User guide
H-5750-8533-06-A

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SPRINT™ Freeform Surface: Editor

Renishaw part no: H-5750-8533-06-A

Issued: 09.2018

Compatibility

This document is intended for use with version 1.1.3 of the SPRINT™ Freeform Surface application.

The application has been developed and tested against Productivity+™ version 3.1 but may also work with later versions.

Caution – Software safety

The software you have purchased is used to control the movements of a machine tool. It has been designed to cause the machine to operate in a specified manner under operator control, and has been configured for a particular combination of machine tool hardware and controller.

Renishaw has no control over the exact program configuration of the controller with which the software is to be used, nor over the mechanical layout of the machine. Therefore, it is the responsibility of the person putting the software into operation to:

- ensure that all machine safety guards are in position and are correctly working before commencement of operation;
- ensure that any manual overrides are disabled before commencement of operation;
- verify that the program steps invoked by this software are compatible with the controller for which they are intended;
- ensure that any moves which the machine will be instructed to make under program control would not cause the machine to inflict damage upon itself or upon any person in the vicinity;
- be thoroughly familiar with the machine tool and its controller, understand the operation of work co-ordinate systems, tool offsets, program communication (uploading and downloading) and the location of all emergency stop switches.

IMPORTANT: This software makes use of controller variables in its operation. During its execution, adjustment of these variables, including those listed within this document, or of tool offsets and work offsets, may lead to malfunction.

Designations

Throughout this document, the following designations are used:

Screen names, fields names, dialogs, selectable menu options and program statement are referenced in oblique font. For example, *Custom Macro: FreeformSurface*; *OutputFormat* property.

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Before you begin

This document contains detailed information about how to use the probing software for programming, operating and controlling your machine tools.

Split into four chapters and four appendices, this document is structured to provide the information that you require to use the probing software effectively.

- Chapter 1 provides a general introduction to the SPRINT Freeform Surface Toolkit.
- Chapter 2 describes how to create a basic Freeform Surface program.
- Chapter 3 introduces further programming techniques.
- Chapter 4 provides an overview of advanced tools available for use with the Freeform Surface Toolkit.

Measurement values

All examples and screenshots given within this document use metric measurement units. Where appropriate, equivalent imperial values are shown in brackets.

Measurement units used by the application are dependent on the selected post processor (**`.RenMF`**) file, and must match those shown in the *Unit Mode* toolbar of Active Editor Pro during program creation.

Folder locations

All folder locations used in this document are examples only. During installation, suitable folder locations will have been determined based on the individual device configuration.

NOTE: This document assumes that both the Productivity+™ CNC plug-in and the SPRINT Freeform Surface: On-machine application are installed to an external data processor, connected to and communicating with, the CNC machine tool control.

Renishaw customer services – calling a Renishaw subsidiary office

If you have a question about the software, first consult the documentation and other information included with your product.

If you cannot find a solution, you can receive information on how to obtain customer support by contacting the Renishaw subsidiary company that serves your country.

When you call, it will help the Renishaw support staff if you have the appropriate product documentation at hand. Please be prepared to give the following information (as applicable):

- The version of the software you are using
- The make and model of your CNC machine tool control
- The exact wording of any messages that appear on your screen
- A description of what happened and what you were doing when the problem occurred
- A description of how you tried to solve the problem

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Chapter 1 – General information

This chapter provides a basic introduction to the SPRINT™: Freeform Surface Toolkit.

Overview

The SPRINT Freeform Surface Toolkit is a combination of software packages that support the scanning of component free-form surfaces. Scanning takes place on a CNC machine tool installed, or operating in conjunction with, the Productivity+™ CNC plug-in system.

The software is designed to support the programming of non-prismatic scanning toolpaths through Productivity+ Active Editor Pro. Offering user-defined reporting in the form of CAD surfaces or sampled points, the application removes the need for complex processing of unfiltered scan data.

Software packages

The SPRINT Freeform Surface Toolkit consists of three elements:

- SPRINT Freeform Surface: On-machine (Renishaw part no. A-5750-2200) – usually installed onto an external data processor which is connected to the CNC machine tool. This component of the Freeform Surface Toolkit deals with data processing and presentation of results to file or NC variables.
- SPRINT Freeform Surface: CNC plug-in Configuration – an installer element which is only required where SPRINT Freeform Surface: On-machine and the CNC plug-in are installed onto separate devices. In such instances, this Configuration element (provided as part of the Freeform Surface On-machine software) must be installed on the device hosting the CNC plug-in.
- SPRINT Freeform Surface: Editor (Renishaw part no. A-5750-2210) – an extension to Productivity+™ Active Editor Pro that provides the functionality to program free-form surfaces.

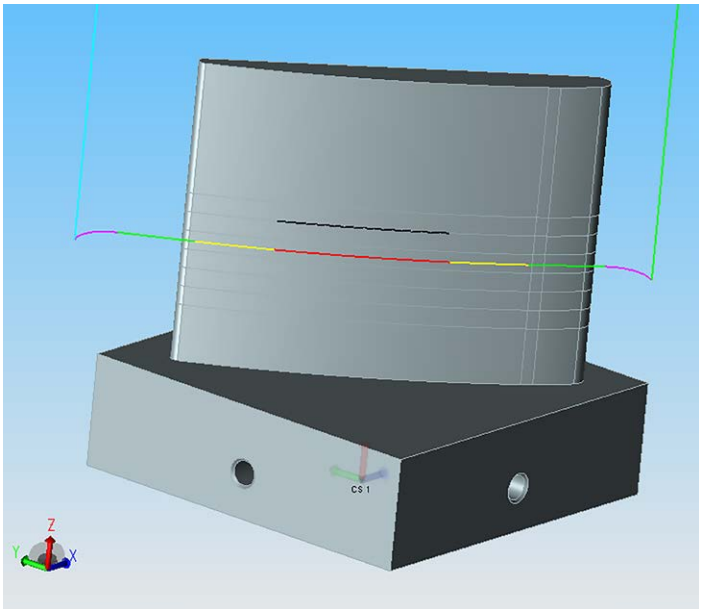
Surface patches

The areas of component surface to be scanned are identified as ‘surface patches’ and are defined by selecting a series of curves on the surface of the solid (CAD) model of the part.

These curves are imported into Active Editor Pro and subsequently selected using the Freeform Surface tool.

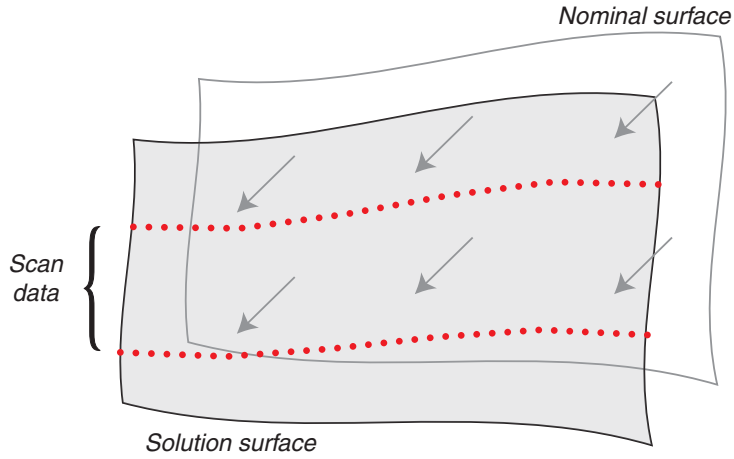
For more information including the number of curves required for various surface types, see “Importing wire geometry” and “ Create a Freeform Surface patch” in Chapter 2 “Basic programming”.

Also see Appendix A, “Required characteristics of selected curves”.



Results and data presentation

The Freeform Surface Toolkit combines a ‘nominal surface’ for each surface patch with the data obtained from corresponding scans to generate a unique ‘solution surface’ for the individual scanned surface.



Solution surface data is saved to disk – which can subsequently be accessed for downstream processing – or sampled to access measurement data from the individual part such as:

- Surface positions
- Surface normal vectors
- Material condition

Any of the sampling data can also be written to NC variables.

NOTE: The solution surface represents the physical part – or a ‘virtual’ surface that is offset from it (see “Surface offsetting”). Data can be sampled from anywhere on the model, and there are no restrictions to the number of samples, however, the best accuracy is achieved when the samples are taken close to the scan curves.

Surface offsetting

Solution surfaces can be offset from the original component solid model. (An offset of zero will produce measurement data that is on the physical surface of the component.)

Consider the following when determining the offset to be used.

- *Downstream processing*

  Some processes may expect data that is offset from the physical part, for example, where tip-centre data is required. In such instances, use an offset equal to the stylus tip (ball) radius.

- *High curvature*

  For high curvature, especially at higher scanning feedrates, it may be necessary to use an offset value approximately equal to the radius of the probe tip used for scanning.

Requirements and prerequisites

The following elements are necessary in order to generate and execute SPRINT Freeform Surface programs.

- SPRINT Freeform Surface: Editor (Renishaw part no. A-5750-2210)
- Productivity+™ Active Editor Pro (Renishaw part no. A-4007-1400)
- Productivity+™ Active Editor Pro: SPRINT™ option (Renishaw part no. A-5226-2010)
- Post processor (**`.RenMF`**) file, correctly configured for the CNC machine tool on which the Freeform Surface Toolkit program(s) will be executed
- Probe database (**`.RenPD`**) containing the OSP60 probe configuration and tool change ID
- A CAD model of the component (for visualisation and collision detection purposes), associated fixturing, and wire geometry of the scan curves

CAUTIONS:
Generated program files produced by the application are only compatible with the specific CNC machine tool make, model and controller type for which the post processor (**`.RenMF`**) file has been configured. Use of these programs on any other CNC machine tool make, model or controller type may result in damage to the machine tool, any loaded tools or workpiece inspection probes.

As each post processor (**`.RenMF`**) file is calibrated to an individual CNC machine tool, it should not be assumed that program files will run successfully on any other machine tools, even those of the same make, model and controller type.

The importance of probe calibration

Calibration of the OSP60 is required to enable the accurate calculation of workpiece surface data and to facilitate correct tool path construction. This ensures that the probe tip is obtaining measurement data from the correct surface of the part. Once calibrated, probing software can be used to compensate for any difference between the position that the stylus touches and the position that is reported to the machine.

During normal use, the difference between the touch position and the reported position does not change, but it is important that the probe is calibrated in the following circumstances:

- when a probe system is to be used for the first time;
- when a new stylus is fitted to the probe;
- when a new shank is fitted to the probe;
- when on-centre adjustment has been carried out;
- when it is suspected that the stylus has become distorted or a probe crash has occurred;
- at regular intervals to compensate for mechanical changes to your machine tool;
- whenever the OSP60 is moved between machines;
- when very tight tolerances need to be achieved;
- when there is a need to take into account temperature changes in the machine environment;
- if repeatability of relocation of the probe shank is poor. In this case, the probe may need to be recalibrated each time it is selected;
- when the 'hard overtravel' threshold is reached (probe status LEDs show red and green).

It is good practice to set the tip of the stylus on-centre, because this reduces the effect of any variation in spindle and tool orientation. A small amount of run-out is acceptable and can be compensated for as part of the normal calibration process.

The probe is calibrated on the machine using a sphere of known size. Typically a sphere of Ø25 mm (or Ø1 inch) is used, but other sizes can also be used. The calibration routine comprises three stages:

- establishing the probe datum;
- determining the location of the calibration sphere and stylus ball radius;
- scanning the calibration sphere.

OSP60 probe tool length must also be accurately set using a tool of known length or a tool setter.

Calibration is performed through the Productivity+™ CNC plug-in software application.

For information on mounting an OSP60 probe, stylus on-centre adjustment and probe calibration, see installation guide *OSP60 SPRINT™ optical scanning probe* (Renishaw part no. H-5465-8504).

Information on the calibration process is also available via the help pages of the CNC plug-in. With the CNC plug-in active on the CNC machine tool, select *CNC plug-in Help* > *Common tasks* > *Calibrating a probe*.

Chapter 2 – Basic programming

Overview

Perform the following steps in order to create a Freeform Surface program that can be executed on a CNC machine tool.

1. Import the wire geometry into Productivity+ Active Editor Pro.

   Additionally, a solid model of the component – and any fixturing that may limit access – can be imported to take advantage of the collision detection functionality within Active Editor Pro.

2. Create Freeform Surface patches using capability within Active Editor Pro.

   Using the *Select Geometry* menu item (*SPRINT Toolkits* > *Freeform Surface* > *Select Geometry*), select wire geometry representing each patch to be scanned. This creates a group of Productivity+ statements that define each Freeform Surface patch.

3. Configure program settings.

   Edit properties in the *ProgramSettings* and *GlobalFFSSettings* custom macros.

4. Configure the Freeform Surface patches.

   Edit properties of each Freeform Surface Path to control various aspects of the measurement such as WCS selection; lead-on distance; lead-off distance; and surface resolution.

5. Visualise the toolpath in Productivity+ Active Editor Pro.

   Check for collisions, review ordering, scan directions and retract moves for optimisation.

6. Configure output.

   Output the solution surface to file, or write sampled points from the surface to file or NC variables.

7. Post process the program.

   The Freeform Surface Editor requires a custom post processing operation accessible from the *SPRINT Toolkits* menu. **Do not use** the standard Active Editor Pro post processing icon or menu option to generate Freeform Surface programs.

These steps are covered in more detail below.

TIP: Content-specific help is displayed by hovering the mouse pointer over individual statement properties (within the *Property Viewer* window) or within dialog boxes.

Having performed the above steps the following will have been created:

- An NC program, which can be uploaded to the CNC machine tool control;
- A folder structure containing supporting files that should be copied to the external data processor hosting the SPRINT Freeform Surface: On-machine application.

NOTE: User guide *SPRINT Freeform Surface: On-machine* (Renishaw part no. H-5750-8531) describes the deployment of supporting files.

Importing wire geometry

Wire geometry for the patches to be scanned should be generated using a suitable CAD tool.

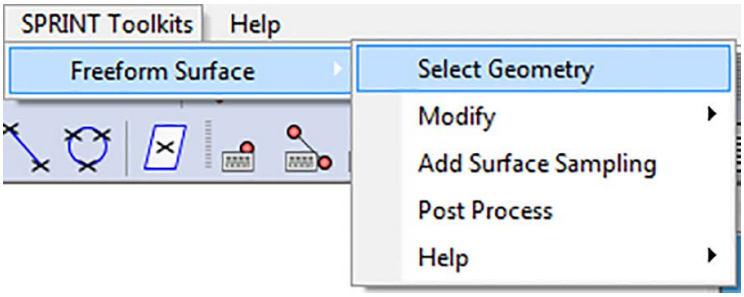
Instructions for this will depend on the particular application being used and are beyond the scope of this document, however it is important that the wire geometry has the characteristics described in Appendix A “Required characteristics of selected curves”.

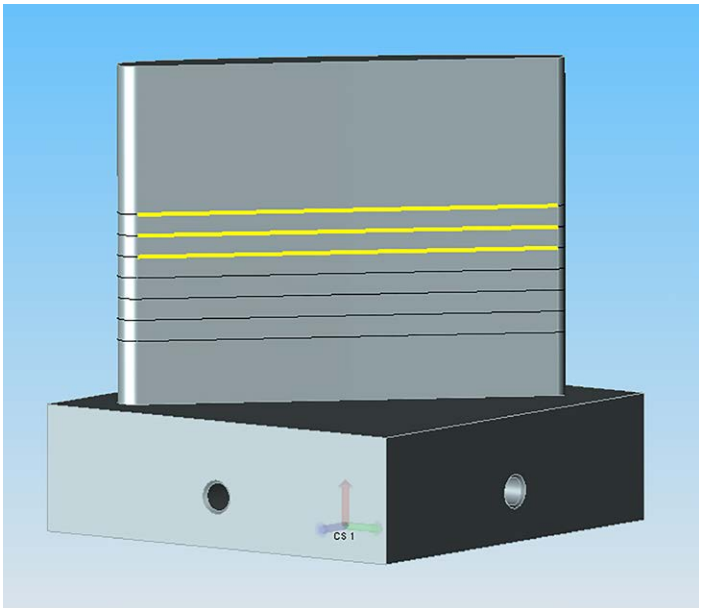
Once you have created your wire geometry, import the model into Active Editor Pro. For further information, see Appendix B, “Importing solid model and wire geometry”.

NOTE: The Freeform Surface Toolkit only requires wire geometry for the creation of measurement programs, however the import of other elements – such as the component and fixturing – is recommended in order to utilise the collision detection functionality within Active Editor Pro.

Create a Freeform Surface patch

Click *SPRINT Toolkits* > *Freeform Surface* > *Select Geometry* and select the wire geometry for the patch to be scanned.





Press *Enter* when complete.

TIPS:

Use *Ctrl* + click or left-click and drag to select multiple curves.

Use *Ctrl* + *Shift* and left-click to automatically select multiple connected sections of a single curve.

Patches can be created from two or more selected curves. The number of curves selected has an important influence on behaviour of the application as described in the table below.

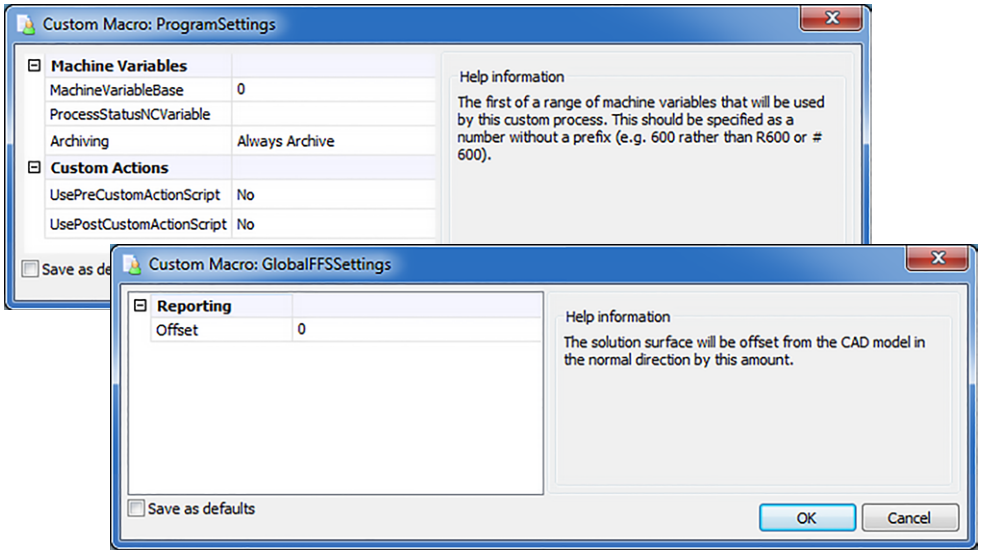
Curves selected	Curves scanned	Surface type	Description
1	-	-	Single curve selection is unsupported.
2	2	Ruled/ ribbon	Both selected curves will be scanned. The bounds of the nominal surface are defined by the *Edge Margin* setting (*Tools* > *Options* > *FreeformSurfaceSettings* > *SurfaceDefinition*).
3	1	Ruled/ ribbon	Only the middle curve is scanned. The outer curves define the bounds of the nominal surface.
4	2	Ruled/ ribbon	The middle two selected curves are scanned. The outer curves define the bounds of the nominal surface.
n (> 4)	*n* – 2	Doubly curved	All but the two outer curves are scanned. The outer curves define the bounds of the nominal surface.

NOTE: The optimum number of scans depends on the specific requirements of the application. Appendix C “The implications of the number of curves used to define a surface patch” describes the issues to be considered and the behaviour of the tool in the various scenarios listed above.

Configuring overall program settings

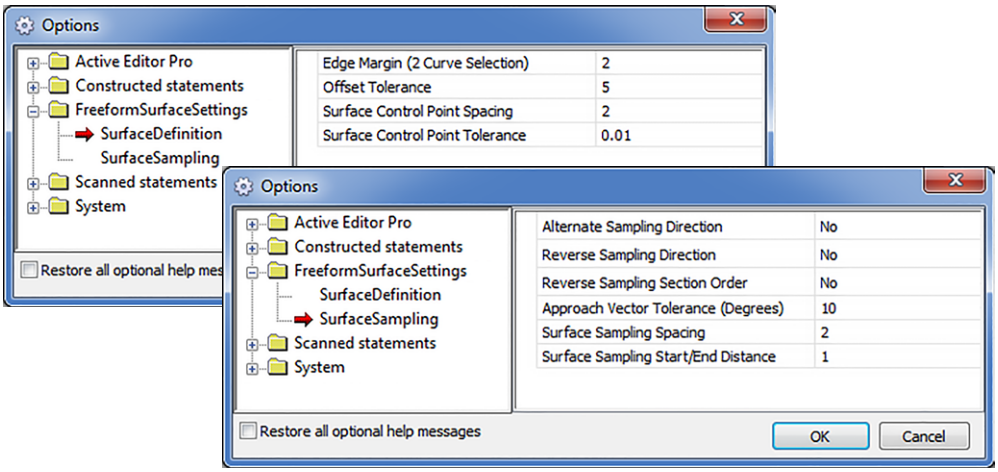
Settings that apply to the Freeform Surface program as a whole can be configured in the *Custom Macro: ProgramSettings* and *Custom Macro: GlobalFFSSettings* statements.

NOTE: These custom macro statements are automatically generated when the first patch is created.



As a minimum, the *ProcessStatusNCVariable* property (in *Custom Macro: ProgramSettings*) should be set to a free NC variable. When the Freeform Surface program is run on a machine tool, this variable will be set to 0 (zero) to indicate success, or a non-zero value to indicate failure.

Settings can also be configured in the *FreeformSurfaceSettings* area of the Active Editor Pro *Options* menu (*Tools* > *Options* > *FreeformSurfaceSettings*), allowing default settings provided by the application to be overwritten for individual patches.



Custom Macro: FreeformSurface property configuration

The top-level custom macro for each patch contains properties that can be used to control various behaviours, such as:

- Initial fitting of the nominal surface to the scan data (recommended for moderate curvature, especially when rastering). (See Appendix D “Configuring the scanning toolpath” for information on rastering.);
- Resolution of the solution surface (lower resolution can be used to filter out unwanted surface noise);
- Saving a solid model of the solution surface to disk.

NOTE: For detailed information refer to individual property help text.

Child statement property configuration

Each Freeform Surface patch within the measurement program is represented by a single, top-level *Custom Macro: Freeform Surface* statement with a number of child statements.

Child statements for a patch consist of:

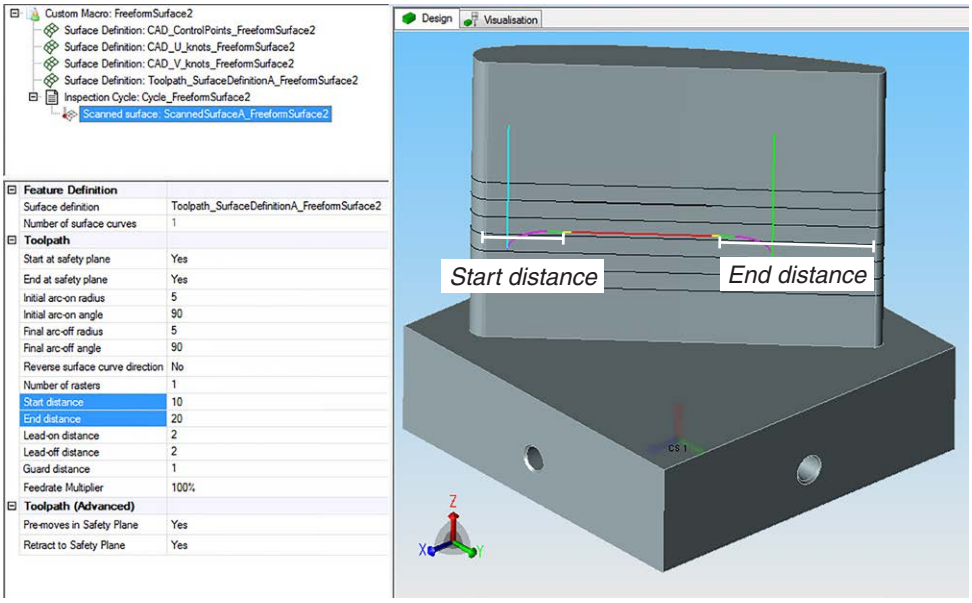
- A number of *Surface Definition* statements.

  These should not be modified and can be ignored.

- An *Inspection Cycle* containing a single *Scanned surface* statement.

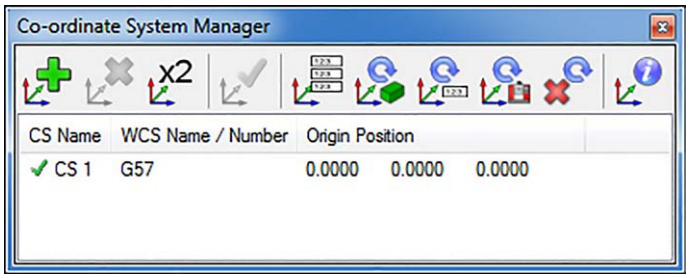
  The properties of these statements can be modified to configure the work co-ordinate (WCS), probe and various characteristics of the scanning toolpath.

  In particular, the selected wire geometry may extend beyond the area of interest. Use the *Start distance* and *End distance* properties of the *Scanned surface* child statement to adjust the length of the measured patch at either end.



Other properties can also be configured. Careful consideration is required as described in Appendix D “Configuring the scanning toolpath”.

NOTE: It may be necessary to use the *Co-ordinate System Manager* to align the *Current CS* (as defined in the *Inspection Cycle* child statement) for access. In this version of the Toolkit, all data is reported in the measurement frame defined by the *Current CS*. It is the user's responsibility to transform the output data into a different frame as required.



NOTE: Feedrate Multiplier
The *Feedrate Multiplier* property in the *Scanned surface* statement controls the scanning speed of the probe, with a value of 100% corresponding to the _SCAN_FULL_FEED defined in the **`.RenMF`** file.

Accuracy and robustness can deteriorate with increased feedrate. It is therefore recommended that accuracy is benchmarked using a feedrate multiplier of 5%. The multiplier used for a particular application can be selected through experimentation to satisfy individual cycle time and accuracy requirements.

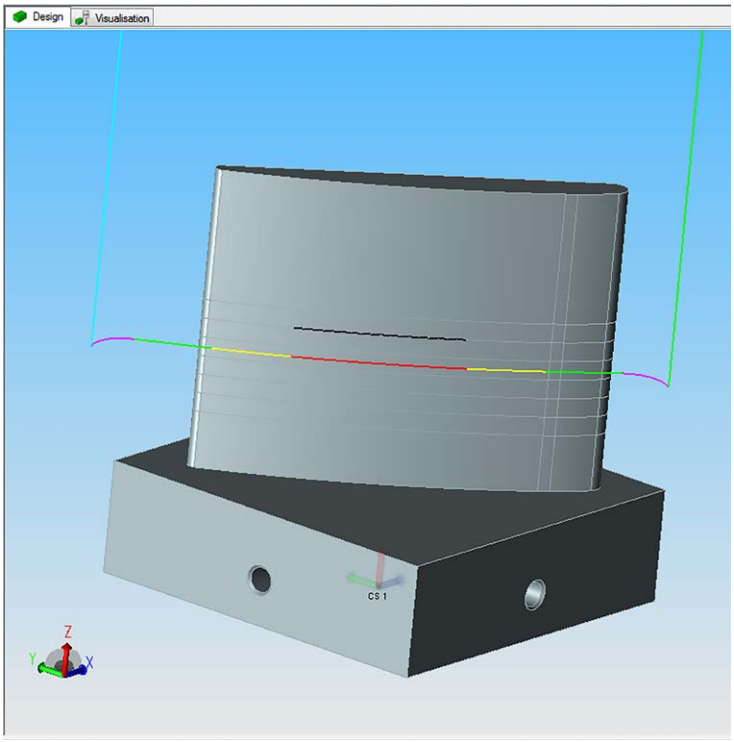
Visualise the toolpath

Once a Freeform Surface patch has been created, Active Editor Pro offers a preview of the toolpath via the Design tab.

The different regions of the toolpath can be identified by their colour.

Toolpath colour	Toolpath region
Magenta	Arc on/arc off
Green	Lead on/lead off
Yellow	Guard distance
Red	Scanning toolpath

NOTE: The toolpath preview shows the stylus (ball) tip bottom position, which, depending on probing angle is equivalent to the tip radius distance **below** the target contact point (and offset by the tip radius distance from the surface).



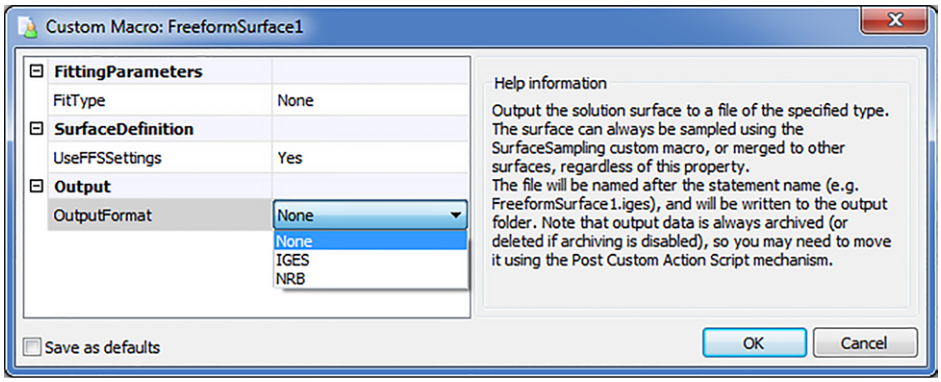
TIP: Use the *Visualisation* tab in Active Editor Pro to view a simulation of the scanning toolpath.

Configure output

Data from the Freeform Surface patch can be reported in a number of ways.

- The solution surface can be written to file in NURBS or IGES format.

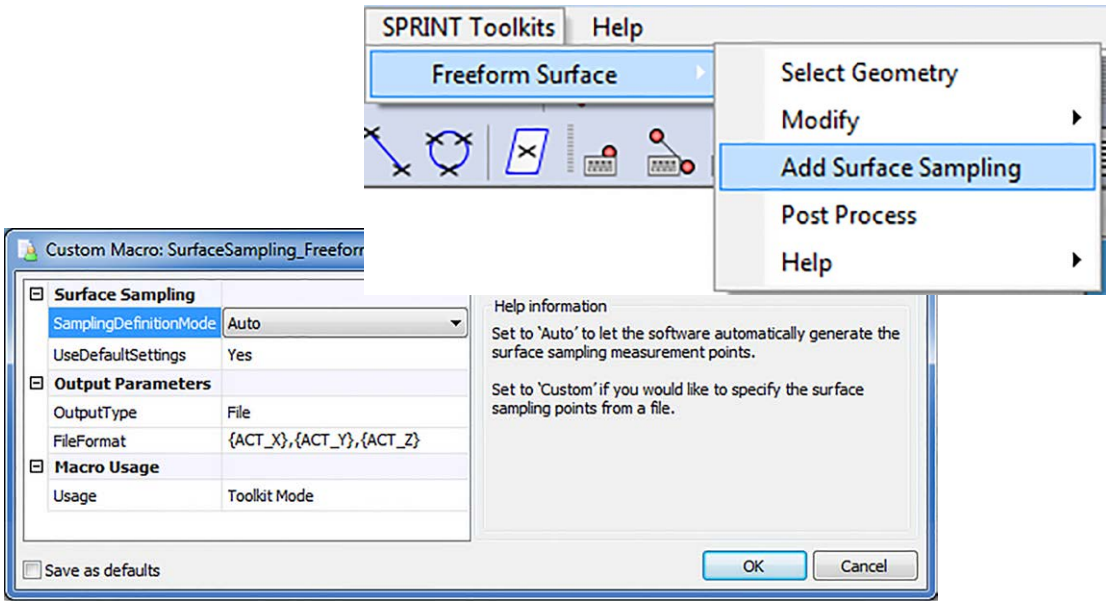
  Use the *OutputFormat* property of the relevant *Custom Macro: FreeformSurface* statement to control output of the solution surface to file.



- User-defined points can be sampled from the solution surface and then written to file or NC variables.

  Select the required *Custom Macro: FreeformSurface* statement – or one of its child statements – and use the *Add Surface Sampling* menu item (*SPRINT Toolkits* > *Freeform Surface* > *Add Surface Sampling*) to add a *Custom Macro: SurfaceSampling* statement.

  The properties of this *SurfaceSampling* custom macro can then be used to specify the points that should be sampled and to configure the output format.



  The points at which the solution surface should be sampled can be automatically generated by the Toolkit or specified by the user (via a comma-separated file containing three columns corresponding to the XYZ positions of the sampling points on the nominal surface).

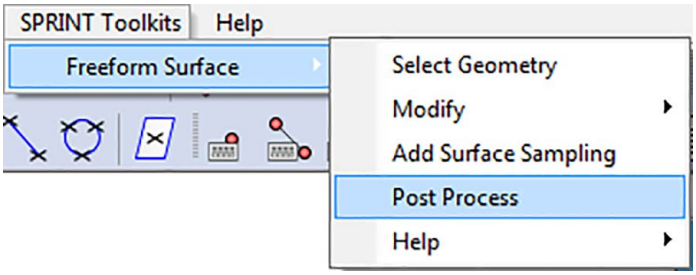
  The Toolkit can output the sampled points to a file – in a user-specified format string – or to NC variables. For further information refer to property help text.

NOTE: For many applications, the deviation reported by the *SurfaceSampling* custom macro is equivalent to the material condition. However, if the *FitType* property of the *Custom Macro: FreeformSurface* statement is set to a value other than *None*, this is not the case. Use of an initial constrained fit is an advanced option for higher curvature surfaces. Renishaw customer services should be contacted if further information about this option is required.

Custom Post Processing

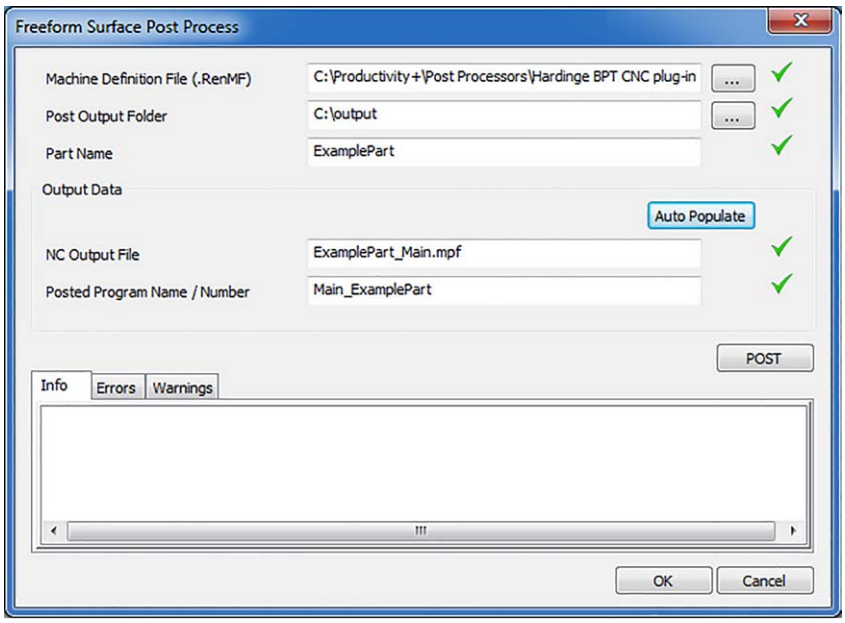
In order for the measurement program created in Active Editor Pro to run on the machine, an NC program must be generated.

This is achieved using the *Post Process* menu item (*SPRINT Toolkits* > *Freeform Surface* > *Post Process*).



Settings in the *Freeform Surface Post Process* dialog box must be configured, ensuring that the specified *Machine Definition File (.RenMF)* matches the .RenMF file used on the CNC machine tool.

Any warnings or errors in the program will appear during posting.



If posting has been successful, the following files will be produced in the specified *Post Output Folder* location:

- *The posted NC program*

  An NC program file, named according to the *NC Output File* field in the posting dialog. This file should be uploaded onto the control and run as normal.

- *Support files folder*

  A subfolder, named according to the *Part Name* field in the posting dialog. This subfolder contains files necessary for the run-time process and **must** be copied into the *External PC Working Folder* (`C:\SPRINT_REMOTE` or equivalent) on the external data processor hosting the Freeform Surface On-machine application before executing the posted program.

Chapter 3 – Further programming

Archiving

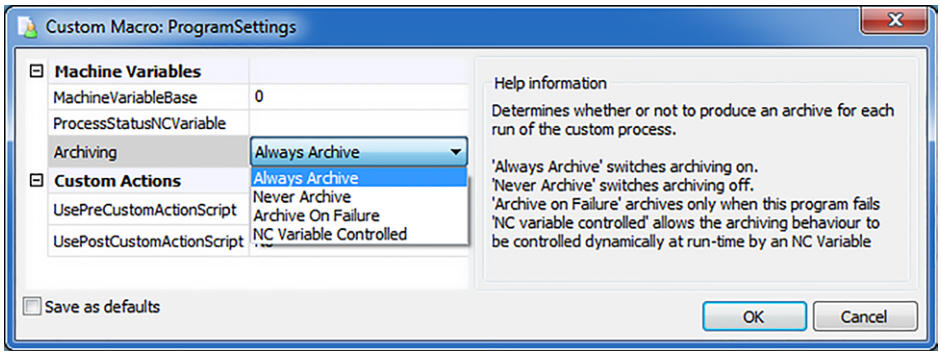
The SPRINT Freeform Surface Toolkit provides an optional archiving mechanism.

When enabled, archiving saves all data from each run to a time-stamped folder.

As well as providing a historical record for later analysis, this provides important functionality for the investigation and analysis of any process failures.

NOTE: Output data is **always** cleared from the part folder structure at the end of each run. The *CustomActionScript* mechanism can be used to copy output data to any user-defined location prior to the process clearing the part folder structure. Use of this mechanism is recommended to ensure output data is available for downstream processes rather than relying on archiving.

Archiving is controlled by the *Archiving* property of the *Custom Macro: ProgramSettings* statement. This can be set to *Always Archive*, *Never Archive*, *Archive On Failure* or *NC Variable Controlled*.



For more information refer to the *Archiving* property help.

NOTE: Archives can be large and over time may fill up the hard drive. It is recommended that the *Archiving* property is set to *Archive on Failure* for long-term use. *Never Archive* should only be used to avoid excessive archiving where regular processing failures are expected. For example, out of tolerance parts causing over/under deflection.

Custom Actions

Custom Action Scripts provide a mechanism to manipulate the file system on the external data processor at key points in the process. Any executable or script can be used, as long as it can be launched from a command line on the external data processor.

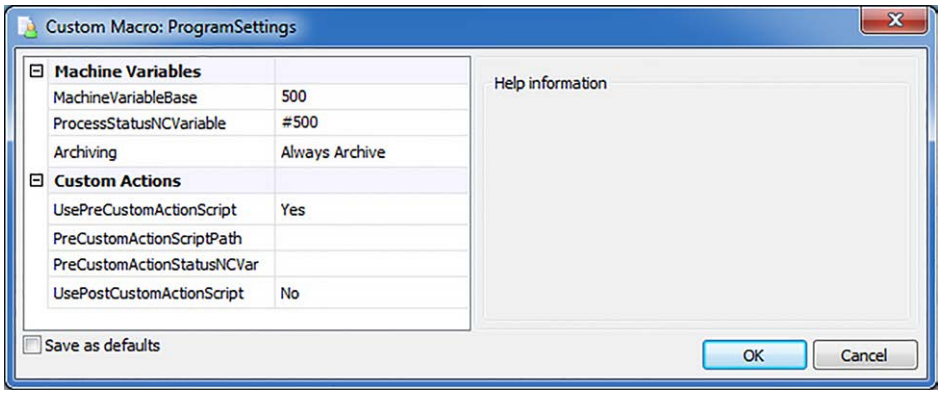
Typical actions may include loading nominal data from a network resource at the start of the process (using the *UsePreCustomActionScript* property), or copying output data to an alternative location at the end of the process (using the *UsePostCustomActionScript* property).

NOTE: All output data is archived to a time-stamped folder that is not easily accessible. The *UsePostCustomActionScript* property allows data in the output folder to be accessed before it is archived.

Files written or moved into the working folder by the *UsePreCustomActionScript* property are protected from the usual clean-up process that occurs at the start of each process.

In each case, the return value of the script or executable is written to the NC variable specified in the *Pre* / *PostCustomActionStatusNCVar* properties. These NC variables can then be checked in the calling G-code program and dealt with as necessary.

The *UsePreCustomActionScript* and *UsePostCustomActionScript* properties can be turned on and off independently.



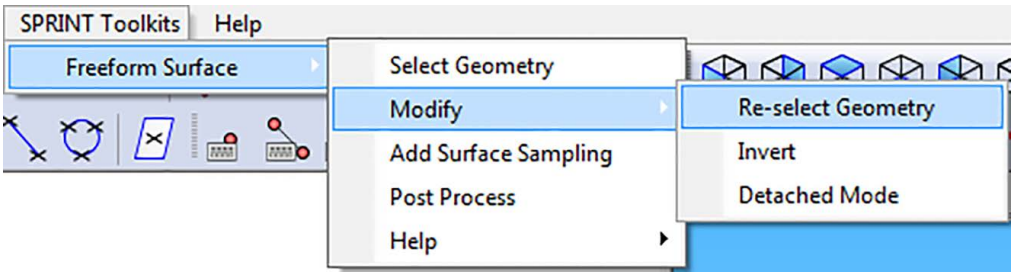
When turned on, the corresponding *CustomActionScriptPath* property should define the full path to the script or executable as seen from the external data processor. The corresponding *CustomActionStatusNCVar* properties should be configured to define free NC variables.

Chapter 4 – Advanced tools

Reselecting geometry

Sometimes there is a requirement to update the geometry associated with an existing Freeform Surface patch; for example, where solid model geometry or a co-ordinate system has been changed after program creation.

To reselect geometry, select the relevant *Custom Macro: FreeformSurface* statement (or one of its child statements) within the measurement program, click *SPRINT Toolkits* > *Freeform Surface* > *Modify* > *Re-select Geometry*.



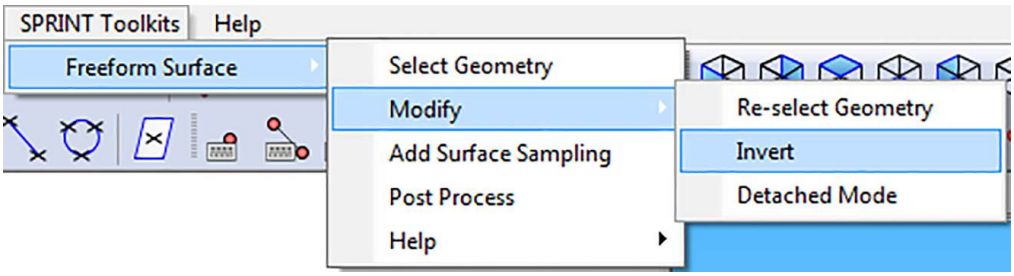
This will modify the data stored in the patch without changing the value of properties set in the *Custom Macro: FreeformSurface*, *Inspection Cycle* and *Scanned surface* statements.

Inverting surface normals

The Freeform Surface Toolkit makes the assumption that when wire geometry is selected, the user is viewing the surface from the side to be scanned: the toolpath is then generated on that side of the surface.

If this assumption is incorrect, the generated toolpath will be on the wrong side of the component, however this can be corrected by using the *Invert* menu item.

Select the relevant *Custom Macro: FreeformSurface* statement (or one of its child statements) within the measurement program, click *SPRINT Toolkits* > *Freeform Surface* > *Modify* > *Invert*.



Running in ‘Detached Mode’

Surface processing is an intensive operation. Where programs involve the scanning of several surface patches, enabling asynchronous processing can provide cycle time reductions.

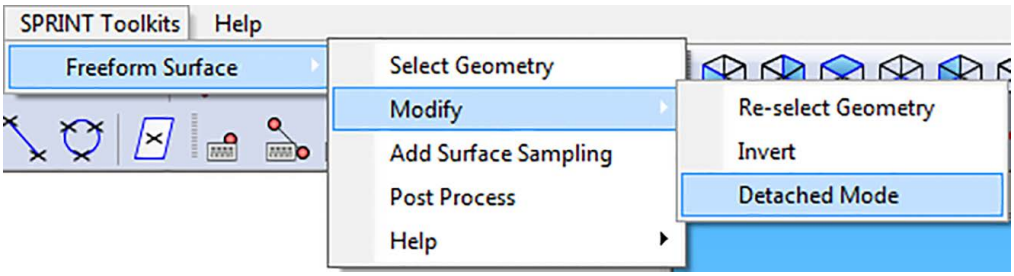
Select the required *Custom Macro: FreeformSurface* statement (or one of its child statements) within the measurement program, click *SPRINT Toolkits* > *Freeform Surface* > *Modify* > *Detached Mode*.

This will add a *Custom Macro: WaitForFFS* statement to the program.

The *Custom Macro: WaitForFFS* statement must be positioned **before** the next statement that relies on the results of the relevant *Custom Macro: FreeformSurface* statement; for example, the corresponding *Custom Macro: SurfaceSampling* statement.

NOTES:
Use this feature with care as positioning the *Custom Macro: WaitForFFS* statement after a dependent statement will cause the process to fail rarely and unpredictably.

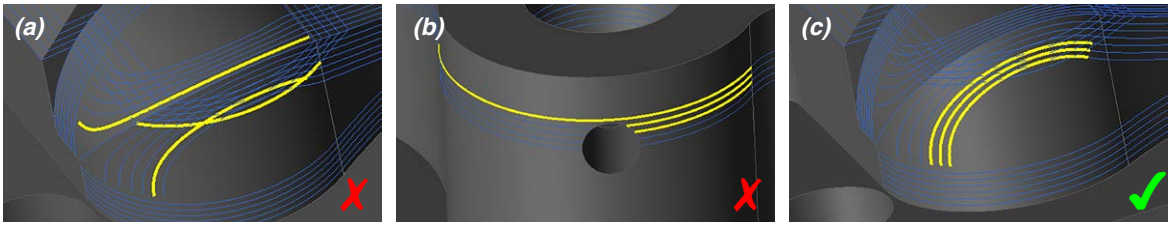
In order to change a *Custom Macro: FreeformSurface* statement back to non-detached mode, simply delete the corresponding *Custom Macro: WaitForFFS* statement.



Appendix A – Required characteristics of selected curves

SPRINT Freeform Surface is designed to measure patches of a surface, provided that the patches have the following characteristics.

- *The patch is defined by a number of roughly parallel curves of approximately equal length.*

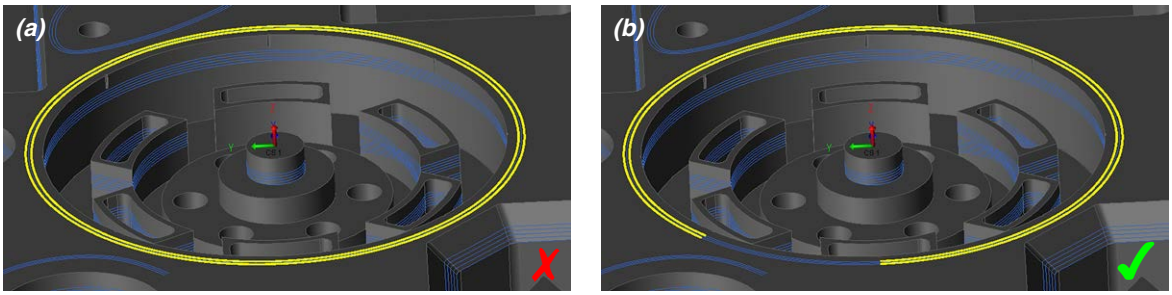


(a) Not acceptable: selected curves are not parallel.

(b) Not acceptable: selected curves are not of equal length.

(c) Acceptable: selected curves are approximately parallel and of approximately equal length.

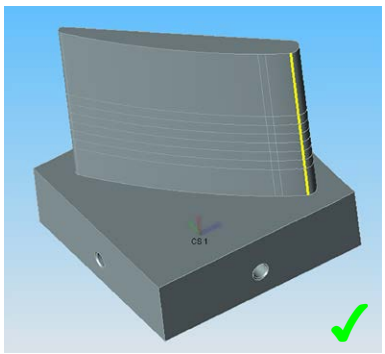
- *The patch is open – the two ends of a single patch do not overlap.*



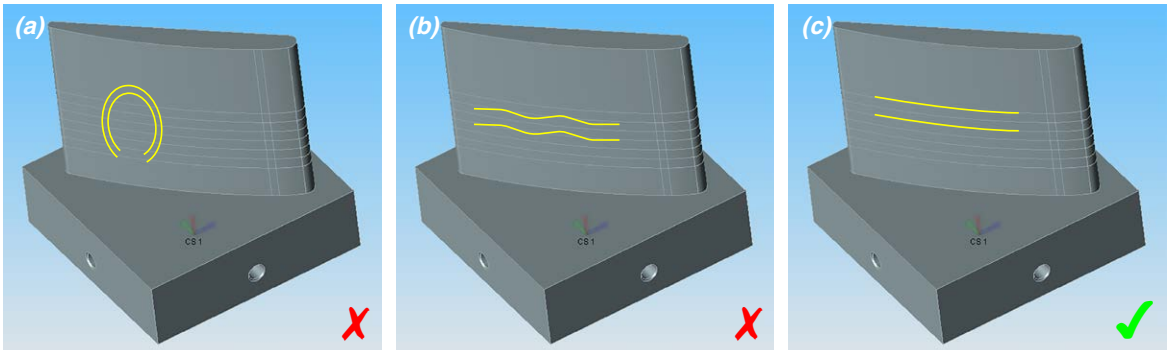
(a) Not acceptable: selected curves are closed.

(b) Acceptable: selected curves are open.

- *It is recommended that scanning is not performed along, or very close (within approximately 1 mm) to, areas of high curvature.*



- *The parallel curves defining a patch should be relatively straight in the surface space.*



(a) Not acceptable: curves are not straight in surface space.

(b) Not acceptable: curves are not straight in surface space.

(c) Acceptable: curves are relatively straight in surface space.

- *Natural variation in physical parts lead to uncertainty in the contact position of the stylus against the surface during scanning.*

  For each scan, it is important that contact occurs within a single region defined by the neighbouring curves. Where the distance between neighbouring curves is small, the contact path may stray outside this region, causing the analysis to fail. A minimum spacing of 0.5 mm between curves is recommended.

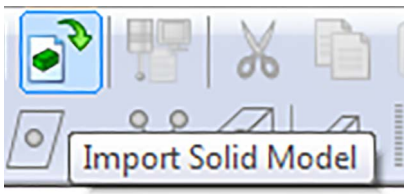
Limitations and validation

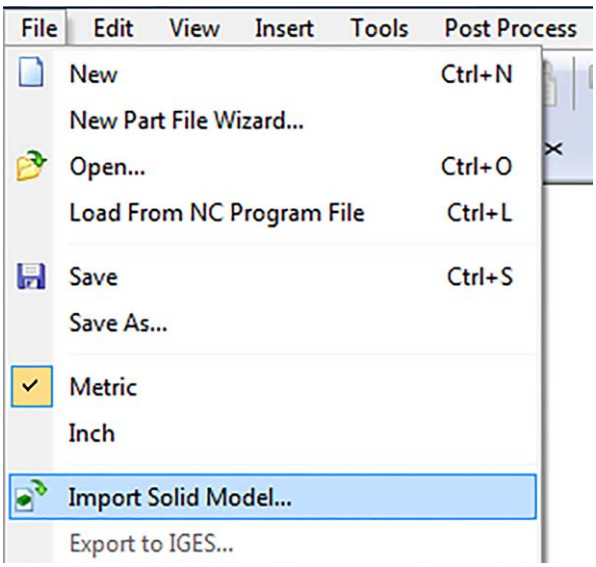
It is extremely difficult to guarantee successful execution and accurate results via automatic validation of the defining curves during program creation. To do so reliably would mean rejecting a large number of feasible cases.

For this reason, validation is limited; instead the user should exercise judgement based on the guidelines above. It is important to assess the accuracy of the results, especially where the capabilities of the tool are being stretched in relation to the guidelines described above.

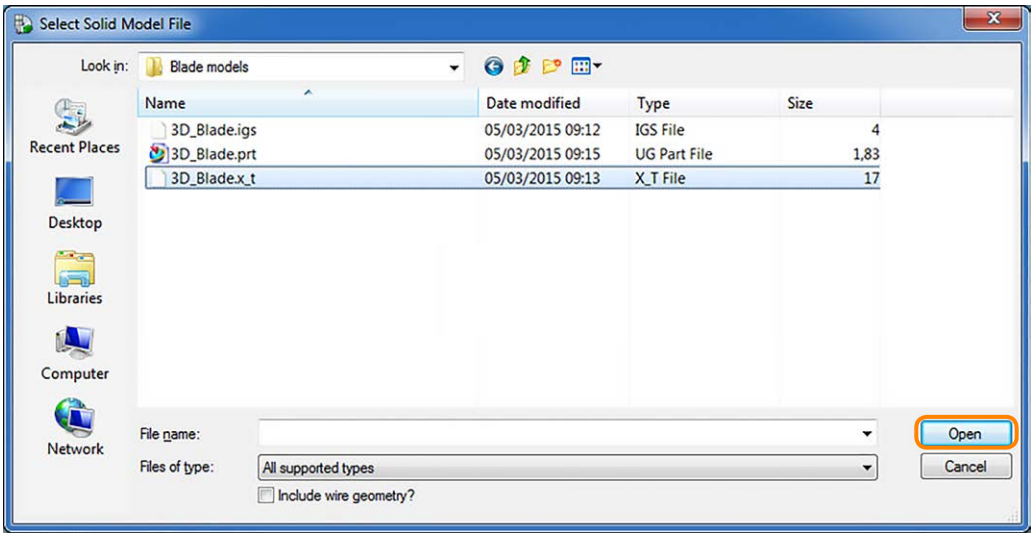
Appendix B – Importing solid model and wire geometry

In Productivity+ Active Editor Pro click the *Import Solid Model* icon (or *File* > *Import Solid Model*).



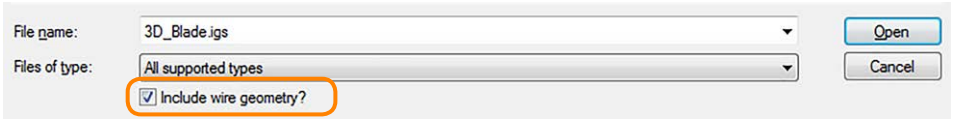


Navigate to and select the required solid model file and click *Open* to import the model into the Active Editor Pro session.



Repeat this procedure to select the file containing the wire geometry.

Ensure the *Include wire geometry?* check box is ticked before clicking *Open*.



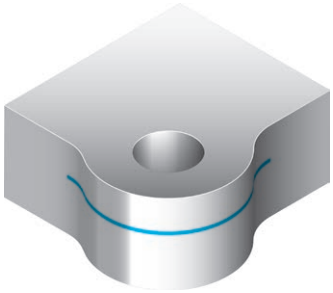
TIP: Hold down the *Ctrl* key and left-click to select and import multiple files in a single operation.

Appendix C – Implications of the number of curves defining a surface patch

When using the SPRINT Freeform Surface Toolkit, the number of selected curves governs how many curves are scanned and the type of information that can be obtained about the part.

The number of curves that should be selected for a given application depends on the characteristics of the part.

Vertical, singly-curved surfaces

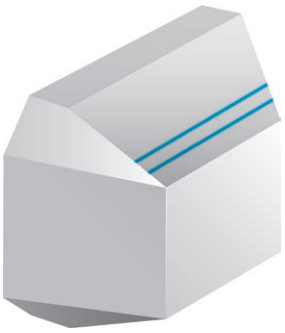


When scanning a vertical, singly-curved surface, a single scan along the direction of curvature of the surface is sufficient. (More curves can be scanned where information about the form of the surface at different heights is required.)

To scan a single curve, three curves must be selected: the central curve is scanned, the other two curves define the extents of the nominal surface. The nominal and solution surfaces are ruled surfaces.

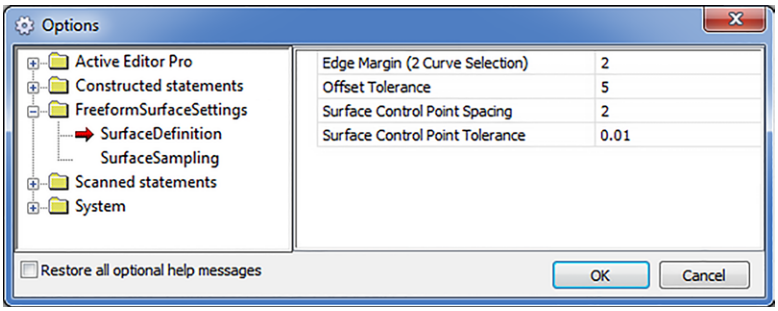
NOTE: A ruled, or 'ribbon', surface is completely defined by its top and bottom edges. It can model curvature in the direction of the selected curves – and twisting – but it cannot model curvature perpendicular to the direction of the selected curves.

Sloped, singly-curved surfaces



When scanning a sloped surface, it is recommended that at least two curves are scanned in order to distinguish surface gradient from material condition.

To scan two curves, either two or four curves should be selected. If two curves are selected, both of these curves will be scanned and the extents of the nominal surface will be defined by the *Edge Margin*, specified in the *Options* menu (*Tools* > *Options* > *FreeformSurfaceSettings* > *SurfaceDefinition* > *Edge Margin (2 Curve Selection)*).



If four curves are selected, the central two curves are scanned and the outer two curves define the extents of the nominal surface. In both cases, the nominal and solution surfaces are ruled surfaces (see "NOTE" above).

Doubly-curved surfaces

In order to model a surface with double curvature, at least three curves must be scanned, which requires the selection of five or more curves.

The outer two curves define the extents of the nominal surface and the remaining curves are scanned. Increasing the number of curves will increase the ability of the Freeform Surface Toolkit to model complex curvature in the direction perpendicular to the selected curves.

NOTE: Contact point uncertainty is an issue for all probing systems, but especially SPRINT due to the freedom of the probe to deflect in three dimensions. The Freeform Surface Toolkit uses the large amount of data from SPRINT to build an actual model of the surface in the area of interest. Provided the number of scan curves is sufficient to represent the shape of the underlying surface, the resultant model can be sampled at known nominal positions to remove uncertainty from the measurements.

Appendix D – Configuring the scanning toolpath

Active Editor Pro allows the properties within the *Scanned surface* statement of each Freeform Surface patch to be configured.

An explanation of the function of some of these properties is provided below.

Please also refer to individual property help.

Toolpath	
Start at safety plane	Yes
End at safety plane	Yes
Initial arc-on radius	5
Initial arc-on angle	90
Final arc-off radius	5
Final arc-off angle	90
Intermediate arc-on radius	5
Intermediate arc-on angle	90
Intermediate arc-off radius	5
Intermediate arc-off angle	90
Reverse surface curve order	No
Reverse surface curve direction	No
Number of rasters	2
Maximum material	0.3
Minimum material	-0.3
Start distance	1
End distance	1
Lead-on distance	2
Lead-off distance	2
Guard distance	1
Feedrate Multiplier	100%

Number of rasters

This property defines the number of times each curve is scanned.

When set to a value greater than one, each curve will be scanned multiple times, and the probe will move slightly closer to the surface with each raster.

Rastering is useful where there is significant uncertainty as to the form and/or position of the part as it increases the likelihood of obtaining valid data for all parts of a scan.

The Toolkit selects and combines the best data from each raster to generate a single set of scan data for use in down-stream processing.

Maximum material and Minimum material

NOTE: These properties are only visible when the *Number of rasters* property is set to a value greater than one (1).

These properties specify the material condition range to be covered during rastering.

As material condition range increases it may be necessary to increase the number of rasters. Take note of any warnings displayed during post processing to ensure that the number of rasters is sufficient to cover the specified material condition range.

[ ] arc-on radius; [ ] arc-on angle; [ ] arc-off radius; [ ] arc-off angle

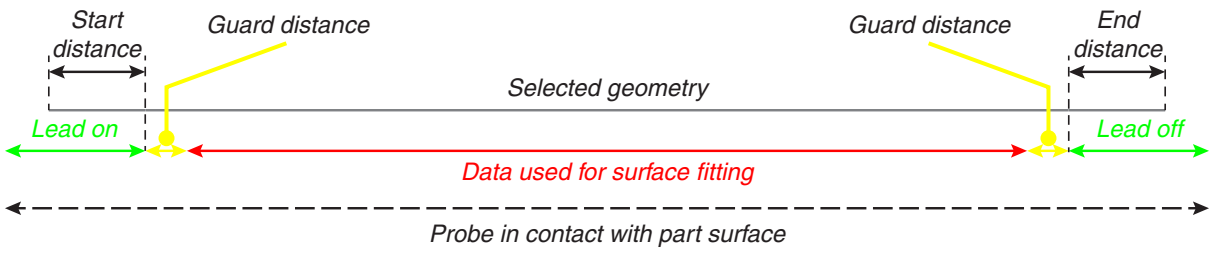
These properties define the path of the OSP60 SPRINT probe as it contacts and leaves the component surface.

Modify these properties as required to avoid collisions where access is restricted.

Start distance and End distance

These properties define the length of the scanned region relative to the selected wire geometry.

Increasing these distances will shorten the scan.



Both *Start distance* and *End distance* properties should be set to a value greater than zero (0) as the Toolkit requires information about the shape of the nominal surface beyond the ends of the scanned region.

It is recommended that the value for both properties is at least 1 (mm): a post-processing warning will be generated if either value is less than this.

Lead-on distance and Lead-off distance

These properties define the distance that the probe is in contact with the surface beyond the ends of the scanned region, allowing data that may be affected by acceleration/deceleration or vibration to be ignored.

NOTE: These distances alter the length of the scan, and so may affect access.

Guard distance

This property defines a distance at the start and end of the scanned region over which collected data is ignored for all rasters. This is particularly important when rastering, in order to ignore data affected by toolpath reversal where lead on/off does not help.

NOTE: In contrast to the *Lead-on distance* and *Lead-off distance* properties, *Guard distance* **does not** change the length of the physical scan, but instead causes data at the ends of the scan to be discarded. When rastering, it is recommended that *Guard distance* should be at least 1 mm. When not rastering, it is recommended that the **sum** of *Guard distance* and *Lead-on distance* are at least 1 mm.

Feedrate Multiplier

This property controls the scanning speed of the probe, with a value of 100% corresponding to the _SCAN_FULL_FEED defined in the **`.RenMF`** file.

Accuracy and robustness can deteriorate with increased feedrate, so it is recommended that accuracy is benchmarked using a feedrate multiplier of 5%. The multiplier used for a particular application can be selected through experimentation to satisfy individual cycle time and accuracy requirements.

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