model.
- Batch resampling of images.

Transformation Models

Various warping transformation models are supported:

- Helmert
- Similitude
- Affine
- Projective
- Thin Plate Spline - *No Residuals*
- Polynomial

The unique design of Register permits you to visually determine if the transformation model is accurate. Since base vector data is displayed over the target image, it is simple to identify inaccuracies in the model. To assist you in the warping process, Register displays statistical information about the accuracy of the transformation model. You can also dynamically change the transformation model and interactively edit the control points on the base document.

When the transformation model is accurate, as many images as necessary can be resampled. Resampling methods include nearest neighbor, bilinear interpolation, and cubic convolution.

Concepts

Registering images or vectors requires that their geometry be altered to fit another geometry taken as a reference. The process consists of two steps. First, a transformation model is built. Second, the images or vectors are resampled through this transformation model.

Throughout this chapter, the terms base and uncorrected are used with a very specific meaning:

- The base is the system of coordinates taken as a reference and onto which the uncorrected data is registered. The base can be vectors, digital images, hard copy, a series of known points, or some other geometric source.
- The uncorrected data is a digital document targeted to fit the base after it is transformed through a mathematical model.

Building a Model

Building a model requires that a set of mathematical functions be built to establish correspondence between any point in the base geometry and the corresponding point in the target geometry.

The way that Register establishes this set of functions is by placing a set of corresponding points, called control points, and interpolating for the remainder of space around the control points. The control points are represented by color marks in both base and uncorrected spaces. The interpolation is done with smooth two dimensional functions like Helmert, Affine, Similitude, Projective, and up to a third degree Polynomial.

To test the accuracy of the interpolation, Register warps a representation of the base vector data to fit the uncorrect data. This visualization illustrates the fit that occurs when you resample the uncorrect data to fit the base data.

This visual feedback assists you as you gather more points and improve the fit. After enough points are gathered to satisfy the requirements of the selected transformation model, the uncorrect image or vectors can be resampled using this model. Since the fit has already been determined visually, the result is “what you see is what you get” resampling.

Warping the base vector data is done dynamically and is normally fast. It is recommended that you warp a small but significant set of base vector data. The set of base vector data can be acquired by extraction from one or several base documents, in digital or analog formats: design files, digital images, analog maps, drawings, plans, lists of known points, and so forth.

With a design file, extract a few representative elements or parts of elements. With a digital image, extract a few representative elements by interpretation. With a hard copy document, digitize a few representative elements. With a list of known points, no base vector data set is needed to use the dynamic warping capability since the control point marks play this role.

You can also use Register to build a model without a set of base vector data and without dynamic warping, which resembles the method that is commonly used with most geometric correction software. However, with this method there is no means to test the accuracy of the model prior to resampling the image or vector file.

Another unique feature of Register is the alleviation of the constraint of finding “true” or “exact” control points. With Register, you can use “fuzzy” control points, because of the visual feedback provided by dynamic warping.

A true or exact control point is a point which can be precisely identified on both the base data set and on the data to be registered. Examples include the crossing of two roads, the corner of a part, the corner of a building, and so forth. A fuzzy control point is a point which can be localized approximately on both documents. Examples include the center of a lake, window, or field, or the top or side of a car, and so forth.

When you use fuzzy control points, pick each point approximately in the base space and pin it in the uncorrected space by determining its general position. The dynamic warping shows if your placement is accurate enough. If not, just move the point.

The following design elements are supported for dynamic warping:

- Arcs
- Cells
- Complex shapes
- Ellipses
- Circles
- Line Strings
- Shared Cells
- Text Nodes
- B-Spline Poles
- Complex chains of strings
- Curves
- Lines
- Shapes
- Text

Standard Registration Transformation Models

When you install MicroStation Descartes, several standard transformation models (RGR files) are copied to the DCARTES\STANDARD directory (offered as the default directory).

These models support basic transformations such as mirrors and rotations of an image. Standard models provided are:

- NEUTRAL.RGR
- 45CLOCK.RGR
- 90CLOCK.RGR
- 135CLOCK.RGR
- 180CLOCK.RGR
- 135COUNT.RGR
- 90COUNT.RGR
- 45COUNT.RGR
- HMIRROR.RGR
- VMIRROR.RGR

W The rotation and the mirror models use (0,0) as the origin of the output image. If you want the output image to be in the same spatial reference as the input image, edit the origin of the output.

Image Resampling

The image resampling process creates a new image, pixel by pixel, by establishing an appropriate value for each pixel. The resulting image is similar to the one from which it is calculated, with a very close radiometry and with a slightly different geometry.

There are two steps in the image resampling process:

- For each pixel of the output image, the first step is to find the corresponding point in the input image by passing it through the established transformation model.
- The second step is to calculate the value of the output pixel by using the value of one or several pixels located on or around the corresponding point in the input image.

The Nearest Neighbor algorithm uses only one input pixel. Bilinear Interpolation uses the four nearest neighbors and calculates the weighted mean. Cubic Convolution uses a four by four matrix of pixels and calculates a type of weighted mean.

The Nearest Neighbor algorithm is faster, but it can cause jagged edges or lines on the output image. The Cubic Convolution algorithm takes longer, but the result is much smoother. The

Bilinear Interpolation is a compromise between the other two methods in both speed and image quality.

The image resampling process can be independent of the process of building a model with control points. It is used with various other kinds of models such as translations, rotations, and scale changes, or even with a neutral model used only to cut images into pieces or to change the resolution of images. A set of standard models is provided with MicroStation Descartes.

Image Resampling can also be done dynamically by choosing to use the transformation matrix of the image. This process is achieved simply by turning OFF the Create a New Image option from the Register dialog box.

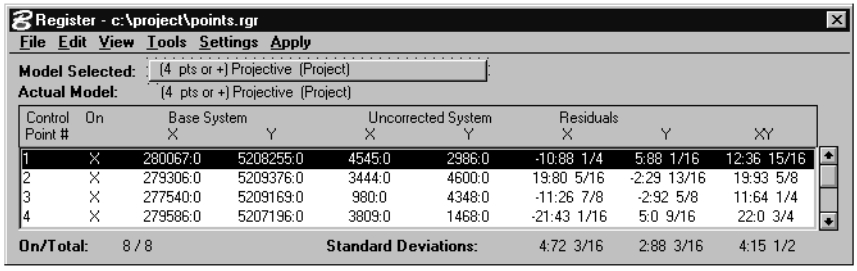
Vector Resampling

The vector resampling process copies or moves the selected design elements through the transformation model. The design elements are selected from the master file or from any reference file by using a fence or a selection set. You control whether each design element type will be considered or ignored by the transformation model. This flexibility is useful when processing many elements.

Register dialog box

Access the Register dialog box by choosing Register from the Utilities menu of Image Manager, or by selecting the Register dialog button from the Register tool box. The title bar of the Register dialog box displays the name of the current model. If a model is not open or if the current model has not been given a name, Untitled displays as the file name.

Register dialog box



Model Selected

Use the Model Selected option menu to select the type of model. The Actual Model field provides feedback on the actual model that can be calculated from currently captured control points.

Below the menu bar of the dialog box and the Model Selection area, the control points used to control the building of a model are displayed.

This information provides feedback to assist you in the building of a model with control points. It includes nine columns, which contain the number of a control point, its on/off status, the X and Y coordinates of this point in the base and uncorrected system, and the residuals of this point relative to the actual model.

✍ A model built with Register is a set of equations that define the correspondence between a point in the uncorrected system of coordinates and the equivalent point in the base system of coordinates. The open/close status of the Register dialog box is saved with a project.

For each model in the following list, the minimum number of required control points is indicated:

Model	Min Pts
Helmert	2
Similitude	2
Affine-1	3
Projective	4
Thin Plate Spline	4
Polynomial-2	6
Polynomial-3	10

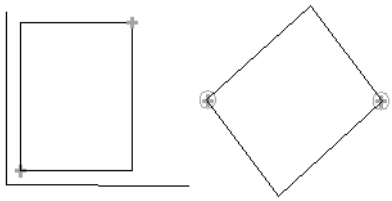
✍ This parameter is saved with a project.

The Helmert model

The Helmert model, also called “rigid body,” performs a rotation and two translations (X and Y); however, no scaling is done. This

model guarantees that the uncorrected data retains its proportions since the image or design elements are only moved and rotated.

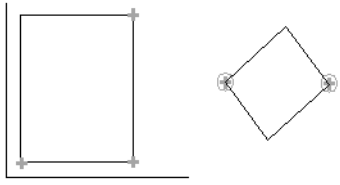
The Helmert model



The Similitude model

The Similitude model performs a rotation, two translations (X and Y), and a scaling that has the same factor for the x- and y-axis. You can use a Similitude model to cut an image, to rotate an image, or to register two images with the same deformation relative to each other.

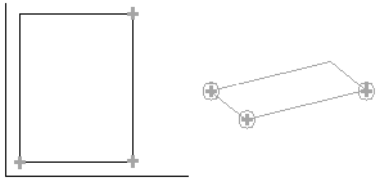
The Similitude model



The Affine-1 model

The Affine-1 performs a rotation, two translations (X and Y), and applies a different scale factor for the x-, y-axis as well as a factor that changes the orthogonality of these axes. You can use the Affine-1 model to register a document that has very little deformation such as a scanned map.

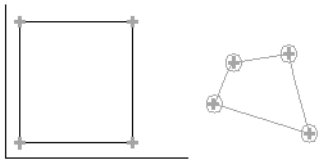
The Affine model



The Projective model

The Projective model projects one plane into another plane. Like the Similitude and the Polynomial-1 models, it can be used to register a document that has very little deformation. For example, you can use it to register an aerial photograph that has little relief.

The Projective model



Thin Plate Spline model

The *Thin Plate Spline model* is based on a four variable mathematical algebraic formula. This means that this model requires at least four pair of control points to resolve the transformation model.

The benefits of this model resides in the fact that in order to compensate for the distortion caused by the rubbersheeting, instead of moving the control points to accommodate the residual values as in the traditional models, the *Thin Plate Spline* does not move the control points but instead, applies a correction elsewhere around the control points.

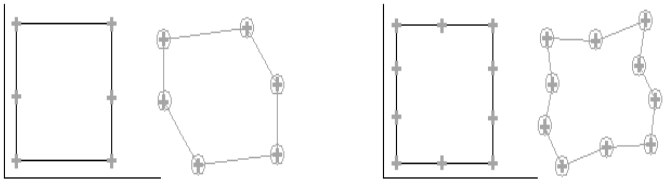
The trade-off is where it will most often be required to enter more control points than a traditional model. Control points will be positioned where the two systems (correct and uncorrected) do not aligned. Control points must be entered until the tanglement is satisfactory.

The Polynomial-2 and 3 models

The Polynomial-2 and 3 models are used to register documents that have moderate relief. However, they are not suitable for documents that contain accentuated relief. For example, you can use these models to register aerial photographs of a city with low

hills, but should not use these models to register aerial photographs of a mountainous region.

The Polynomial models



Actual Model

When there are not enough points to build the requested model, a provisional model, needing less points, is calculated to support the dynamic warping.

When the minimum number of points is reached for the model requested, the Actual Model field displays the same name as the Selected Model option menu. If Dynamic Warping in Views Displaying Uncorrected Data is on and for any reason the model cannot be calculated with the present set of control points, the actual model shown is None.

✍ If Dynamic Warping in Views Displaying Uncorrected Data is off, the actual model is None and the model is not updated after a control point is added, removed, or modified.

Control Point #

The Control Point # column provides a sequential number for all control points entered. If a point is removed or if a new point is inserted between two existing points, the list renumbers.

On

The On column indicates whether the corresponding control point is on or off in the calculation of the actual model. A mark X indicates on. An empty space indicates that this point is turned off. Double-clicking a line of the list toggles the status of the corresponding control point between on and off.

Base System X, Y

The X and Y columns under Base System display the coordinates of control points in the “base” system of coordinates. This system is the one into which the image is to be transformed after it is resampled by applying the model.

Uncorrected System X, Y

The X and Y columns under Uncorrected System display the coordinates of control points in the "uncorrected" system of coordinates.

Residuals X, Y, XY

The residual of a control point is the difference in location between the position where a control point is pinned on the uncorrected system as compared to the position it should be according to the actual model. When a model is built with the minimum number of control points, such as four points for the Projective, there is no residual (except for Helmert). This situation means that the model "trusts" you and puts the calculated point exactly where you pinned it on the uncorrected system.

In fact, since the model has only the minimum number of points, it must make this assumption. As soon as an extra point is provided, it can compare the position you "guessed" with the position it calculates through the model. The difference between your "guess" and the calculated position is the residual.

After a model is updated, the distance between the two corresponding marks reveals the residual for this pair of control points. As long as there is not an extra point, the model is exact, i.e., there is no residual (except for Helmert). Consequently, the two corresponding marks of each pair coincide.

The model supported is always the best fit to all points, when extra points are provided. Normally, when a control point is inconsistent with the others, its residual is greater. The residuals displayed in the Control Points List box are indications of points that can need adjustment. Turning off the point with the greatest residual normally improves the actual model.

Residuals are distances. The three columns X, Y, and XY under Residuals indicate the X component, the Y component, and the magnitude (XY) of this distance.

The Helmert model differs from the other models in respect to residuals. Because this model guarantees that the body of the uncorrected geometry stays rigid (without scale modification), the minimum number of control points usually generates residuals. In fact, with two control point pairs, the Helmert model moves and rotates the rigid body until the residuals are minimized.

✍ If you turn off the only extra point, the new residuals are zero, but do not interpret this situation to mean that all points are satisfactory. There is not a residual when there is not an extra

control point (except for Helmert), independent of whether the points are appropriate.

On/Total

The On/Total field displays the number of control points turned on over the total number of control points in the present list.

Standard Deviation X, Y, XY

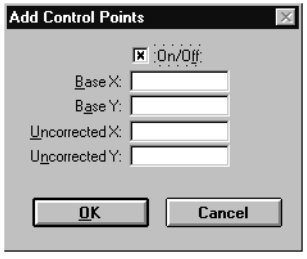
The Standard Deviation field displays the standard deviation for each set of residuals, one for each of the X, Y, and XY columns. The standard deviation values provide a good assessment of the model, and supplement the individual residuals.

File menu

The File menu provides access to all necessary options to manage Register files. A Register file is used to save a transformation model for later use. The same functions (New, Open, Save, Save As) can also be accessed from the Register File tool box (page 8-25).

Edit menu

The Edit menu provides access to various tools and dialog boxes that are used to create or modify a model. Use these features to enter, modify, delete, highlight, or locate pairs of control points, and to identify the coordinate system to which the base data belongs.



Add Control Points dialog box

Edit > Add Control Points

Choose Add Control Points from the Edit menu to manually enter a pair of control points: (Base X, Base Y) and (Uncorrected X, Uncorrected Y).

The On/Off check button toggles this pair of points between on or off. When on, the pair of points is taken into account for the calculation of the actual model and the corresponding marks display in the appropriate views. When off, this pair is suppressed and the marks are not shown. The points, however, can be turned on and used again by using the Modify Control Points dialog box.

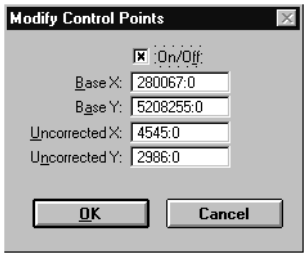
The new pair of points is always added after the previously selected line. If the new line is inserted before the last existing line, a renumbering of the following lines results.

In some situations, this result might not be desirable. Consider when an analog hard copy map is used as the base data. In this

case, the corresponding numbers would be written directly on the map. Any changes in the sequence of the numbers requires a renumbering of the points on the hard copy. To avoid renumbering in such cases, add points to the end of the list.

If you wish to toggle points on or off, double-click on the corresponding line.

Edit > Modify Control Points



Modify Control Points dialog box

Choose Modify Control Points to modify the selected pair of control points by manually editing the following coordinates: (Base X, Base Y) and (Uncorrected X, Uncorrected Y).

The On/Off check button toggles this pair of points between on or off. When on, a pair is taken into account for the calculation of the actual model and the corresponding marks display in the appropriate views. When off, this pair of points is suppressed and the marks are not displayed. Alternatively, double-click on the corresponding line to toggle points on or off.

Edit > Delete Control Points

Choose Delete Control Points to remove the selected pair of control points from the list.

W Removing a line from the list results in renumbering of all subsequent lines.

Edit > Highlight Control Points

Choose Highlight Control Points to highlight the selected pair of control points. This feature uses the same color that MicroStation uses for highlighting elements when they are selected or identified.

Edit > Locate Control Points

Choose Locate Control Points to locate and highlight the selected pair of control points in the center of views that are set for locating control points (See “View > Views Used to Locate Control Points” on page 8-16). This feature is useful for rapidly panning to the location of control points that are not visible. The highlighting is done with the same color that MicroStation uses for selecting elements.

Edit > Coordinate System

Choose Coordinate System to enter a description for the coordinate system for the base data. The coordinate system identified here should be the one into which the image or vectors

will be transformed when it is resampled through the resulting model (the base coordinate system, i.e., the system to which the base vector data belongs).

Coordinate System dialog box

View menu

The View menu provides access to two toggles. One toggle controls the dynamic warping mechanism and the other, the display of control points. Dialog boxes are also provided to permit you to select the views which will display the dynamic warping of vector on uncorrected data and to select the views which will display the location of control points. A final dialog box is used to set the warping window.

View > Dynamic Warping in Views Displaying Uncorrected Data

Dynamic Warping in Views Displaying Uncorrected Data permits you to control the dynamic warping mechanism inside each view where uncorrected data is displayed.

If on, activates both the dynamic warping mechanism and the updating of the model. Each time that a pair of control points is entered or modified, the model is updated and the base vector data is warped. Base vector data is redrawn in views where uncorrected data is displayed, as an overlay to the uncorrected image(s) or vector(s), after being geometrically transformed through the actual model.

If on and the model cannot be calculated with the present set of control points, the actual model displayed will be None and the dynamic warping will not be activated.

Turn off to inhibit both the dynamic warping mechanism and the updating of the model; then, the Actual Model shown will be None.

The dynamic warping process can take time to complete. If you wish to abort it, press the <Esc> key. It is recommended that you use a small set of base vector data in order to accelerate the dynamic warping process. If using a small set of base vector data is not practical, set the warping window so that only the design

elements inside the area that you wish to register are warped (See "View > Warping Window" on page 8-17).

You can also control the warping process for each supported design element type (See "Settings > Elements Transformation" on page 8-19).

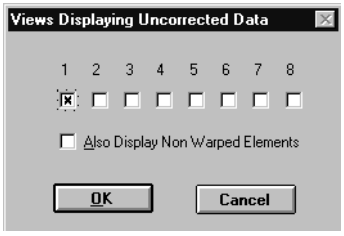
Panning in a view displaying uncorrected data is not recommended when dynamic warping is on. The warping of vectors takes some time and in some circumstances causes MicroStation to not trap the release of the data point button. When this happens, the panning does not stop and performance is seriously degraded. To prevent this situation, move the mouse to another window and click the Reset button (or press the <Esc> key and immediately click the Data button) several times until the panning ceases.

✍ The status of this parameter is saved with a project.

View > Views Displaying Uncorrected Data

Choose Views Displaying Uncorrected Data to identify the view or views where the uncorrected data (the images or vectors to be corrected) will be displayed. If Dynamic Warping in Views Displaying Uncorrected Data is on, the base vector data will be warped over the uncorrected data in the specified views. It will be redrawn after being geometrically transformed through the actual model. In all other views, vector data will behave normally. The check button Also Display Non-Warped Elements controls the presence or absence of non-warped elements (i.e., the original design elements without transformation) in uncorrected views.

View Displaying Uncorrected Data dialog box

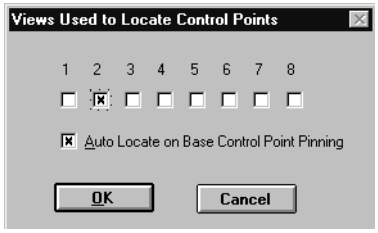


✍ The list of views that display uncorrected data and the status of the check button for displaying non-warped elements is saved with a project.

View > Views Used to Locate Control Points

Choose Views Used to Locate Control Points to identify the view or views where the Locate Control Points feature will be activated (See "Edit > Locate Control Points" on page 8-13).

Views Used to Locate Control Points dialog box



When the Auto Locate on Base Control Point Pinning toggle is on, the selected views will be automatically zoomed around a base control point just after it is pinned.

Use this feature when you want to refine the pinning of control points after you have done it approximately in a view with a smaller scale.

For example, use View 1 for a synoptic display of the whole image. Use View 2 as the detailed view where a zoom occurs automatically after a base control point is selected. Then, View 2 should be selected in the Views Used To Locate Control Points dialog box.

Here is a typical procedure you can follow as an example.

➤ **To use a synoptic view and a detailed view when pinning control points**

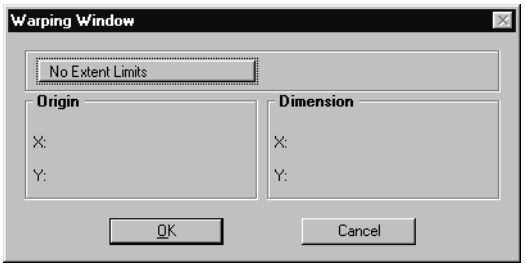
1. Turn on View 2 in the Views Used To Locate Control Points dialog box.
2. Turn on the Auto Locate on Base Control Point Pinning toggle.
3. Select the Place Control Points tool from the Register tool box.
4. Pin a base control point in View 1. View 2 automatically zooms around this point.
5. If the pinning of this point needs refinement, press the Reset button. That removes the last base control point and allows you to pin it again (in the zoomed view).
6. Pin the uncorrected control point and iterate the process from step 4.

✍ The list of views that are used to locate control points is saved with a project.

View > Warping Window

Choose Warping Window to set the size of the warping window. The warping window is the extent in which the dynamic warping occurs if Dynamic Warping in Views Displaying Uncorrected Data from the View menu is on. You should set the size of the warping window if the extent of the design elements is larger than the area that you wish to register. If you choose this option, the time to warp the design elements is reduced since registration does not consider the elements outside of the warping window.

Warping Window dialog box



✍ The status of this parameter is saved with a project.

Use the option menu to choose the method to set the warping window. You may choose among the following options:

- No Extent Limits
- Base Data Extent
- Marks Extent
- User Specified Extent

No Extent Limits sets no limits to the window (the default value).

Base Data Extent sets the size of the warping window to that of the base data. You can adjust this size by using the Plus/Minus field. Entering a positive value increases the window by that percentage. Entering a negative value (with a minus sign) decreases the window by that percentage. The Base Data Extent updates when the Fit Active Design tool from the View Control palette is used.

Marks Extent sets the size of the warping window to the extent of all open marks. You can adjust this size by using the Plus/Minus field; note that this option is not accessible unless you have input at least two marks.

User Specified Extent lets you manually set the warping window in the Window group.

Use the Origins and Dimension groups to manually enter the origin and the dimensions of the warping window. When Base Data Extent or Marks Extent are chosen from the option menu, these groups display the actual parameters that define the window. This window displays in the Views Displaying Uncorrected Data.

View > Show Control Points

Show Control Points permits you to control the display of control point marks.

If on, activates the display of the control points mechanism. Then, both control points for all pairs of points are displayed according to the selected colors (See "Settings > Colors for Control Points" on page 8-18).

If off, suppresses the display of the control points mechanism.

✍ The status of this parameter is saved with a project.

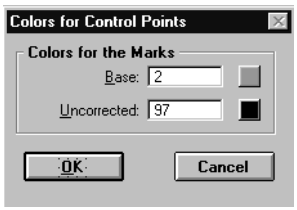
Tools menu

The Tools menu of Register has two items:

- Choose Register to open the Register tool box (See page 8-20).
- Choose Register File to open the Register File tool box (See page 8-25).

Settings menu

Use Register/Settings to set the colors of the symbols that are used to mark the control points, to toggle on or off the Warning When Renumbering option, or to access the Elements Transformation dialog box.



Colors for Control Points dialog box

Settings > Colors for Control Points

Choose Colors for Control Points to set the colors for the symbols that are used to mark control points. Colors for the base control points mark and the uncorrected control points mark can be set independently. Next to each field where the color number is entered, the actual color corresponding to this number displays on a color button. You can also select the color with the color picker that pops up when you click the color button.

✍ The color numbers for the marks are saved with a project.

Settings > Warning when Renumbering

Warning when Renumbering permits you to be warned when the list of control points is going to be renumbered. If a line is inserted or deleted before the last existing line in the control points list box, a renumbering of the next points results.

If on, you are warned when a renumbering is about to occur.

If off, you are not warned when a renumbering is about to occur.

✍ To avoid renumbering, add points to the end of the list or turn a line off instead of deleting it.

✍ The status of this parameter is saved with a project.

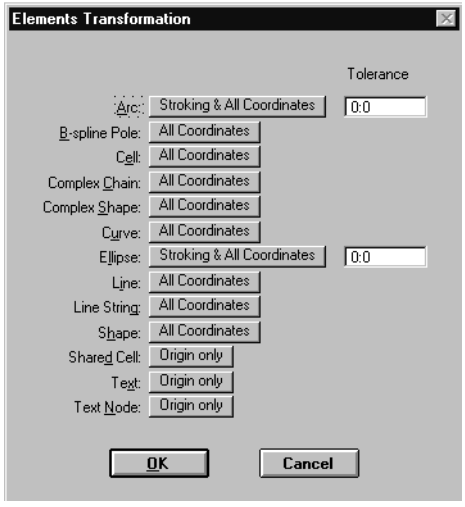
Settings > Elements Transformation

Choose Elements Transformation to control which design element types are used for the dynamic warping process, the Copy Vectors command, and the Move Vectors command. To disable a specific design element type for the transformation process, select the None option for the appropriate option button.

To enable a specific design element type, select the appropriate option for each design element type:

- All Coordinates
- Origin Only
- Stroking & All Coordinates

Elements Transformation dialog box



When All Coordinates is selected, the transformation model is applied to each (X,Y) coordinate of the element.

When Origin Only is selected, the transformation model is applied only on the origin of the element. Others characteristics such as rotation angle, scale, and so forth are not modified.

When Stroking & All Coordinates is selected, the transformation process modifies the original structure (i.e., center point, start angle, etc.) of the element. First, the element is stroked into a complex chain based on the specified Tolerance. Second, the transformation model is applied to each (X,Y) coordinate of the element. If the element does not transform as expected, adjust the Tolerance and repeat the process.

✍ The status of supported design elements types and tolerances are saved with a project.

Apply menu

Apply > To Image

Selecting To Image from the Apply menu opens the Resampling dialog box. Use the Resampling dialog box to set all parameters to resample an image through a geometric correction model built with Register.

Register tool box

Register tool box

This tool box provides access to tools you can use to place, move, or delete control points, to copy or move vectors through the actual model, or to prepare the resampling of the actual image. The last button opens the Register dialog box, but it does not need to be open to use the other tools.

Place Control Points tool

Place Control Points tool

Click the *Place Control Points* tool to place a new pair of control points.

➤ **To place control points**

1. Select *Place Control Points*.
2. Move the base control point mark to the desired place relative to the base data.

3. Pin the base control point mark.
4. Move the uncorrected control point mark to the corresponding place on the uncorrected data.
5. Pin the uncorrected control point mark.

The resulting pair of control points then displays in the control points list box in the Register dialog box, with the status set to on. The pair is inserted just after the previously selected line and the new line is now selected (highlighted). If Dynamic Warping in Views Displaying Uncorrected Data is on, the model updates and the base vector data warping updates in the specified views.

After a model is updated, the distance between the two corresponding marks reveals the residual for this pair of control points. As long as there are not extra points, the model is exact, i.e., there is no residual. Consequently, the two corresponding marks of each pair coincide.

✍ Alternatively, you can pin any control point using the MicroStation XY= key-in. However, the tentative point mechanism is supported only with base data and not with uncorrected data.

Move Control Point tool

Click the *Move Control Point* tool to move an existing control point mark.

Move Control Point tool

➤ **To move a control point**

1. Select the *Move Control Point* tool.
2. Identify an existing control point mark (a base control point mark or an uncorrected control point mark).
3. Accept the control point mark, or reject and retry.
4. Move the control point mark to the desired place relative to the base or to the uncorrected data.
5. Pin the control point mark.

The line in the list box corresponding to the modified control point is now selected (highlighted) and is rewritten with the adjusted coordinates. If Dynamic Warping in Views Displaying Uncorrected Data is on, the model updates and the base vector data warping refreshes in the specified views.

After a model is updated, the distance between the two corresponding marks indicates the residual for this pair of control

points. As long as there is no extra point, the model is exact, i.e., there is no residual. Consequently, the two corresponding marks of each pair coincide.

✍ Only the points turned on can be modified with Move Control Point, since the points turned off are not marked. If you want to toggle points on or off, double-click on the corresponding line.

Delete Control Points tool

Delete Control Points tool

Click the *Delete Control Points* tool to remove an existing pair of control points from the control points list box.

➤ **To remove (delete) a pair of control points**

1. Select the *Delete Control Points* tool.
2. Identify an existing control point mark, whether it is a base control point mark or an uncorrected control point mark.
3. Accept the control point mark, or reject and retry.

When the identified point is accepted, both marks that belong to this pair are deleted and the corresponding line is removed from the list box. The rest of the list is renumbered. If Dynamic Warping in Views Displaying Uncorrected Data is on, the model updates and the base vector data warping refreshes in the specified views.

After a model is updated, the distance between the two corresponding marks reflects the residual for this pair of control points. As long as there are no extra points, the model is exact, i.e., there is no residual. Consequently, the two corresponding marks of each pair coincide.

✍ Only the points turned on can be deleted with the Delete Control Point tool, since the points turned off are not marked. If you want to toggle points on or off, double-click on the corresponding line.

Copy Vector tool

Copy Vector tool

Click the *Copy Vector* tool to copy vectors through the active transformation model. To control which design elements types should be affected (See “Settings > Elements Transformation” on page 8-19).

➤ **To apply the registration model to the vectors**

1. Select the *Copy Vector* tool.
2. Choose the Direction of the transformation from the option button. Choices are Base to Uncorrected or Uncorrected to Base.
3. Identify an element from the appropriate geometry (Base or Uncorrected) according to the selected Direction.
4. Accept the element, or reject and retry.

➤ **To constrain the copy with a Fence or Selection Set**

1. Select the *Copy Vector* tool.
2. Choose the Direction of the transformation from the option button. Choices are Base to Uncorrected or Uncorrected to Base.
3. Draw a fence or build a Selection Set using the MicroStation tools.
4. Select the *Copy Vector* tool again.
5. You are asked to confirm the operation on all selected elements. Click OK to proceed or Cancel to cancel.

If there is not an active transformation model, you are informed. In this circumstance, you should load a transformation model using the File/Open option from the Register dialog box or build one using the Control Points tools from the Register tool box.

✍ When Dynamic Warping in Views Displaying Uncorrected Data is on and the toggle Also Display Non-Warped Elements is off, MicroStation Descartes prevents MicroStation from displaying original design vectors in Uncorrected Views. Consequently, the vectors transformed by the current command do not display. If this is the case when you select Copy Vectors, you are provided with the option to turn on the display of non-warped elements.

Move Vector tool

Move Vector tool

Click the *Move Vector* tool to move vectors through the active transformation model. To control which design elements types should be supported (See “Settings > Elements Transformation” on page 8-19).

➤ **To apply the registration model to the vectors**

1. Select the *Move Vector* tool.
2. Choose the Direction of the transformation from the option button. Choices are Base to Uncorrected or Uncorrected to Base.
3. Identify an element from the appropriate geometry (Base or Uncorrected) according to the selected Direction (elements from a Reference file or locked elements cannot be identified).
4. Accept the element, or reject and retry.

➤ **To constrain the move with a Fence or Selection Sets**

1. Select the *Move Vector* tool.
2. Choose the Direction of the transformation from the option button. Choices are Base to Uncorrected or Uncorrected to Base.
3. Draw a fence or build a Selection Set using the MicroStation tools.
4. Select the *Move Vector* tool again.
5. If at least one of the selected elements is in a reference file, you are informed that this operation is not possible. Otherwise, you are asked to confirm the operation on all selected elements. Locked elements are not moved. Click OK to proceed or Cancel to cancel.

W If there is not an active transformation model, you are informed. In this circumstance, you should load a transformation model using the File/Open option from the Register dialog box or build one using the Control Points tools from the Register tool box.

✍ When Dynamic Warping in Views Displaying Uncorrected Data is on and the toggle Also Display Non-Warped Elements is off, MicroStation Descartes prevents MicroStation from displaying original design vectors in Uncorrected Views. Consequently, the vectors transformed by the current command do not display. If this is the case when you select Move Vectors, you are provided with the option to turn on the display of non-warped elements.

Resample Image tool

Resample Image tool

Used to open the Resampling dialog box and quickly prepare a "fresh" resampling page by setting all parameters with default values:

- In the Job Manager group, the tool goes to the first free page.
- Input Image: the active image (if there is no active image when *Resample Image* is pressed, a message displays).
- Model: the current model, which is previously saved (if the current model is Untitled, it will be given the name of Input Image with the RGR extension).
- Output Image: the same name as Input Image, but with a sequential number (1, 2, 3, etc.) added at the end of the name. If the name already has eight characters, the last character(s) can be overwritten by the added digits.
- Window: All Input Image.
- In the Resampling group, all usual default are used.

You can edit any parameter, or keep all defaults and run the page at once.

Register Dialog tool

Register Dialog tool

Used to open the Register dialog box (See page 8-6).

Register File tool box

Register File tool box

The Register File tool box includes all necessary tools to manage Register files.

A Register file is used to save a transformation model for later use. When it is given a name, it is saved with the project. Any time unsaved changes are going to be lost, a warning message displays giving you an option to save the file.

New Register File tool

Used to create a new Register file.

New Register File tool

➤ **To create a new Register file**

1. Select *New Register File*.

   If a Register file is already open, it closes. The new file is not given a name until it is saved with the Save Register File tool.

Open Register File tool

Used to open a Register file.

Open Register File tool

➤ **To open an existing Register file**

1. Select *Open Register File*.
2. Use the File Navigation dialog box to choose an existing file.

   If a Register file is already open, it is first closed.

Save Register File tool

Used to save a Register file.

Save Register File tool

➤ **To save an unnamed Register file**

1. Select *Save Register File*.
2. Use the File Navigation dialog box to name the file.

➤ **To save a Register file already named**

1. Select *Save Register File*.

   The file will be saved with the same name.

Register Dialog tool

Register Dialog tool

Used to open the Register dialog box (See page 8-6).

Resampling File tool box

Resampling File tool box

The Resampling File tool box includes all necessary tools to manage Resampling files (RSP files). A Resampling file is used to save a schedule of images to be resampled. It can be opened later and be edited or batch processed. The same functions can also be accessed from the File menu of Resampling dialog box.

Any time unsaved changes are going to be lost, a warning message displays giving you the option to save the file.

New Resampling File tool

Used to create a new Resampling file.

New Resampling File tool

➤ **To create a new Resampling file**

1. Select the *New Resampling File* tool.

   If a Resampling file is already open, it closes. The new file is not given a name until it is saved with the Save Resampling File tool.

Open Resampling File tool

Used to open a Resampling file

Open Resampling File tool

➤ **To open an existing Resampling file**

1. Select the *Open Resampling File* tool.
2. Use the File Navigation dialog box to choose an existing file.

   If a Resampling file is already open, it first closes.

Save Resampling File tool

Used to save a Resampling file.

Save Resampling File tool

➤ **To save an unnamed Resampling file**

1. Select the *Save Resampling File* tool.
2. Use the File Navigation dialog box to name the file.

➤ **To save a Resampling file already named**

1. Select the *Save Resampling File* tool.

   The file will be saved with the same name.

Resampling Dialog tool

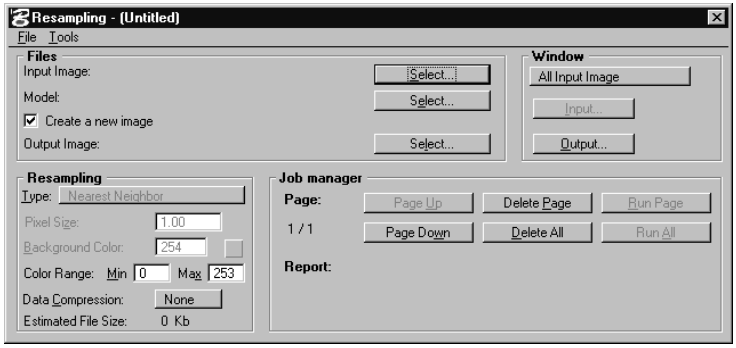
Resampling Dialog tool

Used to open the Resampling dialog box (See page 8-28).

Resampling dialog box

The Resampling dialog box is used to apply a geometric correction model to an uncorrected image. The input data is transformed into an output data set that belongs to the base coordinate system, directly compatible with the base vector data that was used to create the model. Choose To Image from the Apply menu of the Register dialog box to access the Resampling dialog box.

Resampling dialog box



Create a new image

Used to choose whether you would like to actually resample the image or simply use the transformation matrix to apply your changes.

The toggle is automatically checked when the Resampling dialog box opens, but when a Helmert, Similitude, or Affine model is selected, the toggle is automatically unchecked but remains enabled. When a Projective or Polynomial model is selected, the toggle is checked and disabled, since the transformation matrix does not support these models.

✍ Because the transformation matrix is a new addition to MicroStation Descartes, *Register* operations performed solely with the transformation matrix will not appear if the file is opened in MicroStation Descartes 6.0. If you plan to use an image in a previous version of MicroStation Descartes and would like it transformed, you may wish to resample the image at this time.

✍ Only file formats which support a transformation matrix will maintain mirroring operations stored in the transformation matrix. For all file formats without a transformation matrix, such as standard TIFF or BMP files, MicroStation Descartes adds a sister file (hgr or worldfile). However, if this TIFF or BMP are opened in an application where worldfiles are not supported, the information in the transformation matrix will not be applied to the image. If you plan to use a file format which does not support a transformation matrix in another application, you may wish to select Create A New Image and resample the image at this time.

If you decide to use a file format that does not support a transformation matrix, it is possible to resample the image using its own transformation matrix. In order to do this, simply leave the *Model:* field empty and resample. You can also resample a file with its own transformation matrix by using Save As or Batch Convert.

Input Image field

The Input Image field displays the name of the input image file. Click the Select button to open the File Selection dialog box. This dialog box is used to select an existing image file for resampling.

Model field

The Model field displays the name of the transformation model file. If there is an active model in the Register dialog box, it displays in this field. You are prompted to save it if you have made changes since the last save.

To change the current selection, click the Select button to open the File Selection dialog box. This dialog box is used to select an existing RGR transformation model file for the resampling process.

W A model is always connected to the input image through the following parameters found in the header: Origin, Dimensions, and Pixel Size. If you change any of them, the model is no longer valid for this image.

Output Image field

The Output Image field displays the name of the output image file. Click the Select button to open the File Selection dialog box. This dialog box lets you specify the name of the image file that will be created by resampling.

All Input Image

Use All Input Image to define the output window in such a manner that it covers the input image entirely.

All Input Image/Input

Click the Input button with the All Input Image option to open the Input Image Window dialog box. The name of the input image displays in the title bar. No parameter of this dialog box can be edited. This dialog box is used only to display the actual window of the input image, as well as with content reflected in the header of this image.

All Input Image/Output

Click the Output button with the All Input Image option to open the Output Window dialog box. The name of the output image displays in the title bar.

If an output image is not selected, Untitled is displayed. No window parameter (origin or dimension) of this dialog box can be edited. The dialog box is used only to display the window of the output image.

The output window is calculated automatically to cover the entire input image. Only the description of the output image and the pixel size can be entered using the Output Window dialog box. This information is used to prepare the header of the output image.

Specified through Input

Use the Specified through Input option to define the output window through another window which is set in the input system of coordinates.

Specified Through Input/Input

Click the Input button to specify the origin and the dimensions of the input window. The name of the input image and other information is displayed, but cannot be edited. When the output window is set through the input space, it adjusts accordingly and in such a manner that it covers the input window entirely.

Specified Through Input/Output

Click the Output button to open the Output Window dialog box. The name of the output image displays in the title bar. If an image is not selected, Untitled is displayed. No window parameter (origin or the dimensions) of this dialog box can be edited. The dialog box is used only to display the window of the target output image. The values are calculated automatically to cover the input

window entirely. Only the description of the output image and the pixel size can be entered using the Output Window dialog box. This information is used to prepare the header of the output image.

Warping Window

Use the Warping Window option to define the output window by setting its equivalent to the warping window defined with the Warping Window dialog box.

✍ The Input and Output buttons behave like the All Input Image option (See page 8-30).

Specified in Output Space

Use the Specified in Output Space option to define the output window by setting it directly in the output space.

✍ With the Specified in Output Space option, the Input button is not accessible.

Specified in Output Space/Output

Click Output button with the Specified in Output Space option to open the Output Window dialog box. The name of the output image displays in the title bar. If an image is not selected, Untitled is displayed. This dialog box can be used to specify the true origin and dimensions of the output window. All other fields can also be entered or edited in order to prepare the header of the output image.

Type

Three algorithms can be chosen through the Type option menu:

- Nearest Neighbor
- Bilinear Interpolation
- Cubic Convolution

The Nearest Neighbor algorithm uses only one input pixel. Bilinear Interpolation uses the four nearest neighbors and calculates the weighted mean. Cubic Convolution uses a four by four matrix of pixels and calculates a type of weighted mean.

The Nearest Neighbor algorithm is faster, but it can cause jagged edges or lines on the output image. Cubic Convolution usually produces the best results, but the calculation requires more time to process than the other algorithms. The Bilinear Interpolation provides a compromise in quality of output and time to process.

✍ With a gray scale image, all three options are offered. With a color image, only Nearest Neighbor is available.

Pixel Size

Use the Pixel Size field to enter the size of pixels for the output image. Only square pixels are supported; the entered value is taken as the X and Y dimensions of the pixels.

✍ Except for special effects, it is recommended that you set the pixel size of the output image equal to or close to the pixel size of the input image.

Background Color

The background color is a color number or index used to initialize the output image file prior to resampling. Therefore, any part of the output image which is not covered by resampled pixels remains this color. You can enter the background color index into the Background Color field. You can also select the color with the color picker that pops up when you click the color button.

Color Range

The Color Range restricts the resampled pixels colors to be within a specific interval. For each resampled pixel, a color number smaller than the minimum receives the minimum color value and a color greater than the maximum receives the maximum color value. This feature could be used, for example, to ensure that the pixels of the image foreground does not use the same color value as the background color.

Data Compression

Use the Data Compression option menu to choose among the following data compression options:

None	Choose None to resample an image as a file without compression. The exact file size is provided by the File Size indicator.
Deflate	Applies the Deflate compression algorithm to the HMR output image. No data is lost in this compression scheme. The Deflate option is available for 8 bit format images.
PackBits	PackBits is available only for 1 bit format images. The output files are compressed without data loss. The File Size indicator displays the maximum size of your output file.

CCITT3	Often spoken of as Group III compression, is available only for 1 bit format images. The output files are compressed without data loss. The File Size indicator displays the maximum size of output file.
CCITT4	Often spoken of as Group IV compression, is available only for 1 bit format images. The output files are compressed without data loss. The File Size indicator displays the maximum size of output file.

Estimated File Size field

The Estimated File Size field provides an estimate of the projected size of the image file that would be created without compression. If compression is selected, the resulting file size cannot be estimated precisely because it can vary substantially with the image content.

Page Up/Page Down

In Register, each file submitted for resampling has each of the resampling parameters displayed in the Job Manager group boxes. The values for each file can be viewed and edited by scrolling the individual pages. Use the Page Up or Page Down buttons to move from the current page to the previous or next page. If the Page Down button is pressed when there is not an additional page, a prompt asks you if you wish to open a new page. If you open a new page, it is created with the default parameters.

Delete Page

Click the Delete Page button to delete the current page and all of its parameters. This page is removed and all following pages are renumbered. If the first and only page is deleted, it remains open and the parameters are established with the default settings.

Delete All

Click the Delete All button to delete all pages but the first page. The parameters of the first page are established with the default settings.

Run Page

Click the Run Page button to start the resampling process according to the parameters of the current page. Before a job is run, the available disk space is checked based on the estimated file size. If the Data Compression is None and there is not enough space, the resampling job is not run and you are notified by a warning box.

While the batch program is running, a Progress window provides feedback. After the job is completed or terminated, a Report line displays the result of the processing corresponding to this page. It indicates whether the processing was successful and, if not, it declares what error or event caused it to be unsuccessful.

Run All

Click the Run All button to start the resampling process of all pages, one at a time, according to the parameters of each page. While the batch program is running, a Progress window provides feedback. For each page, a Report line displays the result of the batch processing job corresponding to this page. It indicates whether the processing of this job was successful and, if not, it declares what error or event caused it to be unsuccessful.

Page

The Page field indicates the number of the current page and the total number of pages prepared.

Report

For each page, a Report line displays the result of the processing that corresponds to this page. It indicates whether the processing was successful and, if not, it declares what error or event caused it to be unsuccessful.

File menu

The File menu of Resampling provides access to all necessary options to manage Resampling files (RSP files). A Resampling file is used to save a schedule of images to be resampled. It can be opened later and be batch processed. The same functions (New, Open, Save, Save As) can also be accessed from the Resampling File tool box (See page 8-27).

Tools menu

Choose Resampling File from the Tools menu of Resampling to open the Resampling File tool box (See page 8-27).