Discovery Extensibility and Add-ins Developer Guide

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Contents

1: Introduction

Purpose

This document is intended to provide an overview of the Discovery API and its fundamental concepts.

Programming Language

Although the Discovery API can be called from any .NET programming language (for example: C#, F#, C++/CLI, Visual Basic .NET, IronPython), all examples in this document are in C#.

Conventions

Words in **bold** indicate types or members in the API.

2: Creating Add-in Applications

The Discovery Application Programming Interface (API) Developer Guide contains documentation and samples that allow you to create add-in applications that extend the functionality of Discovery. An add-in is a managed code DLL that uses the Discovery API. The API version referred to in this document is API.V22.

This document contains information on the following:

- The basic infrastructure for Add-in customization.
- How to add custom elements to the User Interface.
- An overview of the geometry architecture.

2.1. Getting Started

The Discovery extensibility shares the same architecture as the SpaceClaim Add-in based customization. As a result of this design, many of the extensibility related APIs are coming from the SpaceClaim.Api.V22 dll. The physics related Discovery APIs, as well as some UI extensibility APIs that are specific to the Discovery product, are found in the Discovery.Api.V22.dll. There is no forward compatibility between SpaceClaim and Discovery Add-in, but the underlying architecture is the same: an Add-in that uses the SpaceClaim APIs to customize the User Interface will typically need some tweaks and adjustments to account for the difference in the User Interface between the two products. On the other hand, the geometry APIs used in a SpaceClaim add-in are fully functional in Discovery.

A Discovery add-in is a .NET class library assembly that implements at a minimum the IExtensibility interface. This interface provides the entry point for the add-in and allows the add-in to perform any initialization.

Add-ins that customize the Discovery Ribbon will also need to implement the ICommandExtensibility and IRibbonExtensibility interfaces.

Add-in Startup

During startup, Discovery will perform the following steps to load and initialize add-ins:

1. Locates all XML manifest files that describe available add-ins.
2. Uses the assembly and type name specified in the manifest file to create the add-in object.
3. Verifies that the add-in object implements the `IExtensibility` interface, and then calls `IExtensiblity.Connect`. The add-in performs any internal initialization at this time.
4. Checks to see if the add-in implements the optional interfaces `ICommandExtensibility` and `IRibbonExtensibility`.

Add-in Closedown

When Discovery is closed, add-in’s `IExtensiblity.Disconnect` method is called.

2.2. Creating a C# Add-in

The steps below describe how to create a Discovery C# add-in.

Creating the Add-In Visual Studio Project

1. In Microsoft Visual Studio, create a new C# Class Library project.
2. Add a reference to the API assemblies. Use the Add Reference command in Visual Studio, go to the Browse tab, and locate the API assemblies.
   - For APIs shared with SpaceClaim in the SpaceClaim.Api.V22 folder inside the Discovery installation folder.
   - For Discovery specific APIs in the Discovery.Api.V22 folder inside the Discovery installation folder.

Add-in Initialization

1. The class that serves as the entry point for the add-in must inherit from AddIn and implement the IExtensibility interface.
2. Perform any internal add-in initialization in the Connect method.
3. Perform any internal add-in cleanup in the Disconnect method.

Example code

```
using SpaceClaim.Api.V22;

using SpaceClaim.Api.V22.Extensibility;
namespace YourCompany.Example {
    public class SampleAddIn : AddIn, IExtensibility {
        #region IExtensibility Members
        public bool Connect() {
            // perform any initialization for your add-in here
            return true;
        }

        public void Disconnect() {
            // perform any cleanup for your add-in here
        }
        #endregion
    }
}
```

2.3. Creating Manifest Files

Discovery uses XML `manifest files` to describe add-ins. The manifest file provides two types of information:

- Metadata (name, description). This is presented to the user in the Discovery Options dialog, even for disabled add-ins, which don't get loaded.
- Execution data (assembly, type name, hosting option). This is used to load the add-in when Discovery starts up.

Discovery of Add-ins

Discovery will search for manifest files in all of the following areas:

- In folders beneath the `add-ins` folder: `<CommonApplicationData>\Discovery\AddIns`.
  - The default location on the latest version of Windows is: "`C:\ProgramData\Discovery\AddIns`".
- In folders beneath the AddIns folder inside the Discovery installation folder.
- In the `add-ins` registry key: `HKEY_LOCAL_MACHINE\SOFTWARE\Discovery\AddIns`.

- A string value (REG_SZ or REG_EXPAND_SZ) may be added to this registry key to specify the path of a single manifest filename or the path of a folder where manifest files are located.
- Many of these string values can be added to the `AddIns` registry key.
- The name of each string value is not significant, but it must be unique within the **AddIns** registry key. Therefore a name such as "`BeachSoft.SurfingAddIn`" is recommended.

• The manifest file specified by the `/AddInManifestFile` command line switch supplied when Discovery is run.

  - `Discovery.exe /AddInManifestFile="<path of manifest file>"`.

Notes:

1. Putting the manifest file in the `ProgramData\Discovery\Addins` directory is the approach to follow when an Add-in should only be visible for a single user.
2. Putting the manifest file in the Addins folder inside the Discovery installation folder typically requires Administrative privileges and should be done for add-ins that are installed as part of Discovery.
3. Creating a string value in the add-ins registry is the recommended approach when a third party add-in is installed. This way, Discovery and the add-in do not need to know where each other is installed.

Contents of Manifest Files

Here is an example manifest file:

```
<?xml version="1.0" encoding="utf-8" ?>
<AddIns>
  <AddIn
    name="Sample Add-in"
    description=”Sample commands illustrating how to use the API.”
    assembly="SampleAddIn.dll"
    typename=”Sample.AddIn”
    host="NewAppDomain" />
</AddIns>
```

The AddIns element encloses a list of add-ins. A single manifest file can describe more than one add-in, although commonly it describes just one add-in.

The **AddIn** element has five attributes.

Attribute	Description
name	The name of the add-in. This is presented to the user in the Options dialog.
description	The one-line description for the add-in is presented to the user in the Options dialog.
assembly	The filename or full path of the DLL that contains the add-in. If the assembly attribute only specifies a filename and not a full path, the assembly will be assumed to be in the same folder as the manifest file.
typename	The type of the add-in class to create when Discovery starts up. This type must be derived from AddIn and must implement the IExtensibility interface.
host	The way in which the add-in should be hosted. The only supported value for Discovery is: SameAppDomain. The SpaceClaim options NewAppDomain or NewProcess are related to .NetRemoting, which is not supported in Discovery.

Only the `host` attribute has a default value if not present. All other attributes must be specified.

While developing an add-in, the add-ins folder can be used in one of two ways:

1. Place the add-in assembly and its manifest file in a folder inside the add-ins folder. You can set the build output path directly to this folder to save any copying and set the properties of the manifest file so that it is copied to the output directory. In the manifest file, specify the add-in filename (not the full path) in the assembly attribute.
2. Place the manifest file in the add-ins folder, and the add-in assembly in a folder

Customizing the Ribbon

1. If the add-in needs to customize the ribbon it will implement the IRibbonExtensibility interface.
2. In the GetCustomUI method, return a string that contains the XML description of the items to be added to the ribbon.

2.4. Creating Custom Commands

Custom Commands

All User Interface (UI) objects in Discovery must be associated with a Command. A Command controls the text, tooltip, image, and handles the Executing and Updating events. If a new UI object is added to the Ribbon by the add-in, the add-in must either create a new Command or associate it with an existing Command.

An add-in implements the `ICommandExtensibility` interface to modify or add commands. Discovery calls the `ICommandExtensibility.Initialize` method at startup which allows the add-in to add or modify commands using the appropriate methods on the Command class.

Example code

```
using SpaceClaim.Api.V22;
using SpaceClaim.Api.V22.Extensibility;

namespace YourCompany.Example {
 public class SampleAddIn : AddIn, IExtensibility, ICommandExtensibility {
 ...

#region ICommandExtensibility Members
public void Initialize() {
 Command command = Command.Create("SampleAddIn.CreateGear");
 command.Text = Properties.Resources.CreateGearCommandText;
 command.Hint = Properties.Resources.CreateGearCommandHint;
 command.Image = Resources.CreateGear;
 command.Updating += CreateGear_Updating;
 command.Executing += CreateGear_Executing;
 }

 #endregion

 ...
 }
}
```

2.5. Customizing the Ribbon

Ribbon Customization

In Discovery, add-ins can be used to customize the user interface for their workflows. A good place to start with workflow customization is the ribbon. The ribbon is a graphical control element that appears along a horizontal strip at the top edge of an application window and can be used to organize related commands so that they are easier to find. It is the location in the user-interface where tabs like "Design" and "Simulation" are found. Typically, a ribbon includes tabbed toolbars that are filled with graphical buttons and other graphical control elements and grouped by functionality.

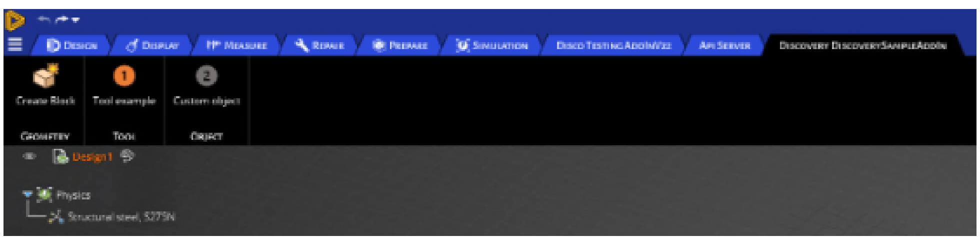
Each add-in can have its own tab or tabs in the ribbon to display and organize the tools created in the add-in.

To customize the ribbon, an add-in implements the IRibbonExtensibility interface. When Discovery is started it calls the add-in’s IRibbonExtensibility.GetCustomUI method, and the add-in returns a string that contains an XML description of the changes to be made to the ribbon. The add-in can add new UI objects to the ribbon or change existing ones.

Each UI object such as buttons, check boxes, etc. must be associated with a previously created Command. The command handles the setting of the UI object's text, image, tooltip, and any events that are raised.

Tabs

Add-ins can add a new tab to the ribbon.



Below is the XML code you can use to create the ribbon tab.

```
<customUI
   xmlns="http://schemas.spaceclaim.com/customui"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xsi:schemaLocation="http://schemas.spaceclaim.com/customui
         http://schemas.spaceclaim.com/customui/SpaceClaimCustomUI.V20.xsd">

 <ribbon>
    <tabs>
      <tab id="Discovery DiscoverySampleAddIn"
command="DiscoverySampleAddIn.RibbonTab" label = “My Tab”>
        <group id ="Geometry" command="DiscoverySampleAddIn.Geometry"
label="Geometry">
   <button id="DiscoverySampleAddIn.CreateBlock" size="large"
command="DiscoverySampleAddIn.CreateBlock"/>
        </group>
        <group id ="Tool" command="DiscoverySampleAddIn.Tool" label="Tool">
   <button id="DiscoverySampleAddIn.button1" size="large"
command="DiscoverySampleAddIn.FooTool"/>
 </group>
 <group id ="Object" command="DiscoverySampleAddIn.Object" label="Object">
   <button id="DiscoverySampleAddIn.button2" size="large"
command="DiscoverySampleAddIn.BarTool"/>
```

```
  </group>
       </tab>
     </tabs>
   </ribbon>
</customUI>
```

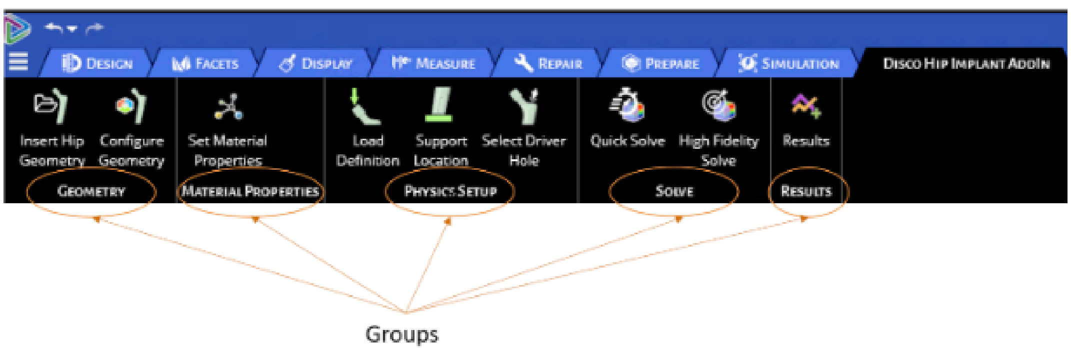
The XML content that defines the ribbon should be placed into the customUI tags. Under the ribbon tag, you can define a new tab using the tab object. It has the following three attributes:

- tab id
- label (optional)
- command (optional)

If a label is defined, it is used as the displayed name on the user-interface. If the label is not defined, the tab id is used as the displayed name.

Groups

A tab is the collection of buttons, but the buttons can be further categorized using "groups." Groups are useful to bring relevant buttons together and give them more context.



In the example above, "geometry," "material properties," etc. are groups that contain relevant buttons and functionalities.

Buttons

Buttons are the controls that can be used to execute a function (like theactivation of a tool). When defining the buttons in the customUI XML, you need to define its identifier (display name), command, and the size of the button. The size of the button should be defined as "large" for standard buttons requiring a row or "small" for mini buttons that require less space. Below is the schema file that contains examples.

```
<?xml version="1.0" encoding="utf-8"?>
<customUI
  xmlns="http://schemas.spaceclaim.com/customui"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://schemas.spaceclaim.com/customui
http://schemas.spaceclaim.com/customui/SpaceClaimCustomUI.V20.xsd">
  <ribbon>
   <tabs>
      <tab id="Discovery DiscoverySampleAddIn"
command="DiscoverySampleAddIn.RibbonTab">
        <group id ="Geometry" command="DiscoverySampleAddIn.Geometry"
label="Geometry">
          <button id="DiscoverySampleAddIn.CreateBlock" size="large"
command="DiscoverySampleAddIn.CreateBlock"/>
```

```
        </group>
        <group id ="Tool" command="DiscoverySampleAddIn.Tool" label="Tool">
          <button id="DiscoverySampleAddIn.button1" size="large"
command="DiscoverySampleAddIn.FooTool"/>
        </group>
        <group id ="Object" command="DiscoverySampleAddIn.Object"
label="Object">
          <button id="DiscoverySampleAddIn.button2" size="large"
command="DiscoverySampleAddIn.BarTool"/>
        </group>
      </tab>
  </tabs>
  </ribbon>
</customUI>
```

Customizing the File Menu

Additionally, custom buttons can be added to the file menu (at the top left, under the Discovery icon).

To add custom buttons to the file menu, encapsulate the tool buttons with <menu> <menu/>.

```
<ribbon>
    <menu>
      <button id="DiscoverySampleAddIn.Button1Tool" position="save" command="
 DiscoverySampleAddIn.Button1Tool"/>
      <button id=" DiscoverySampleAddIn.CustomTestTool3" position="close"
command=" DiscoverySampleAddIn.CustomTestTool3"/>
    </menu>
</ribbon
```

2.6. Customizing Tools

Custom Tool

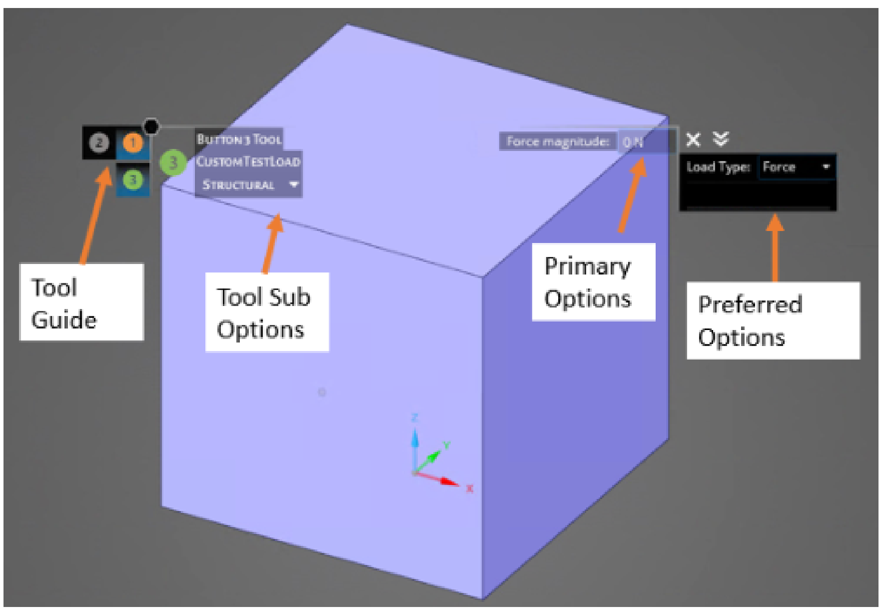
In Discovery, a tool is defined as a piece of functionality related to geometry manipulation (for example, the Pull tool for geometry extrusion) or a physical condition definition (for example, the creation of a Force). The definition of a tool requires user inputs, called tool options.

In the C# code, a tool is defined by a class derived from SpaceClaim.Api.V22.Tool. The OptionsXml property defines the layout of the panel that contains the tool options, like the ribbon XML.

```
class CustomTool : Tool
{
 public CustomTool()
   : base(InteractionMode.Solid) {}
      /*
       * Defines an options panel for the custom tool.
       */
 public override string OptionsXml
     {
  get { return Resources.CustomToolOptions; }
```

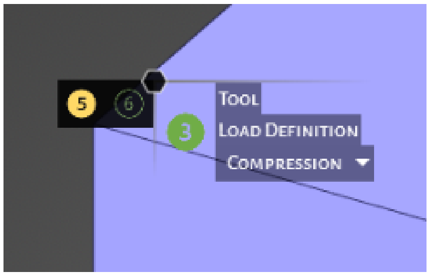
```
        }
}
```

```
<?xml version="1.0" encoding="utf-8"?>
<customUI xmlns="http://schemas.spaceclaim.com/customui">
  <panel command="DiscoverySampleAddIn.BarTool" label="Tool"
modeLabel="TextBox">
    <group id="DiscoverySampleAddIn.BarToolGuide" label="Tool Guides"
optionsType="toolGuide">
      <button id="DiscoverySampleAddIn.TickMark"
command="DiscoverySampleAddIn.TickMark"/>
    </group>
    <group id="DiscoverySampleAddIn.BarTool" label="Textbox Options"
optionsType="primary">
      <container id="DiscoverySampleAddIn.BarToolContainer"
layoutOrientation="vertical">
        <textBox id="DiscoverySampleAddIn.CustomObjetMagnitude"
command="DiscoverySampleAddIn.CustomObjectMagnitude" width="80" label="Double
 only:" />
      </container>
    </group>
  </panel>
</customUI>
```



Tool Guide

Another configurable tool item by the add-ins is the tool guide. It is a short cut for reaching tools from various tabs quickly.




```
<group id=" DiscoverySampleAddIn.CustomTestTool3ToolGuideGroup1" label="Tool
Guides 1" optionsType="toolGuide">
 <button id=" DiscoverySampleAddIn.CustomTestTool3ToolGuide" command="
DiscoverySampleAddIn.TextBoxTool"/>
 <button id=" DiscoverySampleAddIn.CustomTestTool3ToolGuide" command="
DiscoverySampleAddIn.CheckBoxTool"/>
</group>
```

Tool Sub-Options

If a tool has options to choose from, it should be expressed as below:

```
<group id="DiscoverySampleAddIn.FooToolSubOption" label="Tool Sub Options"
optionsType="toolSubOption">
   <toolSubOption id="DiscoverySampleAddIn.FooToolSubOption"
command="DiscoverySampleAddIn.FooToolSubOption" width="80">
        <item label="Sub Option1"/>
        <item label="Sub Option2"/>
   </toolSubOption>
</group>
```

Tool sub option is a collection of tool sub option items (unbounded) that will be shown ina dropdown. In the example above, there are two items with labels, "Sub Option1" and "Sub Option 2," which are also the display names. Using this code, items tools options can be grouped and filtered. The command for the tool sub option can be defined as shown below in C# and linked to the XML by the command name.

```
static class FooToolSubOptionComboBox
    {
        const string commandName = "DiscoverySampleAddIn.FooToolSubOption";

        public static readonly string[] toolSubOptionStrings =
        {
            "Sub Option1",
            "Sub Option2"
        };

        public static void Initialize()
        {
            Command command = Command.Create(commandName);

            string[] items = Array.ConvertAll(toolSubOptionStrings,
toolSubOption => toolSubOption.ToString());
            command.ControlState = ComboBoxState.CreateFixed(items, 0);
        }

        public static Command Command => Command.GetCommand(commandName);

        public static string SelectedLoadType
```

```
        {
            get
            {
                var state = (ComboBoxState)Command.ControlState;
                return toolSubOptionStrings[state.SelectedIndex];
            }
        }

    }
```

Primary Options

The primary options are mostly used to add another level of selection. They should be created as another group in the tool XML file. They are most likely the key input item for the tool.

Below is an example add-in showing how you can create primary options.

```
<group id="DiscoverySampleAddIn.FooToolPrimary" label="Textbox Options"
optionsType="primary">
      <container id="DiscoverySampleAddIn.FooToolContainer"
layoutOrientation="vertical">
        <checkBox id="DiscoverySampleAddIn.CheckBox" label="Unitless"
command="DiscoverySampleAddIn.CheckBox"/>
        <textBox id="DiscoverySampleAddIn.TextBoxDouble"
command="DiscoverySampleAddIn.TextBoxDouble" width="80" label="Double only:"
/>
        <textBox id="DiscoverySampleAddIn.TextBoxDouble2"
command="DiscoverySampleAddIn.TextBoxDouble2" width="80" label="Double only:"
 />
        <textBox id="DiscoverySampleAddIn.TextBoxQuantity"
command="DiscoverySampleAddIn.TextBoxQuantity" width="80" label="Quantity :"
quantityType="temperature" />
      </container>
</group>
```

In primary options, multiple buttons or textbox fields can be stacked together. As shown in the example above, they are added to a container with a layout orientation of "vertical."

The example above also defines some check boxes and text boxes. (See controls for the completelist of controls applicable in the tools.)

Textbox can be set to work with a specific type by setting the quantityType attribute.

Preferred Options

Preferred options can be found on the right-side of the tool and they appear with a black background. Preferred options are built in a similar way to the primary options. You can customizepreferred options with a variety of buttons and set their visibility.

To create a preferred options block, the add-in needs to define a group with optionsType="preferred." Then, using containers, the items layout can be specified.

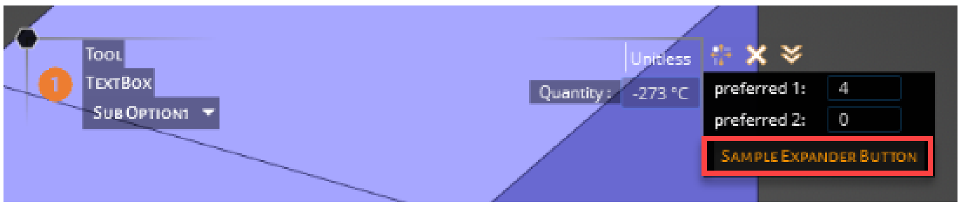
In the example below, the preferred optionsare stacked vertically. As you can see, a button item can be used as an expander to group other items. Also, shown below, the spin box is only visible when a button is clicked. This button functionality can be useful when there are multiple fields that need to be activated under certain conditions.

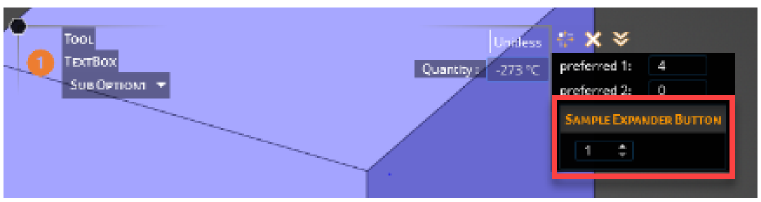
```

<group id="DiscoverySampleAddIn.FooToolPreferred" label="Textbox Options"
optionsType="preferred">
```

```
     <container id="DiscoverySampleAddIn.FooToolContainer"
layoutOrientation="vertical">
       <textBox id="DiscoverySampleAddIn.PreferredTextBox1"
command="DiscoverySampleAddIn.PreferredTextBox1" width="80" label="preferred
1:" />
       <textBox id="DiscoverySampleAddIn.PreferredTextBox2"
command="DiscoverySampleAddIn.PreferredTextBox2" width="80" label="preferred
2:" />
       <button id="DiscoverySampleAddIn.ExpanderButton"
command="DiscoverySampleAddIn.ExpanderButton"  label="Sample Expander Button">

          <spinBox id="DiscoverySampleAddIn.SpinBox"
command="DiscoverySampleAddIn.SpinBox" minimumValue="1" maximumValue="8"
width="35"/>
       </button>
     </container>
</group>
```





Expanded Options

Expanded options allow for further grouping on the tools and they work in a similar way to buttons, but visually they are represented as arrows on the preferred options. To create expanded options, define a group in XML using optionsType="expanded."

```
<group id="DiscoverySampleAddIn.FooToolExpanded" label="Textbox Options"
optionsType="expanded">
        <container id="DiscoverySampleAddIn.FooToolContainer"
layoutOrientation="vertical">
          <textBox id="DiscoverySampleAddIn.ExpandedDouble1"
command="DiscoverySampleAddIn.ExpandedDouble1" width="80" label="expanded 1:"
 />
        </container>
...
```

The items inside of this group only become visible after clicking the double arrow above the preferred options.

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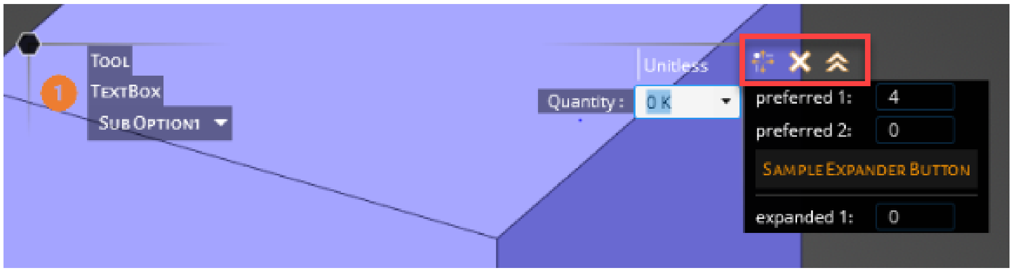


2.7. Custom Objects and Custom Tree

Discovery allows you to create custom objects using custom wrappers and it allows you to display them in a custom tree. This section is a brief introduction to the APIs for custom wrappers and the definition of the custom tree.

2.7.1. Custom Object Wrappers

Within Discovery add-ins, custom objects can be created by implementing one of the wrapper objects. This section covers the following topics:

- CustomWrapper
- DiscoveryCustomWrapper
- PhysicsCustomWrapper

2.7.1.1. CustomWrapper

This is the standard wrapper class from SpaceClaim. For more information on *CustomWrapper*, refer to SpaceClaim documentation.

2.7.1.2. DiscoveryCustomWrapper

A class derived from *CustomWrapper* that provides additional properties for display in the custom tree. Although it is possible to display a *DiscoveryCustomWrapper* in the design tree, the typical usage involves the display in the custom tree. The position of the objects in the custom tree can be defined in two ways:

1. By specifying a *TreeId* and *Group* that link the object to the custom tree definition (see **Custom Tree** section for more information).
2. By specifying a *TreeParent* that makes the custom object child of another custom object. The parent child/relationship is for custom tree display only.

   If specified, the *TreeParent* property overrides the *Group* property and places the object underneath its parent objects.

After the initial specification, the *TreeParent* and *Group* properties can be changed dynamically if desired. The drag and drop functionality (see **Custom Tree** section for more information) takes advantage of the dynamic specification and allows the User Interface to reparent an object either in another group or as a child of another object.

The *DiscoveryCustomWrapper* objects can also display a field in the custom tree. The field is defined by a text (*TreeFieldText*) and a value (*TreeFieldValue*). The *TreeFieldValue* can be specified as a double (no units).

A complete list of the properties of *DiscoveryCustomWrapper* objects is given below:

- **Name**: gets and sets the name of the wrapper object.
- **Group**: gets and sets the custom tree group of the wrapper object.

- **TreeId**: gets and sets the tree id of the wrapper object. This is how a tree can automatically find all items that are defined to it when it is refreshed.
- **ImageKey**: gets and sets the image key for the wrapper objects.
- **TreeFieldText**: gets and sets the tree field text.
- **TreeFieldValue**: gets and sets the tree field value (double is supported) .
- **TreeParent**: gets and sets the tree parent object which can be another custom object.
- **ShowInDesignTree**: specifies whether the custom object should show in the design tree.

2.7.1.3. PhysicsCustomWrapper

A class derived from *DiscoveryCustomWrapper* with two extra properties:

1. Simulation
2. TreeFieldQuantity

This wrapper can be used for objects connected to simulations. Each wrapper object is linked to one simulation. The Discovery code deletes/updates when a simulation is deleted or duplicated. It also shows in the custom tree only those objects which are associated with the current simulation. When you create a new simulation or change to a different one, the tree updates and the objects not associated with the simulation are not displayed.

Additionally, while *DiscoveryCustomWrapper* objects has only a value field on the custom tree, *PhysicsCustomWrapper* objects can display *TreeFieldQuantity*, which is a value with units. The *TreeFieldQuantity* field can be used to display a physical quantity associated with the object.

Sync-ing TreeField and HUD properties

In the Discovery UI paradigm, the *TreeField* is used as a short cut for an entry from the HUD that displays the tool options associated with the object in the tree. The *TreeField* is visible even though the tool is not selected, so custom objects can be modified regardless of whether their tool is active. When an add-in uses the *TreeField,* it is its responsibility to keep its value in sync with the HUD properties.

```
protected override void OnEnable(bool enable)
        {
            if (enable)
            {
                CustomObjectMagnitude.Command.TextChanged +=
barObjectMagnitudeCommand_TextChanged;
                Document.DocumentChanged += TreeField_Updated;
            }
```

The add-in can register a listener to the *DocumentChanged* event in order to be notified of changes in the quick field. The *DocumentChanged* event can be filtered for changes in the custom object and the appropriate action can be taken to sync the event payload to the corresponding property.

```
private void TreeField_Updated(object sender, DocumentChangedEventArgs e)
        {
            foreach (var changedObj in e.ChangedObjects)
            {
                if (changedObj is CustomObject customobject)
                {
                    var changedLoad = BarObject.GetWrapper(changedObj as
CustomObject);

                    if ((CustomObjectMagnitude.Command.Text !=
changedLoad.TreeFieldQuantity.ToString()))
                    {
```

```
                        CustomObjectMagnitude.Command.Text = 
changedLoad.TreeFieldQuantity.ToString();
                        WriteBlock.ExecuteTask("update quantity", () => 
UpdateTreeQuantity(changedLoad));
                    }
                }
            }
        }
```

When the HUD property associated with *TreeField* is changed, it is the add-in responsibility to set the *TreeField* property to the updated value.

```
customBarObject.TreeFieldQuantity = customBarObject.RatioQuantity;
```

The Discovery code automatically updates the *User Interface* in response to the *TreeField* change.

2.7.2. Custom Tree

Discovery uses trees to represent objects for geometry and physics. Add-ins can use the custom tree to display their own custom objects.

Within an add-in a custom tree is defined by implementing the *ITreeHierarchy*interface. The class that implements *ITreeHierarchy*interface must be marked with the attribute

```
[Export(typeof(ITreeHierarchy))]
```

Using Managed Extensibility FrameWork (MEF), Discovery collects the classes that implement *ITreeHierarchy* and adds them to the application at the startup.

The interface has the properties below that a custom tree can define and modify.

- **ID**: identifier for custom tree.
- **TreeName**: user visible name for the custom tree.
- **DefaultGroup**: default group for custom tree items.
- **RootGroups**: list of the items that displayed as root nodes.
- **SubGroupMapping**: dictionary to define the hierarchy in tree items. Key is the parent node, value is the list of child nodes.
- **GroupsToDisplayName**: dictionary to match the tree groups and their display names on the tree.
- **GroupsToImages**: dictionary to match the tree groups and their images.
- **DefaultGroupThreshold**: minimum number of items required to form a group value of 0 or 1 groups immediately of -1 or lower never groups
- **UseParentGroupingThresholds**: whether subgroups will use the same threshold and other rules as the parent group
- **CountIndirectChildren**: if true, counts direct non-group children and counts each direct subgroup child as its indirect children, else counts each direct subgroup as 1
- **IgnoreThresholdAfterFirstSubGroup**: when true, groups will ignore its threshold and will form immediately if it contains a subgroup and anything else
- **UseDeepGrouping**: when true, grouping will be applied to the children of every node in the tree instead of just the root node
- **GroupsToImageKeys**: when true, enables you to change the grouping of objects using drag and drop
- **RootNodeImageKey**: image key for the root node.
- **StageIdentifiers**: identifiers of stages where this tree will be displayed.
- **IsDragEnabled**: when true, enables you to change the grouping of objects using drag and drop
- **CanDrop**: allows add-in control on enabling/disabling the target of the drop

The *Custom tree* definition is flexible in terms of its hierarchy and how objects are represented with respect to each other. The drag and drop feature also enables changing the hiearchy during the session. As noted in the previous section, the specification of a *TreeParent* for a custom objects overrides the group definition.

Figure 1. Custom objects are organized in linear form.

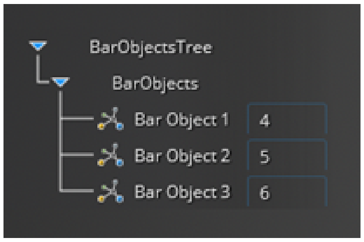
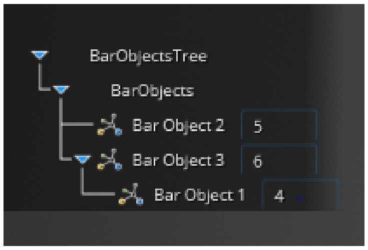


Figure 2. Object 1 is nested into object 3.



By using the *StageIdentifer* property add-ins can control the visibility of the custom tree based upon the current stage. The *Custom Tree* will only show in the stages specified in the *StageIdentifers* list and won't be displayed in the other stages. In the figures below, the tree is shown in the *CustomStage* that the add-in defined, but it is not shown in the *Refine* stage.

2.8. Sample Projects

The Sample Add-in project (C#) contains programming examples of how to use various areas of functionality in the API.

Sample Project	Version	Language	Link
Discovery Basic Template #1: Command Example • Demonstrates how to create an add-in and use a command to create a sample block.	API V241	C#	Visit the Ansys Discovery Space
Discovery Basic Template #2: Tool Example • Demonstrates how to define a button that activates a tool on the HUD. The tool has a textbox for double values and a second toolbox for an example physical quantity temperature. A check box allows you to switch between the two textboxes, chaining their visibility and keeping values in sync between the two fields.	API V241	C#	Visit the Ansys Discovery Space

Discovery Basic Template Installer #3: Custom Object/Custom Tree Example • Includes the functionality from the Discovery Basic Template #2: Tool Example and adds functionality to create a custom object that is displayed in the custom tree. The example shows how to link the custom object with the tool properties displayed in the HUD.	API V241	C#	Visit the Ansys Discovery Space
Sample Add-in • Copy Component - Show how to create a new translated component instance. • Create Assembly - Shows how to create a simple assembly with two positioned instances of one part, and one instance of another part. • Create Block - Shows how to create a block by extruding a rectangular profile. • Create Gear - Shows how to create a simple gear by extruding a complex profile involving lines and arcs. • Create Hole - Shows how to create a hole by subtracting a cylinder. • Create Notes - Shows how to create an annotation plane and then create notes at various angles, with different fonts and colors. • Create Torus - Shows how to create a torus by sweeping a circular profile around a larger circle. • Export - Shows how to export a document in various file formats. • Find Matching Faces - Shows how to traverse bodies and faces in an assembly and compare their geometry. • Scene Graph - Creates a scene graph. • Select Loop - Shows how to access the topology of a body and traverse edges, loops and fins. • Sketch Tool - Shows how to create an interaction tool for sketching lines. • Spin Component - Demonstrates animation by rotating selected component. • Profile Tool - Shows how to create and modify a custom object using an interaction tool.	API V241	C#	Visit the Ansys Discovery Space

Building the Sample Add-in Project

1. Download the SampleAddin zip file and unzip it.

> **Note:** Note: Use the Extract All command on the content menu in Windows Explorer.

2. In the extracted folder, locate the reference to the NuGet package (NuGet.config) and delete it.
3. Launch Visual Studio and open the project file (SampleAddin.csproj). Alternatively, you may double-click the project file and open it with Visual Studio.
4. In the Solution Explorer in Visual Studio, right-click References and select Add Reference.
5. In the Reference Manager, select the Browse tab. Locate the API assembly in the subfolder inside the Discovery Installation folder. Right-click this reference and set Copy Local to False.
6. Build the project is Visual Studio.

   > **Note:** Build the project using x64.

7. Launch Discovery.

   The Sample Add-in will appear in the Discovery Ribbon.

> **Note:** Samples that require a beta version of the API must reference that beta version.

> **Note:** To build the samples or any add-in, .NET 4.8 is required. If .NET 4.8 is not available to build with in your version of Visual Studio, the Microsoft .NET Framework 4.8 Developer Pack can be downloaded and installed for Visual Studio 2017 and Visual Studio 2019.

> **Note:** Sample projects have their build output path set to a folder beneath "%ALLUSERSPROFILE%\SpaceClaim\AddIns", which means Discovery will automatically find the add-in at start-up (see Manifest Files).

Add-ins Frequently Asked Questions

1. **What can I do when my Add-in project can't build because it's missing references or packages? Add-ins require several Discovery DLL libraries:**

   Discovery.API.2X

   SpaceClaim.API.2X

   SpaceClaim.API.2X.Internal

2. **What can I do when my Add-in project is built, but I can't see it in Discovery?**

   Either the Add-in is not completely built, or it is just not visible on Discovery.

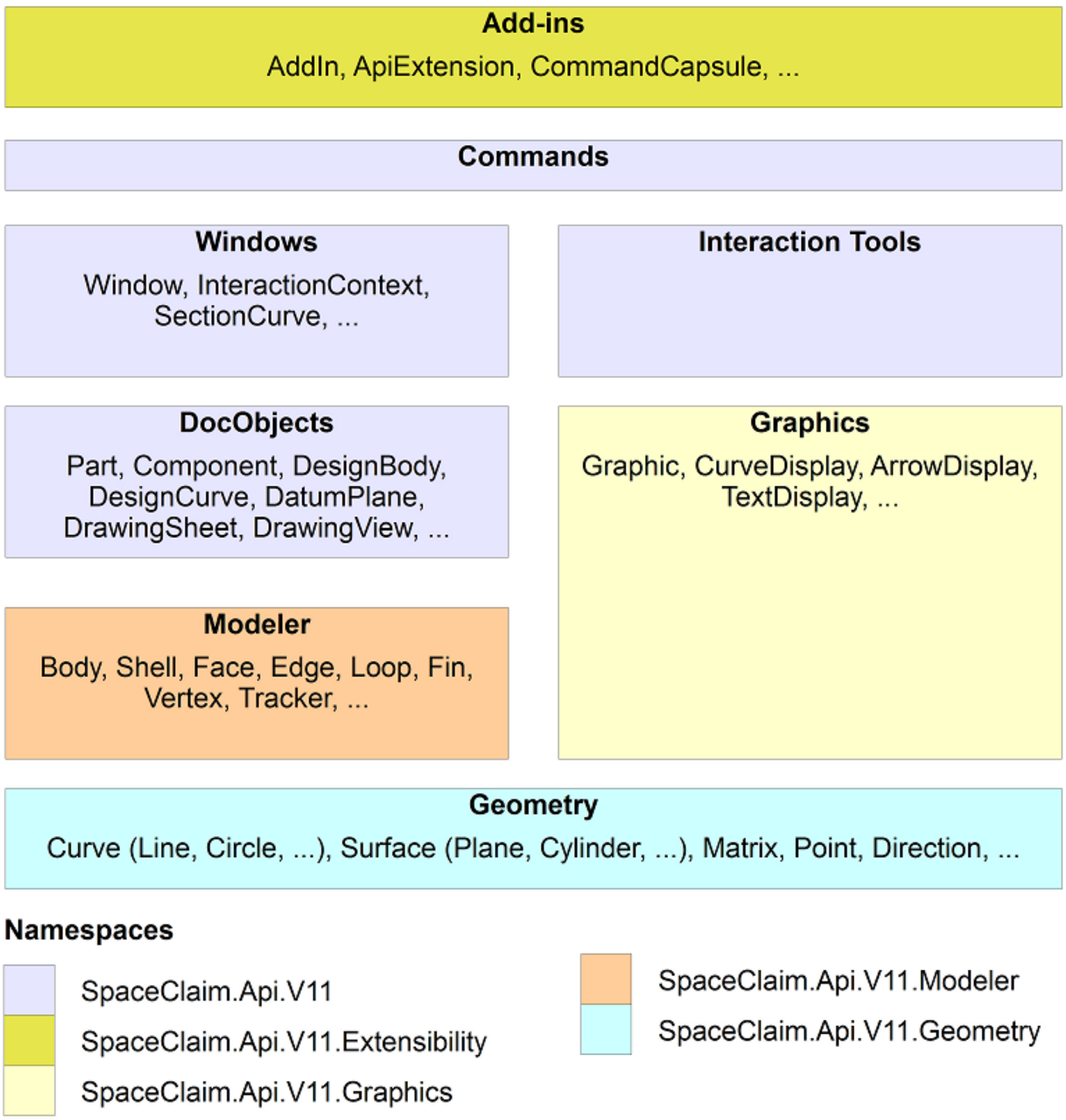
   Check Discovery Settings > Add-in and determine if the add-in is present. If it's found, go to the Ribbon section in the advanced part.

If the add-in is not found, verify that the add-in output files are configured for the Program Data folder. The manifest file will also appear there.

3: Geometry API Overview

The diagram below shows a conceptual view of the geometry architecture as presented through the API.

For the purposes of this diagram, each box represents a module, where each module makes use of other modules below it in the diagram. The box sizes have no significance.



These modules are merely conceptual groupings, since the only separation apparent in the API is the separation into namespaces, which are shown in different colors in the diagram.

Listed within many of the modules in the diagram are examples of types published by that module.

3.1. Doc Objects

Of particular importance is the distinction between *doc objects*, and the lower-level modeler and geometric objects. Doc objects, as the name suggests, belong to documents. They are first class objects, since they belong to a parent-child hierarchy, and they provide monikers (for persistent identifiers) and update states (for associative update).

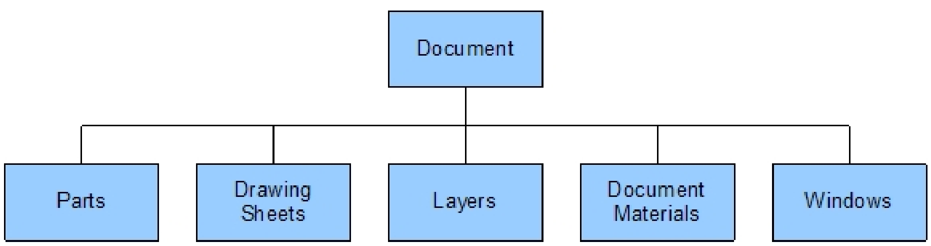
Many doc objects have references to modeler or geometry objects:

- Design bodies, design faces, and design edges are doc objects that have a reference to a corresponding modeler object: a body, face, or edge. You can create a modeler body without creating a design body, but this means no document is modified and nothing appears in the window. This can be useful if you want to perform some modeling calculation. You may or may not create a design body at the end.
- Design curves are doc objects that have a reference to a trimmed curve, which is a geometry object. Again, you can create curves and trimmed curves without ever creating a design curve, but design curves are what get displayed in windows. (You can create graphics display primitives, which reference geometry objects too, and these also get displayed in the window, although display primitives are not doc objects.)
- Datum planes are doc objects that have a reference to a plane, which is a geometry object. Again, you can create planes and other surfaces without ever creating a datum plane.

Typically, the doc object will have more properties than the modeler or geometry object that it references, such as name, layer, visibility, or color.

3.2. Document Structure

A document contains the following objects:



Parts

A document always contains at least one part, known as its *main part*, and this represents the design. If the main part has internal components (instances of other parts that belong to the same document), the document will contain other parts too.

Internal components are also used for beam profiles, mid-surface parts, and sheet metal unfolded parts.

The structure of a part is described below.

Drawing Sheets

A document contains zero or more drawing sheets.

The structure of a drawing sheet is described below.

Layers

A document contains one or more layers. There is always a *default layer*, and if you delete another layer, all its objects are moved to the default layer. You cannot delete the default layer. The default layer is not the same as the *active layer*, which is the layer to which new objects are assigned. The active layer is a property of the window.

Materials

A document contains zero or more document materials, which are materials used by parts, design bodies, or beams in that document.

Windows

A document contains one or more windows, but it may not have any windows loaded. If the document is explicitly opened, then its windows are also loaded and opened, but if a document is loaded implicitly, for example because it is referenced from another open document, then its windows are not loaded.

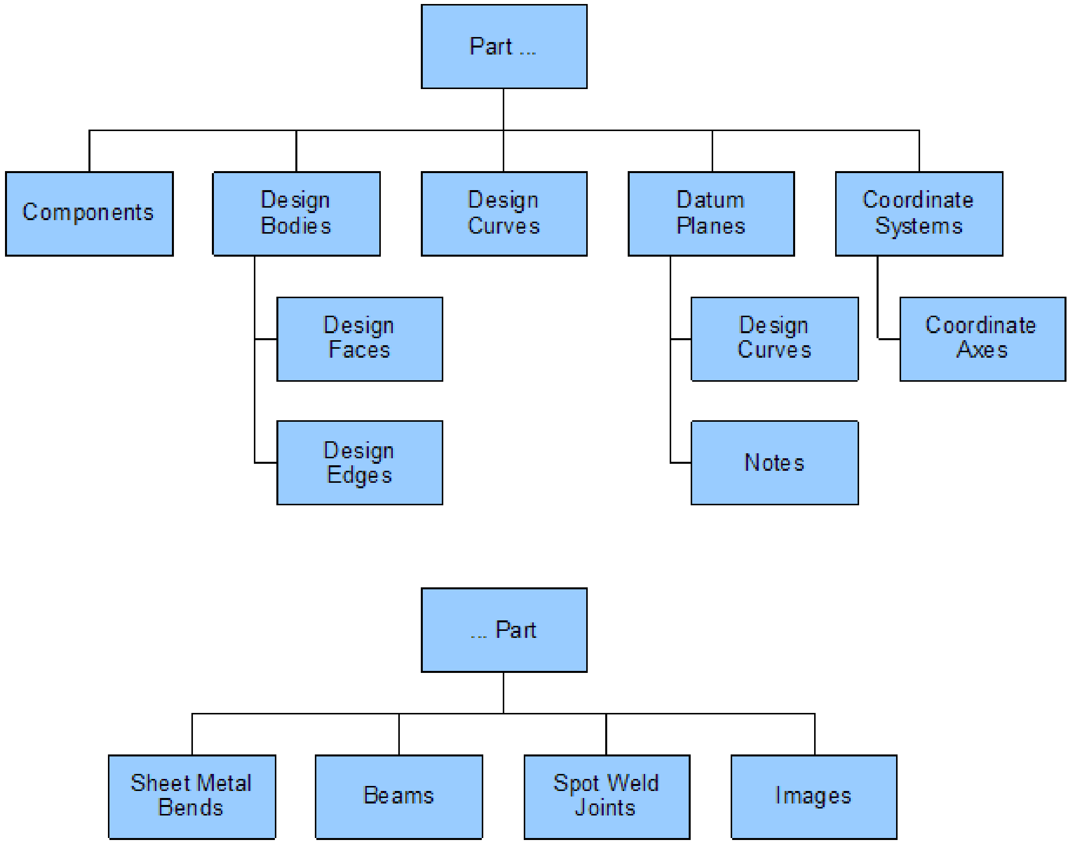
A window shows a *scene*, which is the root of the object hierarchy it displays. The window scene can be a part or a drawing sheet belonging to the same document.

The window also provides access to *interaction contexts*, which allow you to work in a specific coordinate space. The interaction context presents the current selection in that coordinate space. A useful interaction context is the *active context*, which is the context in which the user is working.

3.3. Part Structure

The Discovery object model is quite flat, with the part being a bucket for many objects:

Components



A part contains zero or more components. A component is an instance of another *template* part. The template part may belong to the same document (an internal component), or it may belong to another document (an external component).

Design Bodies

A part contains zero or more design bodies. A design body can be open (a surface body) or closed (a solid body). A design body contains design faces and design edges.

Design Curves

A part contains zero or more design curves. Design curves have 3D geometry, even though they are often sketched in a plane. For example, if you copy and paste design edges, design curves are created, and these need not lie in a plane.

Design curves can also belong to datum planes and drawing sheets.

Datum Planes

A part contains zero or more datum planes. As well as serving as construction planes, as the name suggests, datum planes can also contain design curves and text notes, which lie in the plane. When the datum plane is moved, its children are moved too.

Coordinate Systems

A part contains zero or more coordinate systems. A coordinate system contains three mutually perpendicular coordinate axes.

The world coordinate system, which can be displayed in the user interface, does not belong to any document, and is not presented through the API.

Sheet Metal Bends

If a part is a sheet metal part, then it contains zero or more sheet metal bends, which might be cylindrical or conical. If a part is a sheet metal part, then it has a sheet metal *aspect*, which is a companion object presenting sheet metal information, including bends.

Beams

A part contains zero or more beams, which have a trimmed curve path, a planar cross section, and information about the position and orientation of the cross section relative to the beam path.

Spot Weld Joints

A part contains zero or more spot weld joints. A spot weld joint has a collection of spot welds, each of which welds two or more points on design faces.

Images

A part contains zero or more images. An image is a picture or video, either positioned in space or wrapped onto a design face. An image can also belong to a drawing sheet.

4: Geometry Architecture

This section discusses the geometry architecture and includes the following sections:

- Documents and Doc Objects
- Application Integration
- Storing Custom Data
- Identifiers During Export
- Geometry and Topology
- Accuracy
- Units

4.1. Documents and Doc Objects

A Document is the unit of loading and saving. Assuming it has been saved, a document corresponds to a Discovery scdoc file on disk.

A DocObject is an object that belongs to a document. Doc objects are not the only objects that get saved when the document is saved, but they are the only objects that have a Document property. Examples of doc objects include: Part, Component, DesignBody, DesignFace, DatumPlane, and Note.

Doc objects provide:

- A parent-child tree containment hierarchy.
- Monikers for persistent identification.
- Update states to indicate that the doc object has changed.
- Custom attributes for storing 3rd party data.

4.1.1. Parent-Child Hierarchy

Doc objects are part of a parent-child containment hierarchy, where the *parent* represents the container and the *children* represent the contents. If a doc object is deleted, all its *descendants* (its children, recursively) are also deleted.

For example, a Part contains zero or more DesignBody objects, each of which contains one or more DesignFace objects. The parent of a design face is a design body, and the parent of a design body is a part. Similarly, a design body is a child of a part, and a design face is a child of a design body.

```
Public static void Example(DesignBody desBody) {
 Part part = desBody.Parent;

 // a part is a root object, so it has no parent
 Debug.Assert(part.Parent == null);
 Debug.Assert(part.Root == part);

 // GetChildren<T> returns immediate children of type T
 foreach (DocObject child in part.GetChildren<DocObject>()) {
  // Parent returns the immediate parent
  Debug.Assert(child.Parent == part);
 }
```

```
// DesignBody.Faces is equivalent to GetChildren<DesignFace>
foreach (DesignFace desFace in desBody.Faces) {
 // Root returns the topmost parent
 Debug.Assert(desFace.Root == part);
}

// GetDescendants<T> gets all nested children of type T
   // the search starts with the object itself
foreach (DesignFace desFace in part.GetDescendants<DesignFace>()) {
 // GetAncestor<T> crawls up the parent chain to find an object of type T
 Debug.Assert(desFace.GetAncestor<Part>() == part);

 // the search starts with the object itself
 Debug.Assert(desFace.GetAncestor<DesignFace>() == desFace);
}
}
```

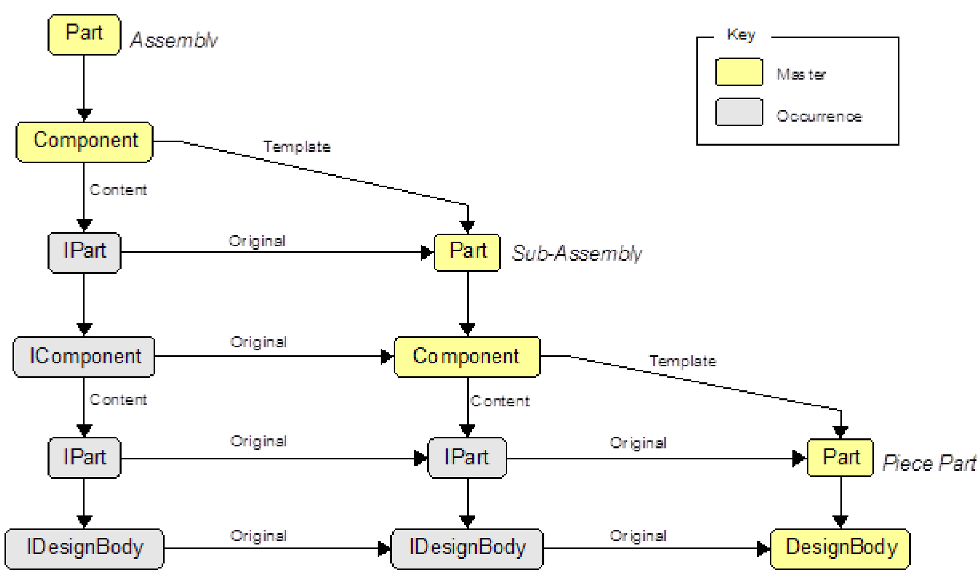
The parent chain continues up the hierarchy until the *root* object is reached. This is the topmost parent, which itself has no parent (its parent is null). Examples of root objects are: Part, DrawingSheet, and Layer.

All doc objects in the same parent-child hierarchy belong to the same document. The Document class provides properties to access its root objects: MainPart, Parts, DrawingSheets, and Layers.

4.1.2. Parts and Components

A Part contains zero or more DesignBody objects and zero or more Component objects. This means a part can contain both design bodies and components, in which case it is neither a pure piece part, nor a pure assembly. This is supported so that the interactive user can restructure design bodies into components, or vice versa.

A component is an *instance* of a *template* part. It has a *placement* matrix to position the component into assembly-space. The template is neither a child nor a parent of the component. If the parent-child hierarchy is visualized as an inverted tree structure with the root at the top and leaf nodes at the bottom, then the template is a sideways reference to another part, which is the root of another



The template part may live in the same document as the component, giving rise to what the interactive user would call an *internal component*, or it may live in another document, giving rise to an *external component*. Strictly speaking, it's the template part that is either internal or external, not the component itself.

4.1.3. Occurrence Chains

If the template object itself contains instances, occurrences of occurrences are produced. For example, this happens with a two-level assembly, since the top-level assembly contains a component that instantiates a sub-assembly part, which itself contains a component that instantiates a piece part.

4.1.4. General Objects and Masters

In general, a doc object is either an occurrence, or a *master*. When dealing with *general* doc objects (doc objects that might be occurrences or masters), interfaces are used, e.g. IPart, IComponent, and IDesignBody. These all derive from IDocObject.

There are some methods and properties that for theoretical or practical reasons are not presented by occurrences, and are therefore only presented by masters. When dealing with masters, classes are used, e.g. Part, Component, and DesignBody. These all derived from DocObject, which implements IDocObject.

Part implements IPart, Component implements IComponent, and so on, so a master supports everything that a general object supports, and often more besides.

Note that although Part is always a root object, IPart may or may not be a root object. If the IPart happens to be a master, then it is a root object, but if it happens to be an occurrence, its parent will be an IComponent or an IDrawingView.

4.1.5. Originals and Masters

IDocObject is the base for all doc object functionality. It provides members for traversing the parent-child hierarchy (Children, GetChildren<T>, GetDescendants<T>, Parent, GetAncestor<T>, Root), which we have already met, and it also provides members for traversing the occurrence structure:

- Original – Gets the original IDocObject, else null if this is a master.
- Master – Gets the ultimate original, i.e. the DocObject master at the end of the occurrence chain. If the object is a master, the object itself is returned.
- Instance – Gets the instance that produces this occurrence, else null if this is a master.

4.1.6. Transforming to Master-Space

The most common of these properties to use is Master, because the master can provide methods and properties not available on the general object. Since the master might be in a different coordinate-space to the general object, TransformToMaster can be used to get the transform that maps objects in general-space to objects in master-space.

```
Public static void Example(Icomponent comp, Frame placement) {
 // the Placement property is available on Component, but not Icomponent
 Component master = comp.Master;

 // map placement frame into master-space
 Matrix transToMaster = comp.TransformToMaster;
 Frame masterPlacement = transToMaster * placement;

 // apply master placement frame to master component
 master.Placement = Matrix.CreateMapping(masterPlacement);
}
```

4.1.7. Getting Occurrences

Having done some work in master-space, it may be necessary to obtain an object in general-space. This is common if the original object came from the window selection, and you wish to set a new selection in the window.

The window selection is always in window-space, i.e. in the same coordinate-space as the scene shown in that window (the same coordinate-system as Window.Scene). So if the window shows an assembly, then the selected objects are in assembly-space.

GetOccurrence can be used to obtain an object in general-space. It returns an occurrence that is similar to a companion object supplied. Note that the companion object is a general object, which may or may not be an occurrence. If it is an occurrence, then an equivalent occurrence is returned for the subject. If it is not an occurrence, then the subject itself is returned. This allows you to write code that works correctly without testing whether the object is in fact an occurrence.

```
Public static void Example() {
 Window window = Window.ActiveWindow;
 if (window == null)
  return;

 // the selected component is in window-space
 IComponent oldComp = window.SingleSelection as IComponent;
 if (oldComp == null)
  return;

 // copy the component master
 Component oldMaster = oldComp.Master;
 Component newMaster = Component.Create(oldMaster.Parent, oldMaster.Template);

 newMaster.Placement = oldMaster.Placement;

 // get an occurrence of the new master in window-space
 IComponent newComp = newMaster.GetOccurrence(oldComp);

 // select the newly created component
 window.SingleSelection = newComp;
}
```

4.2. Application Integration

This section covers the following topics:

- Persistent Identifiers
- Replacements
- Update States

4.2.1. Persistent Identifiers

Doc objects have persistent identifiers, called *monikers*, which can be recorded and later *resolved* to return the doc object again. The Moniker property returns a moniker for the doc object, and the Resolve method returns the doc object again.

Internally, master doc objects have an identifier, which is globally unique. Occurrences are identified by the instance, which is a master, along with the original object, which might itself be an occurrence. A moniker is an object that encapsulates the identifiers of the one or more master objects involved in the identity of the subject.

To record a moniker, you can record its string representation using ToString. The length of this string depends on the number of master objects involved. The format of this string is not documented, so you should not attempt to construct or modify such a string.

To convert the string representation back into a moniker, you can use `FromString`.

```
public static void Example(IDesignFace desFace) {
 Document doc = desFace.Document;

 // all doc objects provide a moniker
 Moniker<IDesignFace> desFaceMonikerA = desFace.Moniker;

 // resolve the moniker in the document to obtain the original object
 Debug.Assert(desFaceMonikerA.Resolve(doc) == desFace);

 // the string representation can be recorded
 string monikerText = desFaceMonikerA.ToString();

 // the moniker can be reconstructed from the string
 Moniker<IDesignFace> desFaceMonikerB =
Moniker<IDesignFace>.FromString(monikerText);
 Debug.Assert(desFaceMonikerB.Resolve(doc) == desFace);
 }
```

To resolve a moniker, a document must be provided as the context. Discovery allows more than one version of the same scdoc file to be loaded at the same time, so the same moniker could potentially be resolved in more than one document.

Since the internal identifiers involved are globally unique, there is no danger of resolving the moniker in an unrelated document. If you attempt to do so, `null` will be returned to indicate that the object was not found.

4.2.2. Replacements

If the doc object has been deleted, Resolve returns null to indicate that the object was not found. Sometimes doc objects can get replaced during a command. For example, if a design face is split during a modeling operation, it will be replaced by two new design faces. Perhaps one of these new design faces gets split itself, or perhaps one of them gets deleted.

Behind the scenes, replacements are recorded, and when Resolve is called, if the object has been replaced, the moniker automatically returns one of the survivors, or null if there are no survivors.

- If it is important to know whether the object is a survivor, rather than the original object, you can compare its moniker with the moniker you already have, using the == operator. If the object is a survivor, it will have a different moniker.
- If it is important to obtain all survivors, ResolveSurvivors can be used instead. Note that this method only returns surviving replacements, so if the object hasn't been replaced at all, no survivors are returned.

4.2.3. Update States

A doc object master has an *update state*, which tells you if the object has changed.

Each time the doc object master is changed, its update state changes. Conversely, if the update state has not changed, then the object has not changed. When an object is changed due to an undo (or redo) operation, its update state is undone (or redone) too.

The update state is persistent, so you can store its string representation and use it in another Discovery session.

```
public static void Example(DesignFace desFace) {
 // doc object masters provide an update state
 UpdateState beforeStateA = desFace.UpdateState;

 // the string representation can be recorded
 string stateText = beforeStateA.ToString();

 ModifyDesignBody();

 // test whether the design face was changed
 if (desFace.UpdateState != beforeStateA)
  Debug.WriteLine("Design face was changed.");

 // the update state can be reconstructed from the string
 UpdateState beforeStateB = UpdateState.FromString(stateText);
 Debug.Assert(beforeStateA == beforeStateB);
}
```

Update states are not provided for occurrences, but you can store the update states of the instances involved in the occurrence chain, along with the update state of the master. PathToMaster returns these instances.

The update state only represents the state of the object itself, and not the state of other objects it contains or references. For example, the update state of a part is not changed if a child design body is modified. Similarly, although the update state of a component will change if its placement is modified (since this is a property of the component itself), the update state will not change if its template part is modified.

4.3. Storing Custom Data

This section covers the following topics:

- Document Properties
- Custom Attributes
- Attribute Propagation

4.3.1. Document Properties

Documents have two types of properties:

- *Core properties* cover standard fields such as *description*, *subject*, *title*, and *creator*. The set of core properties is fixed. You cannot create new core properties.
- *Custom properties* allow 3rd party applications to store data with the document. Each custom property is a name-value pair.

So that custom property names do not clash when different applications choose a custom property name, the name should be prefixed with the application or add-in name, as in the following example:

```
public static void Example(Document doc) {
 CustomProperty.Create(doc, "BananaWorks.ApplicationVersion", 14);

 CustomProperty property;
 if (doc.CustomProperties.TryGetValue("BananaWorks.ApplicationVersion", out
property))
  Debug.Assert((double) property.Value == 14);
}
```

Note that a document can contain more than one part, so if you want to store data for a part, this is best done by storing a custom attribute on the part master (see next topic).

4.3.2. Custom Attributes

Doc object masters provide custom attributes so that 3rd party applications can store data. Two types of attribute are provided: text attributes and number attributes. An attribute is a name-value pair. A doc object can have a text attribute and a number attribute with the same name.

So that attribute names do not clash when different applications choose an attribute name, the name should be prefixed with the application or add-in name, as in the following example:

```
public static void Example(DesignBody desBody) {
 desBody.SetTextAttribute("BananaWorks.SkinCondition", "Ripe");

 string skinType;
 if (desBody.TryGetTextAttribute("BananaWorks.SkinCondition", out skinType))
  Debug.Assert(skinType == "Ripe");
}
```

Multiple values can be stored as multiple attributes with distinct names, or they can be formatted into a single text string using String.Format or an XML serializer.

4.3.3. Attribute Propagation

Attributes applied to doc object masters are propagated if the object is replaced. For example, if a design face has a text attribute, and this face is split during a modeling operation, the replacement design face fragments will also carry the same text attribute.

4.4. Identifiers During Export

When an ACIS or Parasolid file is written, either by the user or by calling Part.Export, *name* attributes are attached to face and edge entities in the file to indicate which design face or design edge master they came from. This is useful if the model is changed and then a new file is exported, since corresponding faces and edges will have the same *name* attributes.

- An ACIS *name* attribute is a "named attribute" (ATTRIB_GEN_NAME) with the attribute name, "ATTRIB_XACIS_NAME".
- A Parasolid *name* attribute is a system attribute with the name, "SDL/TYSA_NAME".

Design face and design edge masters have an ExportIdentifier property, which returns a string containing the value of the name attribute that is written when the object is exported.

4.4.1. Identifying Objects in ACIS and Parasolid Files

This section covers the following topics:

- Identifiers During Export
- Foreign Identifiers During Import and Export

4.4.2. Foreign Identifiers During Import and Export

There may be a requirement to import a model from another system, modify it in Discovery, and then export it again, such that the other system can track the identity of faces and edges during this round trip.

When importing an ACIS or Parasolid file, if any body, face, or edge entities have *id* attributes, these are converted to Discovery text attributes on the resulting design body, design face, or design edge masters. These text attributes have the reserved name, "@id".

- An ACIS *id* attribute is a "named attribute" (ATTRIB_GEN_NAME) with the attribute name, "ATTRIB_XACIS_ID".
- A Parasolid *id* attribute has the name, "ATTRIB_XPARASOLID_ID", and has an attribute definition, which is described in the documentation for the Part.Export method.

Attributes applied to doc object masters are propagated if the object is replaced. For example, if a design face has a text attribute, and this face is split during a modeling operation, the replacement design face fragments will also carry the same text attribute.

When exporting an ACIS or Parasolid file, if any design bodies, design faces, or design edges have text attributes with the name, "@id", these are written as *id* attributes applied to resulting ACIS or Parasolid entities.

4.5. Geometry and Topology

This section addresses the following topics:

- Unbounded Geometry and Trimmed Objects
- Topology
- Doc Objects and Geometry Design
- Curves
- Design Bodies
- Shape in General

4.5.1. Unbounded Geometry and Trimmed Objects

In Discovery, geometry is conceptually unbounded, e.g. a Plane extends indefinitely, a Sphere is complete, and a Line is infinite in length. On top of this there are *trimmed* objects, which are bounded and therefore provide additional properties:

- ITrimmedCurve – a bounded curve. It provides Length and parametric Bounds.
- ITrimmedSurface – a bounded surface. It provides Area, Perimeter, and a parametric BoxUV.
- ITrimmedSpace – a bounded region of 3D space. It provides Volume and Surface Area.

All of these inherit from IBounded, which provides GetBoundingBox.

A trimmed curve has a Geometry property that returns the Curve, and a trimmed surface has a Geometry property that returns the Surface. A trimmed region even has a Geometry property that returns a Space object representing all of Cartesian 3D space.

Trimmed curves and trimmed surfaces also have an IsReversed property, which tells you whether the sense of the object is the opposite of the sense of its geometry. The sense of a trimmed curve is its direction, and the sense of a trimmed surface is which way its normals face.

4.5.2. Topology

The topology of a model is made of Body, Face, and Edge objects, along with other objects (shells, loops, fins, and vertices) that describe in more detail how they connect up.

- Body inherits from ITrimmedSpace. It also provides Faces and Edges.
- Face inherits from ITrimmedSurface. It also provides surrounding Edges.
- Edge inherits from ITrimmedCurve. It also provides adjacent Faces.

Topology classes have more information than the trimmed object interfaces that they implement:

- Trimmed object interfaces have no concept of connectivity.
- Although they can return area and volume, respectively, ITrimmedSurface and ITrimmedSpace say nothing about the shape of their boundary. (With ITrimmedCurve, the boundary has no shape as such, since the curve is simply bounded by parameter values.)

4.5.3. Doc Objects and Geometry

Topology objects (Body, Face, Edge, etc.) and geometry objects (Plane, Cylinder, Line, etc.) are not doc objects. They are not part of a parent-child hierarchy, and they do not have monikers or update states. They are lower level objects, since they might be referenced by a doc object, but they have no knowledge of documents and doc objects themselves.

You can construct geometry, trimmed objects, and even solid bodies, in order to perform geometric calculations, without modifying a document:

```
public static void Example() {
 // create infinite line with zero parameter at the origin
 Line line = Line.Create(Point.Origin, Direction.DirX);

 // create line segment from (-0.01, 0, 0) to (0.01, 0, 0)
 ITrimmedCurve trimmedCurve = CurveSegment.Create(line, Interval.Create(-0.01,
 0.01));
 Debug.Assert(Accuracy.EqualLengths(trimmedCurve.Length, 0.02));

 // find closest point to (0.05, 0.05, 0)
 CurveEvaluation eval = trimmedCurve.ProjectPoint(Point.Create(0.05, 0.05,
0));

 // closest point on line segment should be (0.01, 0, 0)
 Debug.Assert(eval.Point == Point.Create(0.01, 0, 0));
}
```

The document is modified when you create doc objects. For example, you might create a design curve from a trimmed curve.

4.5.4. Design Curves

Design curves are what the end user refers to as *sketch curves*. They are called *design curves* in the API for consistency with design bodies, design faces, and design edges.

A DesignCurve is a doc object, which has a trimmed curve Shape.

```
public static void Example(Part part) {
 Line line = Line.Create(Point.Origin, Direction.DirX);
 ITrimmedCurve shape = CurveSegment.Create(line, Interval.Create(-0.01, 0.01));
```

```
 // create a design curve
 DesignCurve desCurve = DesignCurve.Create(part, Plane.PlaneXY, shape);

 // the Shape property returns the trimmed curve
 Debug.Assert(Accuracy.EqualLengths(desCurve.Shape.Length, 0.02));

 // override the layer color
 desCurve.SetColor(null, Color.DarkSalmon);
}
```

A design curve has other properties that are outside the concept of a trimmed curve, such as layer, color override, and name.

4.5.5. Design Bodies

Just as a DesignCurve is a doc object, which has a Shape of type ITrimmedCurve, there is a similar pattern for bodies:

- A DesignBody has a Shape of type Body.
- A DesignFace has a Shape of type Face.
- A DesignEdge has a Shape of type Edge.

This is only true for these doc object masters. For the corresponding general objects, less information is available:

- IDesignBody has a Shape of type ITrimmedSpace.
- IDesignFace has a Shape of type ITrimmedSurface.
- IDesignEdge has a Shape of type ITrimmedCurve.

This means, you can only access detailed topology information, such as loops and fins, from masters:

```
public static void Example(IDesignFace desFace) {
 // we can get the area from the ITrimmedSurface shape
 double area = desFace.Shape.Area;

 // but to access loops, we need to use the master
 DesignFace desFaceMaster = desFace.Master;
 // if we access geometry, remember we are now in master-space
 Matrix transToMaster = desFace.TransformToMaster;

 DesignBody desBodyMaster = desFaceMaster.Parent;

 // the master Shape is a Face rather than an ITrimmedSurface
 Face face = desFaceMaster.Shape;
 foreach (Loop loop in face.Loops)
  foreach (Fin fin in loop.Fins) {
   Edge edge = fin.Edge;

   // get from shape back to doc object master
   DesignEdge desEdgeMaster = desBodyMaster.GetDesignEdge(edge);

   // from master to occurrence equivalent to desFace
   IDesignEdge desEdge = desEdgeMaster.GetOccurrence(desFace);
  }
}
```

However, the general interfaces do provide some convenient connectivity traversals at the doc object level:

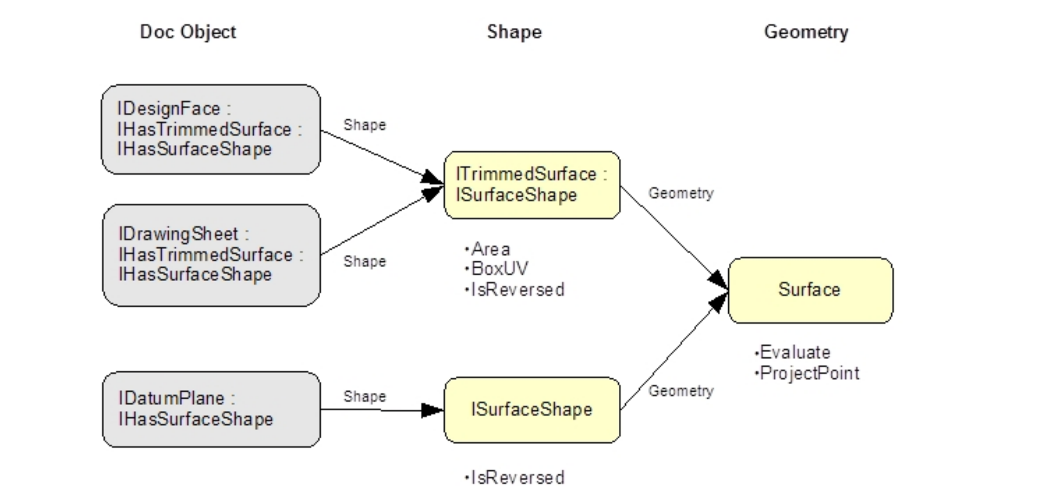
```
public static void Example(IDesignFace desFace) {
 IDesignBody desBody = desFace.Parent;

 // the Edge property returns the edges in the face boundary
 foreach (IDesignEdge desEdge in desFace.Edges) {
  Debug.Assert(desEdge.Parent == desBody);

  // the Faces property returns the faces that meet at this edge
  Debug.Assert(desEdge.Faces.Contains(desFace));
 }
}
```

4.5.6. Shape in General

Shape also applies to doc objects that have untrimmed geometry, e.g. a datum plane. DatumPlane implements IHasSurfaceShape and its Shape, not surprisingly, is a ISurfaceShape. Compare this to DesignFace, which implements IHasTrimmedSurface and has a Shape of type ITrimmedSurface. This parallel path exists because IHasTrimmedSurface is derived form IHasSurfaceShape, and ITrimmedSurface is derived from ISurfaceShape. Therefore, whether the geometry is untrimmed or trimmed, there is always a two step traversal, first to Shape, and then to Geometry:



4.6. Accuracy

This section covers the following topics:

- Linear and Angular Resolution
- Comparing Lengths and Angles
- Comparing XYZ Objects
- Comparing UV Objects
- Comparing Geometry

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4.6.1. Linear and Angular Resolution

Internally, geometric calculations are performed to machine double precision. When comparing the results of calculations, values should always be compared to within a specific resolution. These resolutions are provided by the Accuracy class:

- Two lengths are considered equal if their difference is less than LinearResolution.
- Two angles are considered equal if their difference is less than AngularResolution.

For example, when ContainsPoint is called to determine whether a point lies in a surface, internally the distance from the surface might be calculated, and the result is true if this distance is less than LinearResolution.

4.6.2. Comparing Lengths and Angles

The Accuracy class provides methods for comparing lengths and angles.

The CompareLengths method takes two arguments, *lengthA* and *lengthB*, and returns an integer result:

- -1 *lengthA* is less than *lengthB*.
- 0 *lengthA* is equal to *lengthB* to within linear resolution.
- +1 *lengthA* is greater than *lengthB*.

This method provides general comparison of two lengths, but for common situations, such as comparing with zero, or testing whether two values are equal, simpler and more readable methods can be used:

```
public static void Example(double lengthA, double lengthB) {
 // same as CompareLengths(lengthA, lengthB) == 0
 bool equalLengths = Accuracy.EqualLengths(lengthA, lengthB);

 // same as CompareLengths(lengthA, 0) == 0
 bool lengthIsZero = Accuracy.LengthIsZero(lengthA);

 // same as CompareLengths(lengthA, 0) > 0
 bool lengthIsPositive = Accuracy.LengthIsPositive(lengthA);

 // same as CompareLengths(lengthA, 0) < 0
 bool lengthIsNegative = Accuracy.LengthIsNegative(lengthA);
}
```

Corresponding methods are provided for angles: CompareAngles, EqualAngles, AngleIsZero, AngleIsPositive, and AngleIsNegative.

4.6.3. Comparing XYZ Objects

The basic XYZ types, Point, Vector, Direction, Box, and Frame, have resolution tests build in, so you can compare objects using the == operator. For example, two points are equal if the distance between them is less than the linear resolution, and two directions are equal if the angle between them is less than then angular resolution.

```
public static void Example(Plane plane, Point point) {
 // project point onto plane
 SurfaceEvaluation eval = plane.ProjectPoint(point);
 Point pointOnPlane = eval.Point;

 // points are the same if less than linear resolution apart
 bool planeContainsPoint = point == pointOnPlane;
```

```
    // ContainsPoint is more efficient, but gives the same result
    Debug.Assert(planeContainsPoint == plane.ContainsPoint(point));
}
```

4.6.4. Comparing UV Objects

The same is not true for the surface parameter UV types, PointUV, VectorUV, DirectionUV, and BoxUV, or for the curve parameter type, Interval. These types do not know whether the parameterization they represent is linear, angular, or some other type. For example, for a plane, the U parameterization is linear, but for a cylinder, the U parameterization is angular. For a NURBS surface, the U parameterization is neither linear nor angular.

Therefore, you should not use the == operator for these types. When comparing parameters, you should use the appropriate length or angle comparison method for each of the U and V values. For NURBS parameterization, angular comparison could be used, but it is safest to evaluate points and compare these instead.

4.6.5. Comparing Geometry

To say that two surfaces or two curves are equal is ambiguous, since there is more than one interpretation of the concept. For example, with two planes:

- They could be coplanar, but the normals could be opposed.
- They could be coplanar, with normals having the same sense, but their frames and hence their parameterization might be different.
- They might be identical in every way.

You should not use the == operator with surface and curve types, since that will only test for reference equality.

Geometry.IsCoincident and ITrimmedCurve.lsCoincident are provided to make comparisons. They only test for coincidence, which means any of the above cases would pass.

4.7. Units

This section covers the following topics:

- System Units and User Units
- Outputting Values
- Inputting Values
- Custom Conversions

4.7.1. System Units and User Units

Internally Discovery works in SI units: meters, kilograms, and seconds. The API also works in SI units.

The user may be working in some other units, but internally the units are still SI units. Conversions are done when values are presented to the user, or input by the user.

The Window class provides conversions between system units (SI units) and user units.

4.7.2. Outputting Values

Window.Units.Length.Format produces a length string that can be presented to the user, which includes the units symbol. As well as performing units conversion, this method also formats the output according to whether the user is working in decimals or fractions.

Window.Units.Angle.Format provides the same functionality for angles.

4.7.3. Inputting Values

To parse a length string entered by the user, you can use Window.Units.Length.TryParse. As well as converting to system units, this method also handles expressions, and values with explicit units stated:

- "(1 + 2) * 3 ^ (3/3 + 3)" = 243
- "1cm + 1 1/2 mm" = 0.0115

Window.Units.Angle.TryParse provides the same functionality for angles.

4.7.4. Custom Conversions

If you need more control over the formatting, you can use Window.Units.Length.ConversionFactor and Window.Units.Length.Symbol for lengths, or Window.Units.Angle.ConversionFactor and Window.Units.Angle.Symbol for angles.

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5: Release Notes

Available with this release: **Release Notes V24.1**.

5.1. V24.1

The **V24.1** version of the **Discovery APIs** contains the following changes and additions:

Distinction between Core APIs and APIs for customizing the user interface

- In versions preceding v24.1, the *Discovery.Api.Vxx.dll* encompassed the complete set of Discovery APIs. The *Discovery.Api.V241.dll* now exclusively contains the APIs relevant to Core functionality. The user interface customization APIs have been isolated into a distinct .dll named *Discovery.API.V241.UserInterface.dll*. Notably, referencing the *Discovery.API.V241.UserInterface.dll* automatically incorporates a reference to the Core API.

Refactoring namespaces from "Solver" to "Stages"

- As stages and solver fidelity can be defined by add-ins within their custom stages, the following APIs, originally accessible under the **Solver** class, are now accessible through the **Stages** class:
  - **SetStage**
  - **GetCurrentStageIdentifier**
  - **GetFidelity**
  - **SetFidelity**

SIDCustomization

- SID customization has been improved to enable add-ins to incorporate the **Notification hexagon**, unless overridden by add-in-defined functionality. Additionally, it is now feasible to integrate a customized **Selection Button**, similar to the one found in the standard **Discovery** application.

Scripting APIs support new functionality

- Commands within the **DetectTool** namespace for identifying and collecting problematic areas in geometry.
- Commands within the **EnvironmentalProperty** namespace for monitoring the environmental impact of selected materials.
- Commands within the **SubdivisionSurfaces** namespace related to the utilization of subdivision surfaces in geometry.
- Commands and properties within the **Welds** namespace for modeling welding processes.

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Persistence of Vision Raytracer Pty. Ltd.

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Australia

POV-Ray Licence Agreement

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Persistence of Vision Ray Tracer (POV-Ray)

Version 3.6 License and Terms & Conditions of Use

version of 1 February 2005

(also known as POVLEGAL.DOC)

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