Student Notes:

CATIA V5 Training
Foils

Imagine and Shape

Version 5 Release 19
January 2009

EDU_CAT_EN_IMA_FF_V5R19

About this course

Objectives of the course

Upon completion of this course you will be able to:

- **Identify and use the tools specific to the Imagine and Shape workbench**
- **Create new product shapes**
- **Improve product styles**
- **Modify the product style surfaces using Shape Design tools**

Targeted audience

Product Stylists, Industrial Designers

Prerequisites

Students attending this course should be familiar with the CATIA Generative Shape Design

Student Notes:

Student Notes:

Table of Contents (1/2)

Student Notes:

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Student Notes:

Introduction to Imagine and Shape

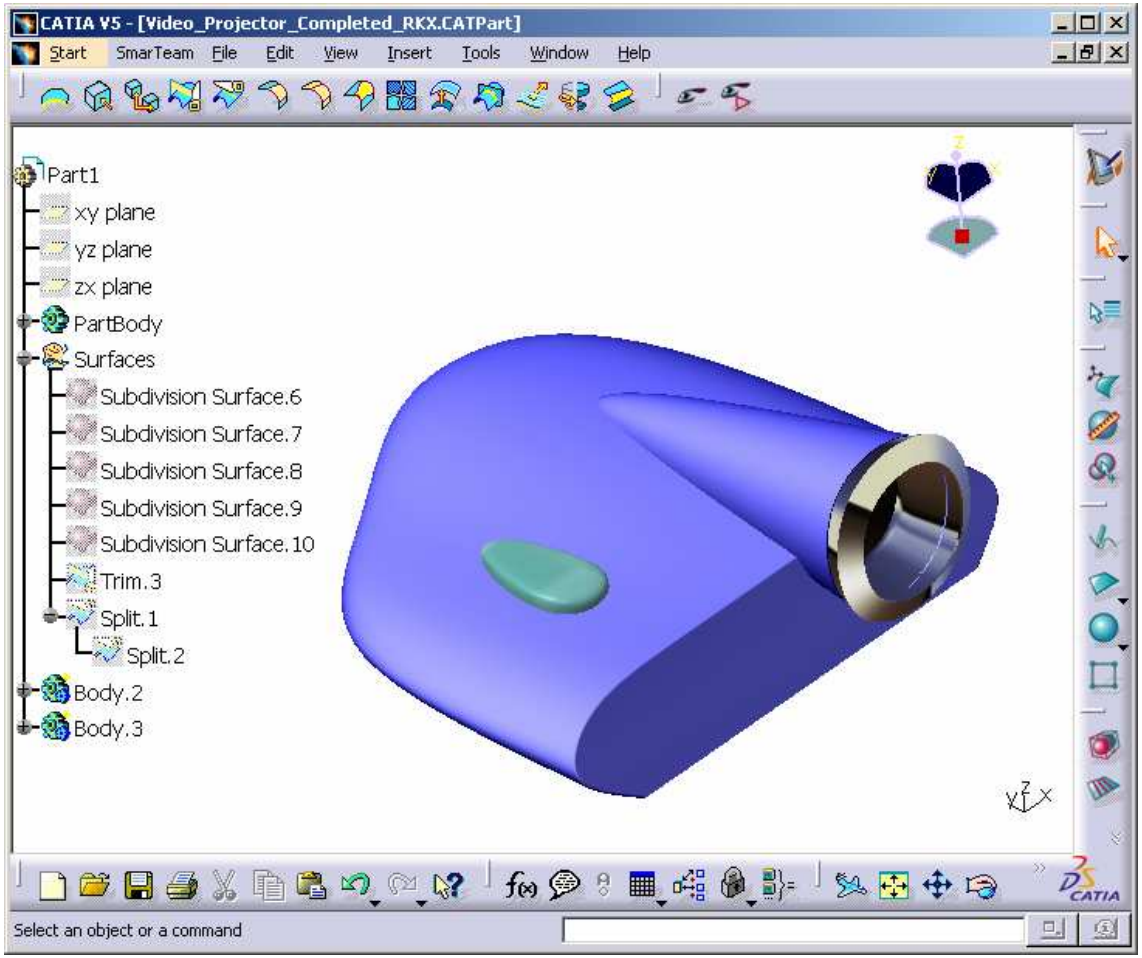
In this lesson you will be introduced to the working environment of Imagine and Shape Workbench.

- Overview of Imagine and Shape Workbench
- Accessing the Workbench
- Imagine and Shape: User Interface
- Imagine and Shape: Recommended Settings
- Imagine and Shape Common Tools

Student Notes:

Overview of Imagine and Shape

You will get an overview of Imagine and Shape workbench.

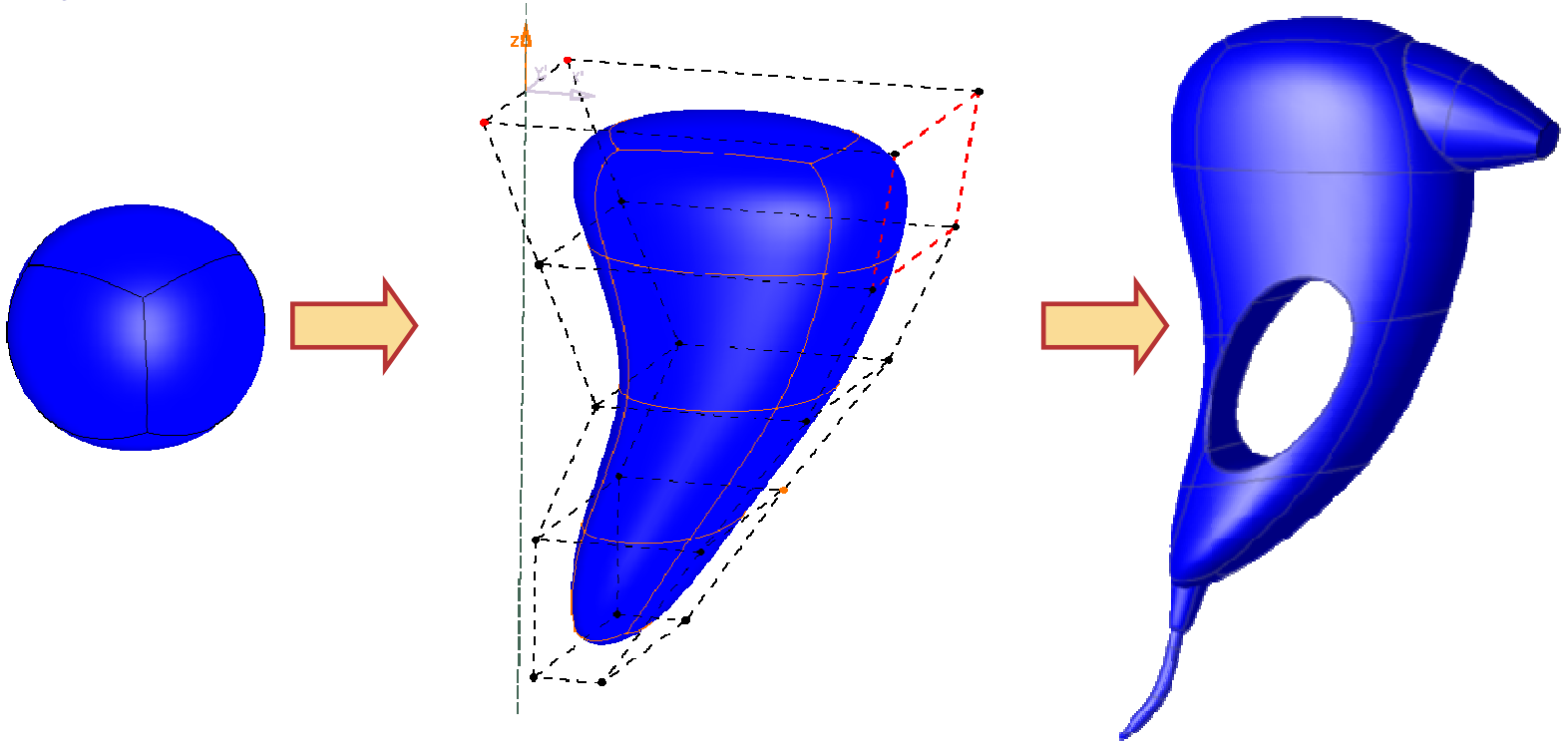


Student Notes:

Overview

Imagine and Shape is used in the product conception stage. The basic principle behind this workbench is to start with a simple closed or planar shape, then to reach the idea you have in mind by manipulating and refining the mesh of this shape by rotation, translation, scaling or subdivision. You can also use GS1/GSD operators to combine the surfaces and finalize the shape.

Surfaces created in Imagine and shape workbench are based on “Subdivision Surface” theory.

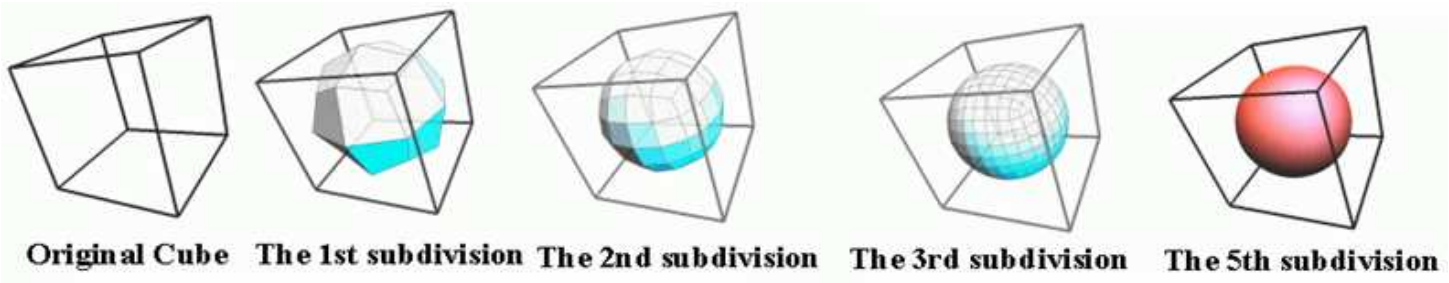


Student Notes:

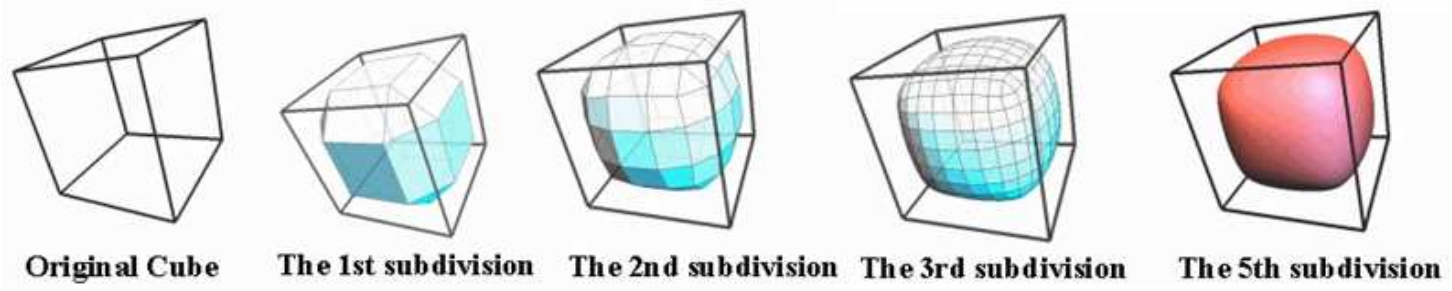
Introduction to Subdivision Surfaces

The origin of subdivision surfaces goes back to 1978 when Catmull and Clark, and Doo and Sabin first proposed to generalize bi-cubic and bi-quadratic patch methods to meshes of arbitrary topology.

- **Catmull-Clark subdivision surface**

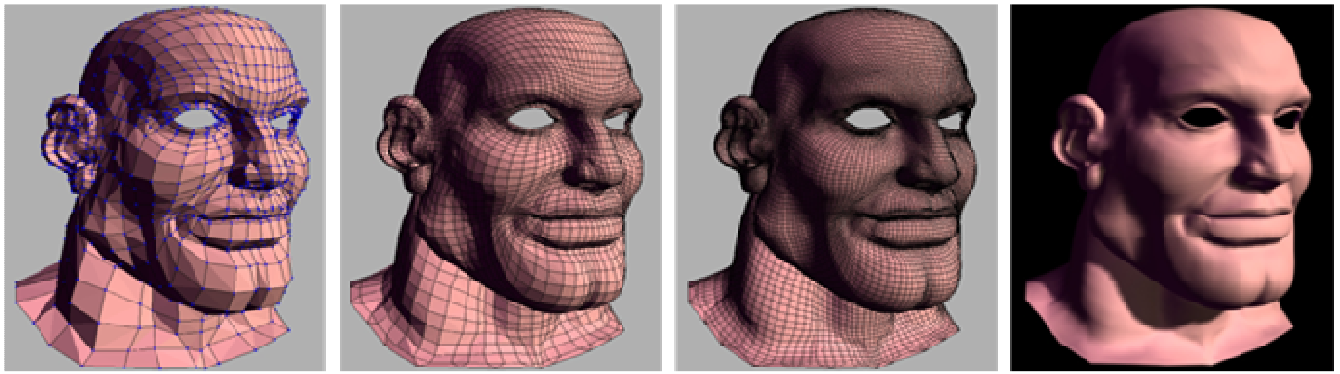


- **Doo-Sabin subdivision surface**



What is a Subdivision Surface

Subdivision is an algorithmic technique to generate a smooth surface as a sequence of successively refined polyhedral meshes.



- **Subdivision algorithms are exceptionally simple, work for arbitrary control meshes and produce globally smooth surfaces. Special choices of subdivision rules allow for the introduction of features into a surface in a simple way.**
- **Subdivision-based representations of complex geometry can be manipulated and rendered very efficiently, which makes subdivision a highly suitable tool for interactive animation and modeling systems.**

Student Notes:

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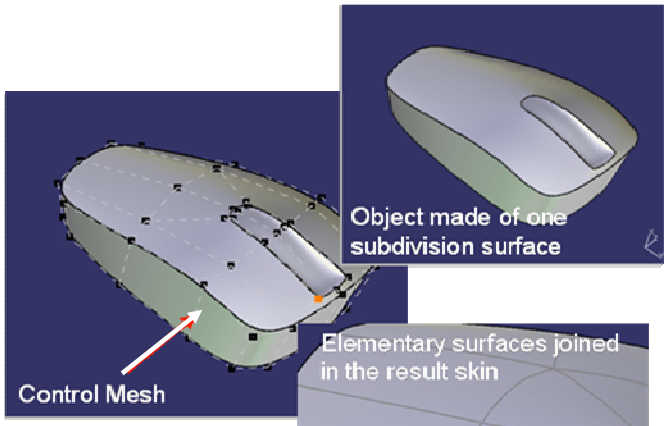
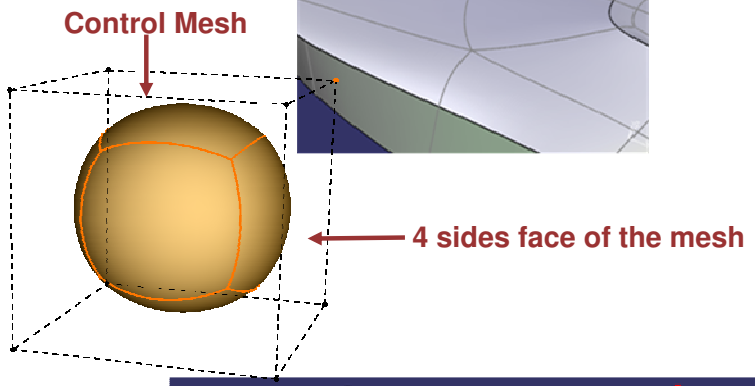
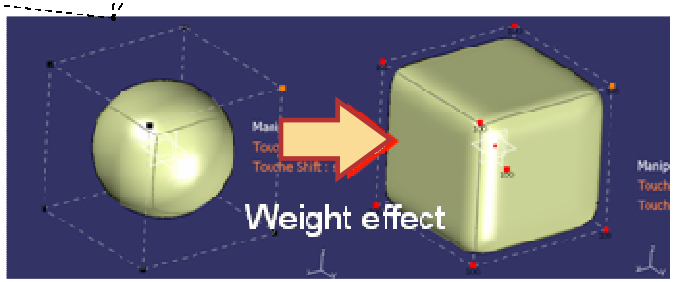
Subdivision Surfaces in Imagine & Shape

- The subdivision surfaces in CATIA V5 IMA are exact surfaces (Bezier or NURBS and not a polygonal approximation) computed to reach an aesthetic shape.
- A subdivision surface can be seen as a skin made of elementary surfaces, it can be closed or open.
- Since the topology of the shape is arbitrary, it enables the description of a large variety of complex topologies.
- The definition and the control of the shape is made using a mesh made of 4-sides faces.
- Some mesh attributes can be added to control the local attraction of the surface and so obtain sharp or smooth edges in a single surface.



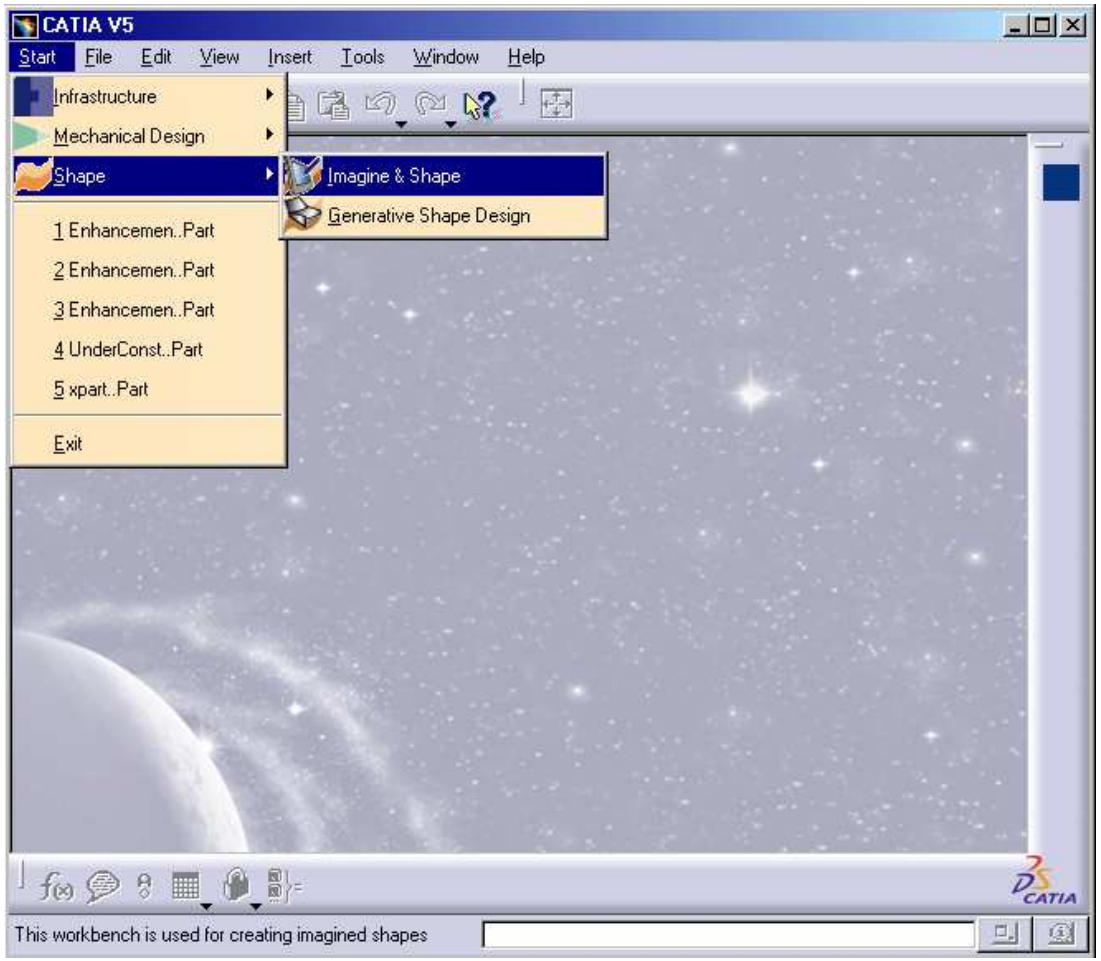




Student Notes:

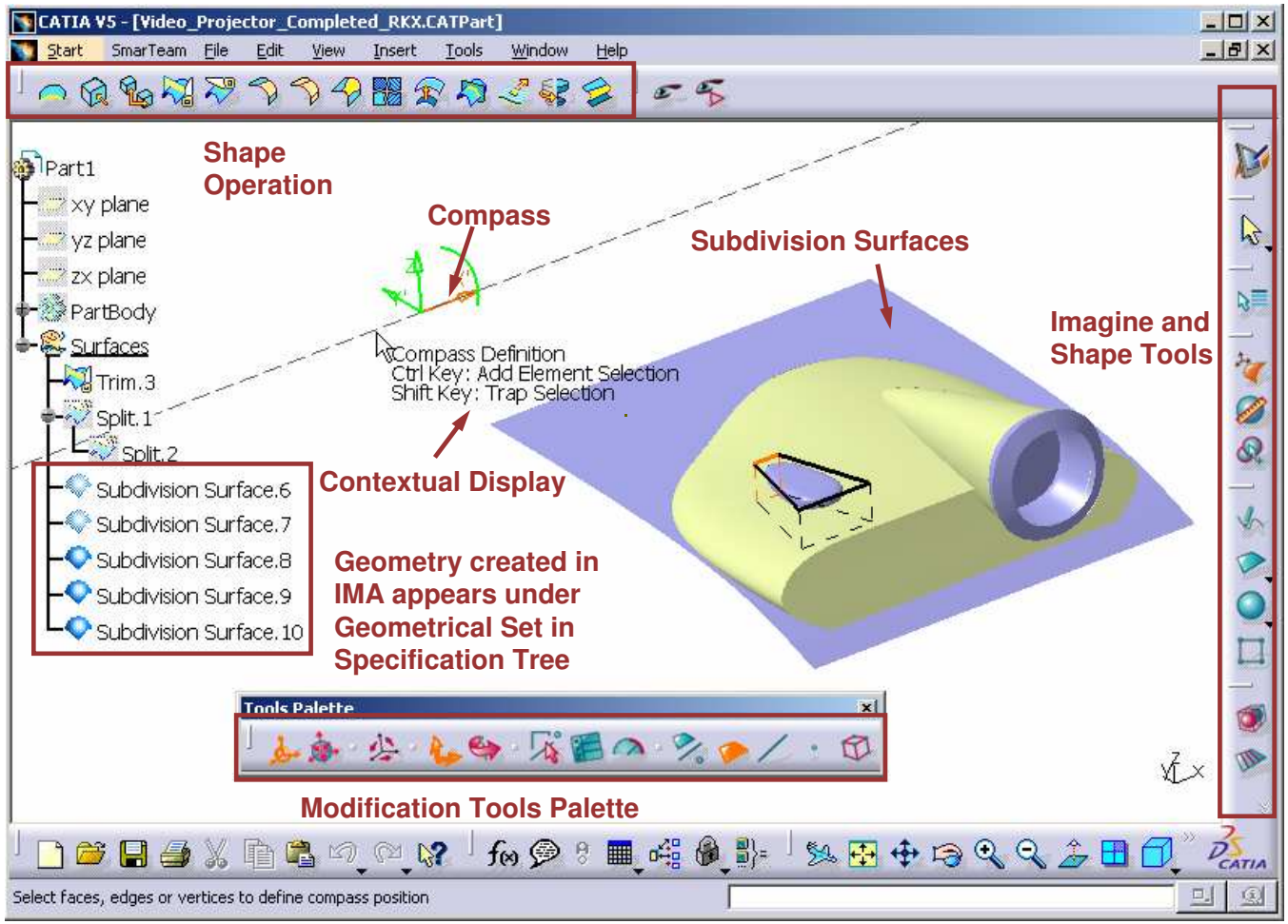
Accessing the Workbench

Click "Start > Shape > Imagine & Shape"



Imagine and Shape: User Interface (1/6)

Student Notes:

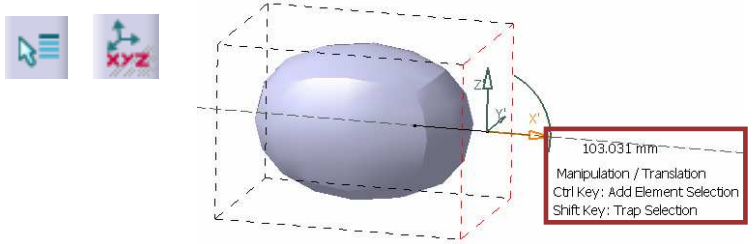


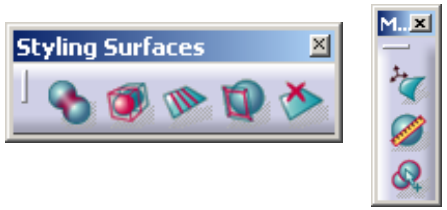
Student Notes:

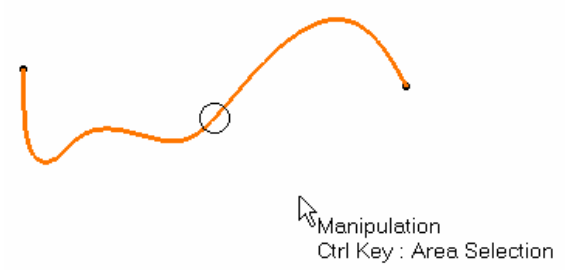
Imagine and Shape: User Interface (2/6)

General behavior:

- General Options
  - Text information to inform you about the current function and which is linked to the mouse pointer can be displayed at all times.
  - The contextual display can be turned on and off using these icons.
  - Three levels are available for Level Text Help:
    - First level: no display
    - Second level: Manipulation/Translation
    - Third level: display all information
- Toolbars
  - All functions have associated and dedicated toolbars to access options.
  - No dialog boxes are then displayed, saving screen space.
- Option keys
  - The shift and control keys are frequently used to manage selection and actions.
  - The contextual help gives you a clear message about the active keys and their actions.
- Control from a Distance
  - The mouse pointer does not need to be placed on an element (or even very close to it) to change its shape.
  - This feature gives you a real productivity gain by enabling faster interaction with elements and handles.







Here, the shape of the curve is being modified by dragging the mouse pointer. The pointer does not need to be close to the curve to achieve this.

Student Notes:

Imagine and Shape: User Interface (3/6)

Toolbar	Icon	Name
Workbench		IMA workbench
Selection		Select/ Selection Trap
General Options		Text Help Level
		Show Coordinates
Creation		Sketch Curve
		Open surface creation
		Closed surface creation
		Number of Sections
		Revolve
		Extrude

Toolbar	Icon	Name
Styling Surfaces		Merge
		Extrusion
		Face Cutting
		Face Subdivision
		Erasing
Modification		Modification of curve/ surface
		Dimension
		Multi Selection

Student Notes:

Imagine and Shape: User Interface (4/6)

Toolbar	Icon	Name
Operations		Link
		Symmetry
		Working Zone Definition
		View and Selection mode
Shape Operations		Boundary
		Extract
		Trim
		Split
		Shape Fillet
		Edge fillet
		Variable Fillet
		Join
		Offset

Student Notes:

Imagine and Shape: User Interface (5/6)

Toolbar	Icon	Name
Shape Operations (Continued)		Intersection
		Extrude
		Revolve
		Blend
		Multiple Extract
Update		Update All
		Manual Update mode
View Management		View Selection F4
		View Modification F2

Note: All commands in IMA are available by shortcuts.

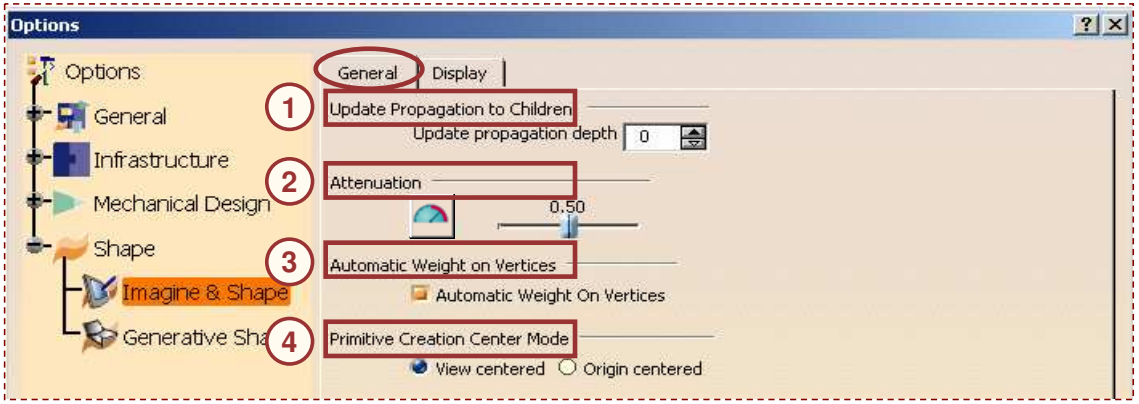
Imagine and Shape: User Interface (6/6)

Toolbar	Icon	Name
Tools Palette (For Modification)		Compass Definition
		Reset Compass
		Translation
		Local normals
		Rotation
		Affinity
		Alignment
		Attraction
		Pick
		Data Definition
		Attenuation
		All Type Selection
		Face Selection
		Edge Selection
		Vertex Selection
		Select All

Student Notes:

Imagine and Shape: Recommended Settings (1/3)

Student Notes:

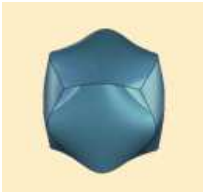


1. **Update propagation:** This option allows you to define the level of children to be updated when working in Manual update mode.

2. **Attenuation:** This option lets you define the ratio between the mouse displacement and the actual displacement of the manipulator. This option is important to improve the accuracy of mesh control.

3. **Automatic Weight on vertex:** Weight is automatically applied on vertex when there are at least three connected edges. This option is checked by default.

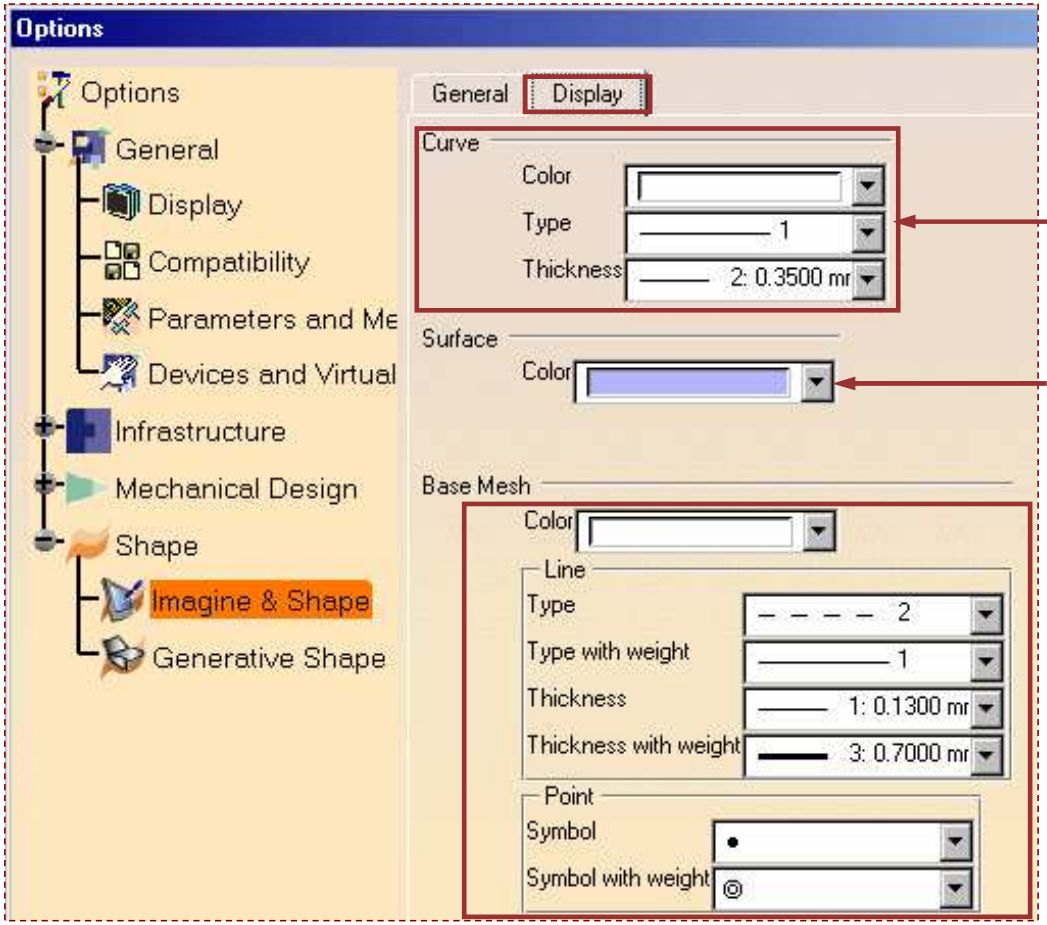
Without Automatic Weight option



With Automatic Weight option

4. **Primitive creation center mode:** This option lets you specify the center of gravity of a primitive at the center of the screen or at the origin of a part.

Imagine and Shape: Recommended Settings (2/3)



These options let you define the graphic properties for curves.

This option lets you define the color of surfaces.

These options let you define the graphic properties for base meshes.

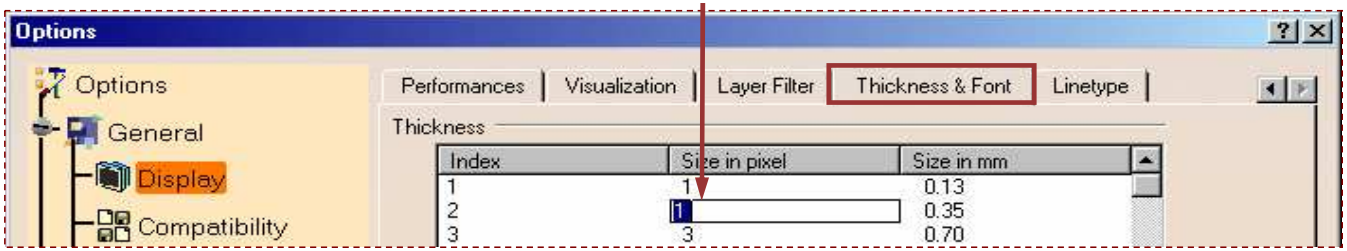
Student Notes:

Imagine and Shape: Recommended Settings (3/3)

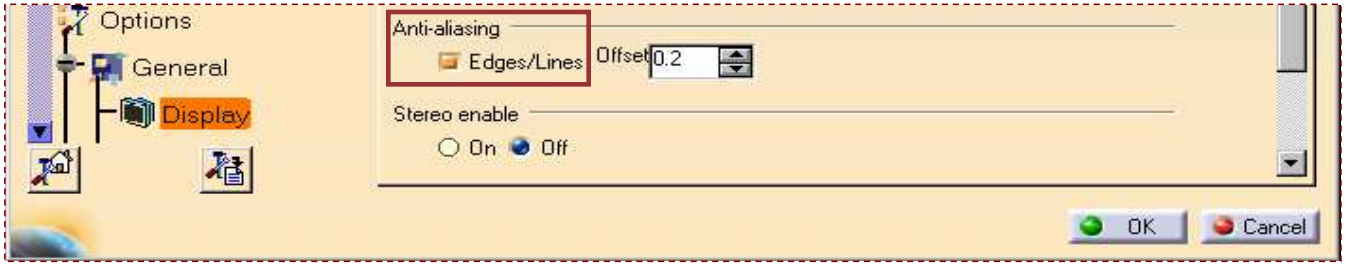
Student Notes:

To get a nice look of the environment, set the following:

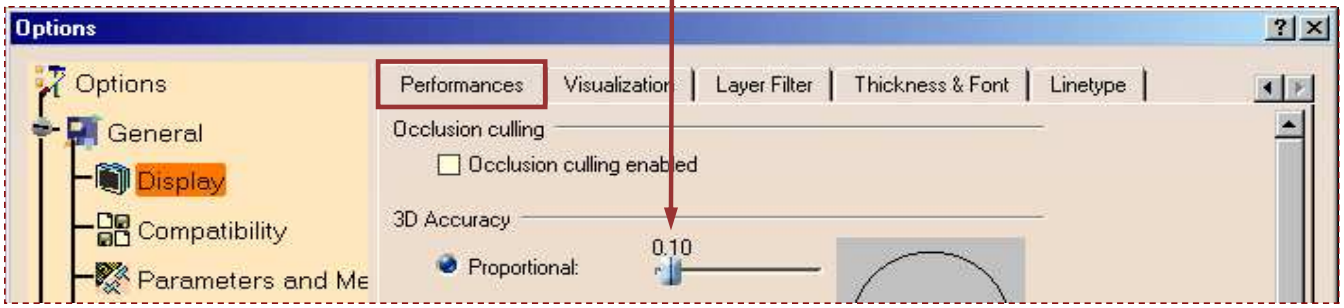
- **Set the Thickness of type 2 lines to “1” (instead of “2”)**



- **Under ‘Visualization’ tab set the ‘Anti-aliasing’ ON.**



- **Enable 'Proportional' option and set to “0.1” to maximize dynamic display performance.**

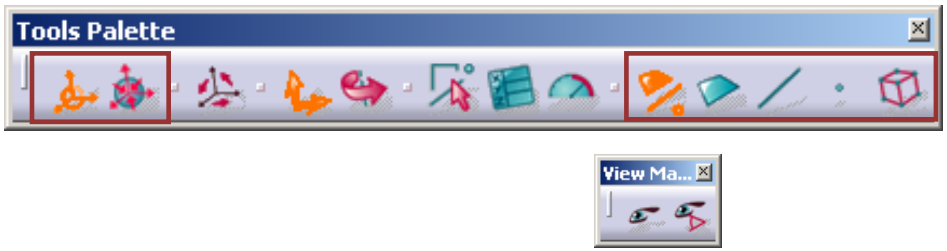


STUDENT GUIDE

Student Notes:

Imagine and Shape Common Tools

You will learn about the tools which can be accessed on the fly while creating and manipulating surfaces.



Student Notes:

Selection Tools (1/3)

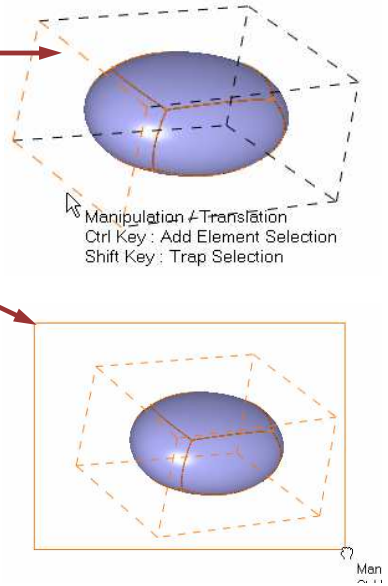
In most functions the modification Tools Palette contains a set of icons dedicated to mesh selection.

- **Using one of the selection icons enables a filter mode to only select specified mesh elements.**

Toolbar	Icon	Name
Tools Palette (For Modification)		All Type Selection
		Face Selection
		Edge Selection
		Vertex Selection
		Select All

Selection Tools (2/3)

- Use a single click to select the element (moving the mouse as close as necessary to highlight the element).
- Use the shift key to perform a trap selection.
  - Press the shift key
  - Draw the trap
  - Release the shift key
- Use the control key to add or remove the selection.
  - An unselected element is added to the selection
  - A selected element is removed from the selection
- Use the combination of shift and control key to add or remove a trap selection.



Student Notes:

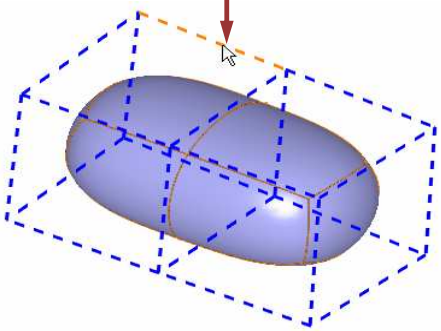
Student Notes:

Selection Tools (3/3)

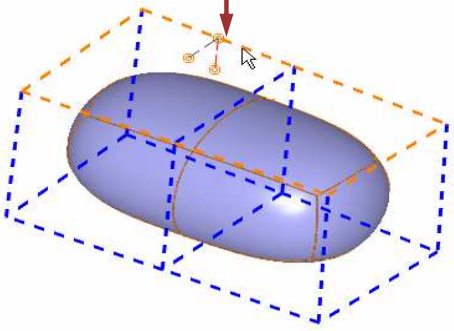
When you select an edge, you can propagate the selection.

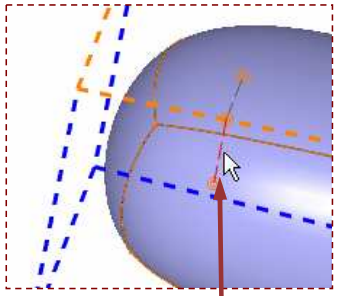
Use Propagation icon to propagate edges selection.

Without propagation option only one edge is selected.

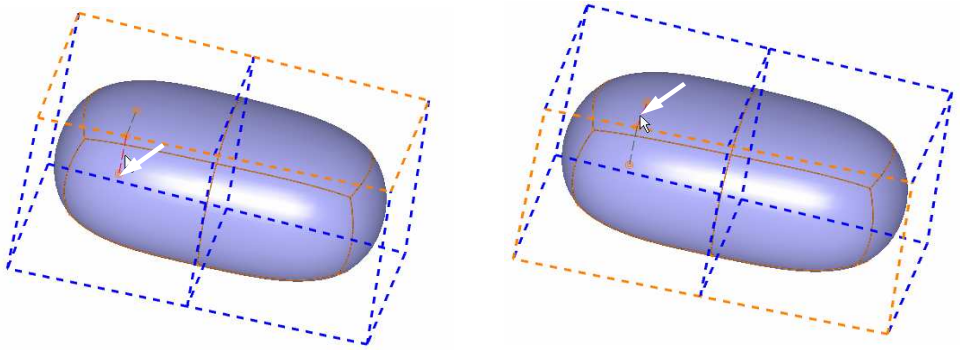


With propagation option a set of connected edges is selected





The manipulator allows you to select two different sets of connected edges.



Same edge selected but with a different mouse pointer position.

Student Notes:

Compass Definition (1/5)

- For several functions, the contextual toolbar contains a set of icons dedicated to compass management.

- Use the dedicated icon to modify the origin and the orientation of the compass.

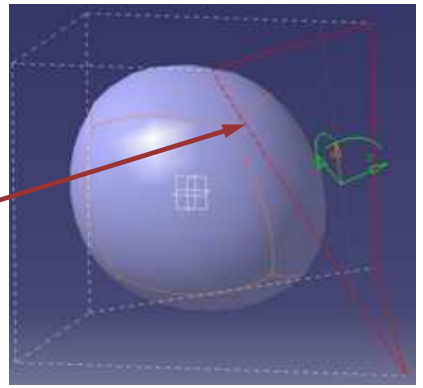
- The toolbar contains a set of dedicated options:

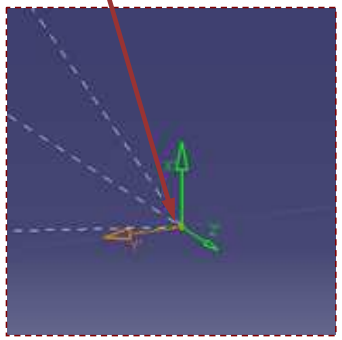
Toolbar	Icon	Name
Tools Palette (For Compass definition)		Compass Definition
		Reset compass
		Axes Permutation
		Translation
		Rotation
		Pick 3D element

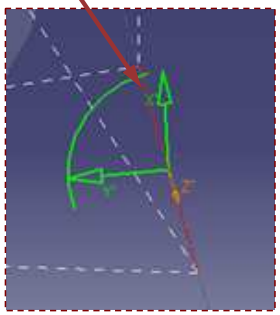
Compass Definition (2/5)

- The compass is defined depending on the selected element:
  - Generally, the compass plane (x and y axis) is defined using a mean plane computation of the selected elements.

- Selecting a face
  - Align the compass X-Y plane on the mean plane of the face.
- Selecting an edge
  - Align the Z axis of the compass along the edge direction.
- Selecting a point
  - Define the compass origin.
- Any combination is possible.





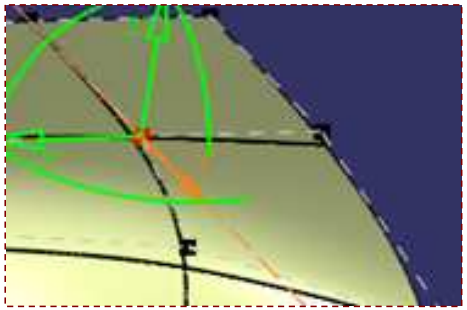


Student Notes:

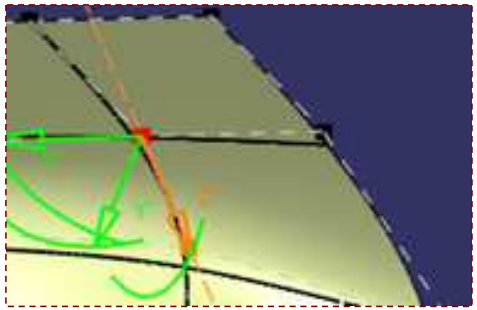
Compass Definition (3/5)

Defining the compass using vertices:

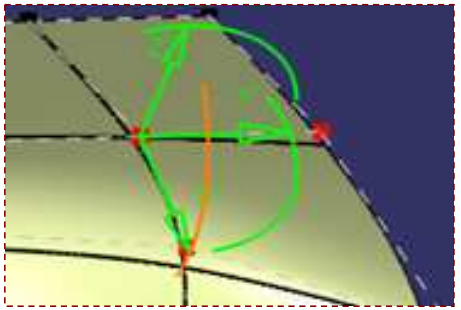
- The compass origin is locked using a single click on a vertex and is not modified if you add elements to the selection. To free its position, use the second icon on the toolbar.
- By selecting three vertices successively you define:
  - The compass origin
  - The Z axis
  - The X and Y axis



The compass origin



The Z axis



The X and Y axis (the previous Z axis is replaced by X axis)

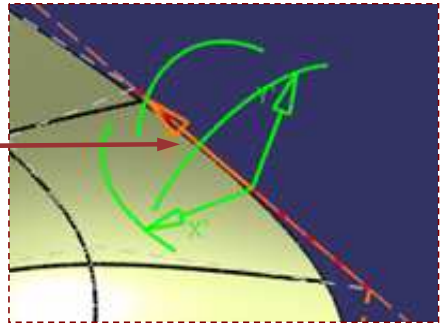
Student Notes:

Compass Definition (4/5)

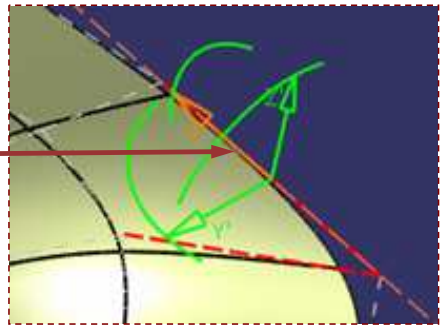
Student Notes:

Defining the compass using edges:

- **Selecting an edge defines the Z axis.**



- **Selecting successively two edges defines the XY plane.**



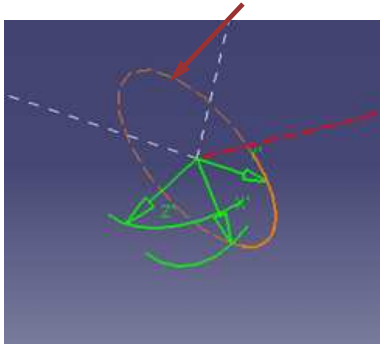
- **You can also select a set of elements using multi selection (control key or trap using shift key).**

Compass Definition (5/5)

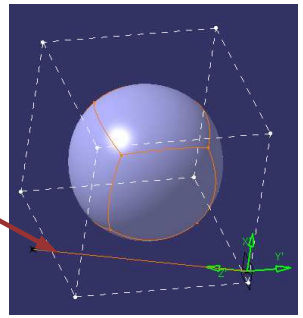
Student Notes:

- Use the third icon to switch the compass axis.
  - X changes to Y, Y to Z and Z to X

- To freely define the compass, use one of the following icons to perform translation and rotation.



- Use the Pick icon to pick 3D element in 3D area. The compass aligns to this element.

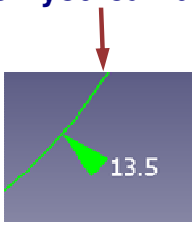


- Use the icon to exit the compass definition.

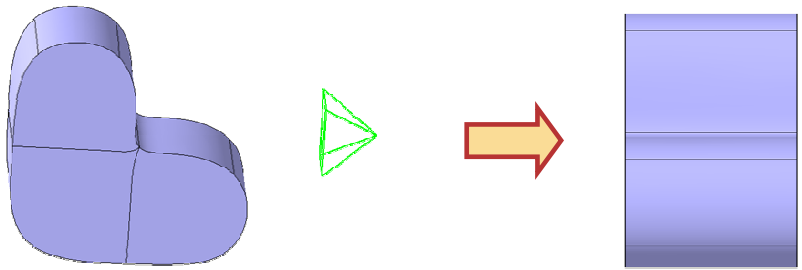
Student Notes:

Managing the Views

- View Modification (Shortcut =F2)
  - Press F2 key on the keyboard.
  - Select Parallel or Perspective view.
  - For Perspective view option you can define interactively the focal angle (Default 15°).



- View Selection (It allows to quickly change the view orientation)
  - Press F4 key on the keyboard.
  - Move the mouse pointer around your model.
  - A green pyramid appears.
  - Select the required view.



Use F4 key + Shift-trap + Ctrl for better productivity in edge/vertex/plane selection.

Curve Modeling

You will learn how to create and deform surfaces. Also, you will learn how to link a curve to a surface.

- **Curve Creation**
- **Curve Deformation**

Student Notes:

Curve Creation

You will learn how to create curves in Imagine and Shape workbench.

Student Notes:

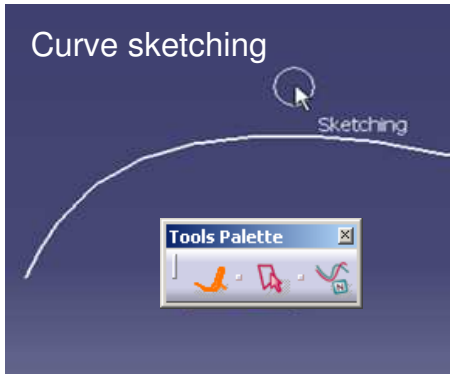
About the Curve Creation Modeler

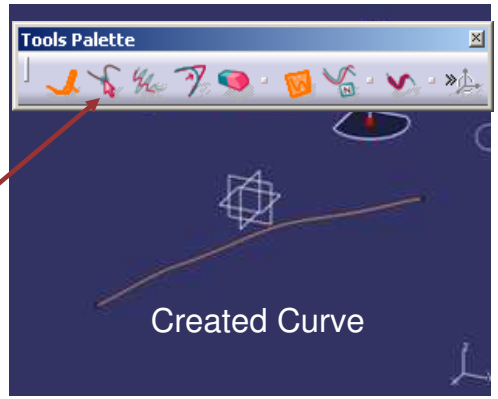
- **A powerful curve modeler based on an aesthetic approach supports the subdivision surfaces technology**
- **This new modeler provides users with a natural and intuitive way of drawing and controlling complex curve**
- **These curves can be created in the model afterwards**
- **The subdivision surfaces can then be controlled by curves for global deformation**
- **The connections between curves are G3.**

Student Notes:

How to Create a Curve

- Use the dedicated Sketch Curve icon to create a new curve.
- A tools palette is displayed. If you want to create a curve lying on a plane use “Plane Selection” icon and select the plane.
- If you don’t specify a plane, the curve will be created on the view plane.
- To create a curve, use the mouse to sketch or use a pen palette if possible (better feeling).
- Click and keeping the left mouse button pressed, describe your sketch, and then release the mouse button. During the mouse manipulation a temporary curve will be displayed.
- As soon as you release the mouse button, the curve is created; the temporary curve will be smoothed to display the final curve.
- The tools palette will then contain additional options (see Curve Manipulation section)
- You can then continue to sketch to refine the curve





Student Notes:

Curve Deformation

You will learn how to deform existing curves.

Student Notes:

About Curve Deformation

Student Notes:

The interaction is based on natural drawing and direct manipulation

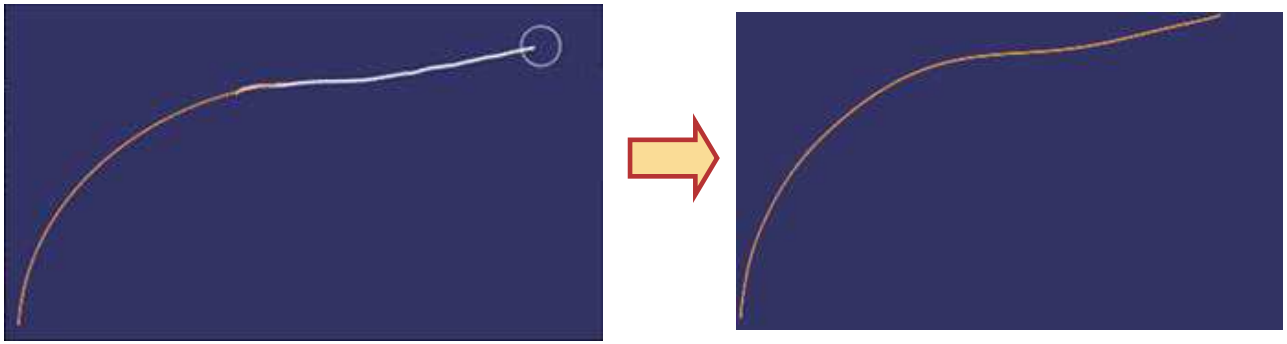
Toolbar description:

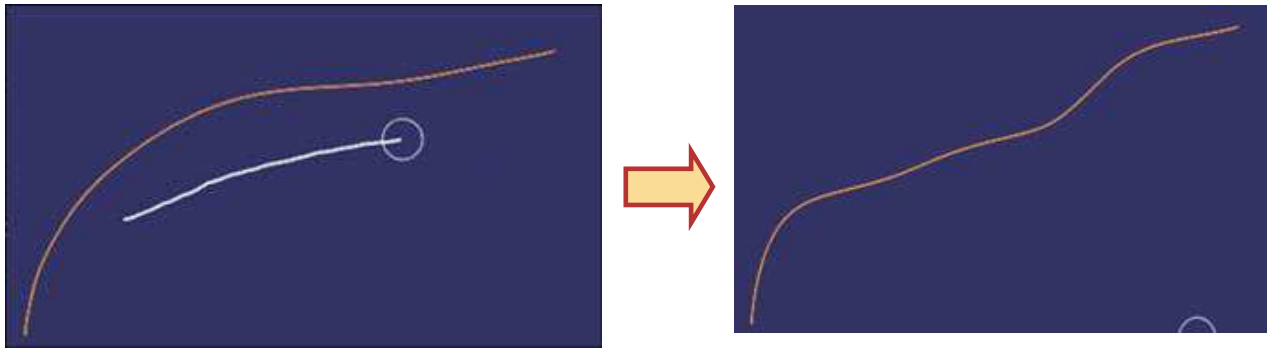
Icon	Name
	Curve sketching
	Direct deformation
	Smoothing
	Fillet definition
	Erase
	Planar constraint
	Characteristics
	Area Selection
	Transformations

Redefining a Curve by Sketching

The Curve sketching option allows you to draw and refine a curve in the same way as drawing with a pen and paper.
Use a pen tablet to better control the drawing.

You can iterate by drawing as many sketches as you want; the curve will be recomputed and updated each time.





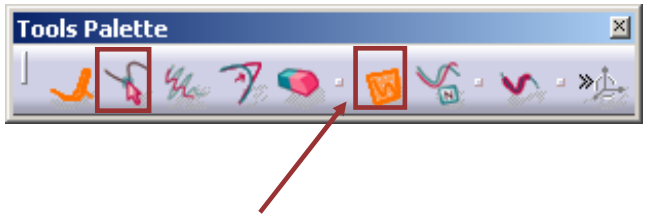
Student Notes:

Student Notes:

Manipulating the Points

The Manipulate a point option allows you to manipulate the curve.

- **Select the curve to modify.**
- **Press, and keep pressed, the left mouse button.**
- **Move the mouse to reach the required curve.**
- **Release the mouse button.**
- **If the “curve plane” option is activated the manipulation is allowed only in the plane where the curve has been created.**
- **If the “curve plane” option is not activated the manipulation is allowed in all directions.**



Student Notes:

Smoothing a Curve

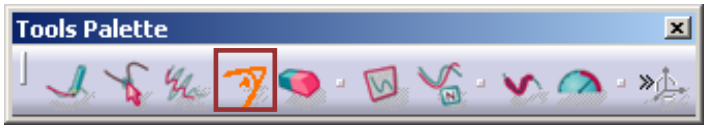
The Smoothing option allows you to smooth a curve

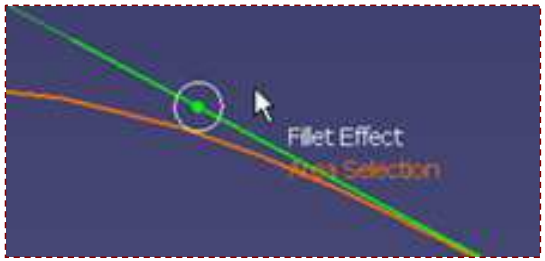
- **Select the curve to smooth**
- **Click anywhere to smooth the curve**
- **The more you click the more the curve is smoothed**
- **To smooth only a portion of the curve, press the Ctrl key and select the portion to be smoothed.**
- **Smooth the portion as explained above**

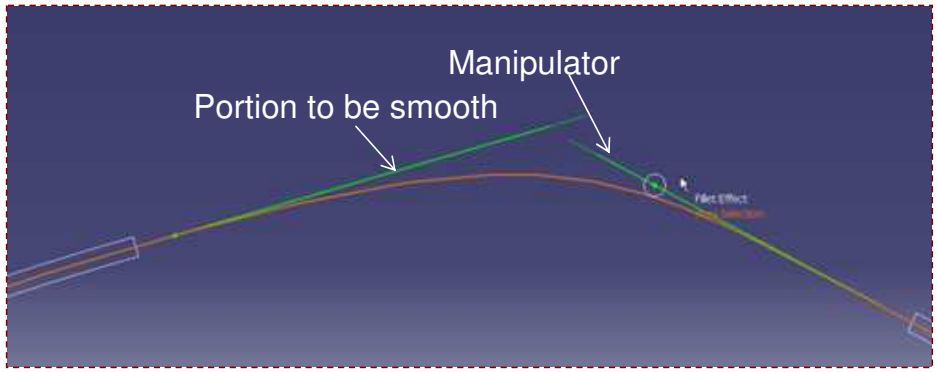
Filleting a Curve (1/2)

The Fillet option allows you to smooth and better control the shape in a local area.

- **Select the curve**
- **Select the Fillet option**
- **Press and keep the left mouse button pressed**
- **Move the mouse along the curve to select the area where you want to apply the Fillet**
- **Release the mouse button**
- **Drag the manipulator along the green curve to define the Fillet**



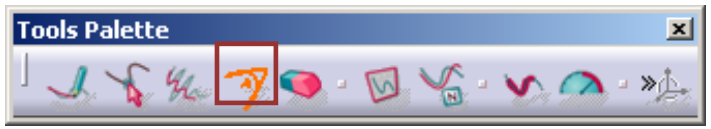


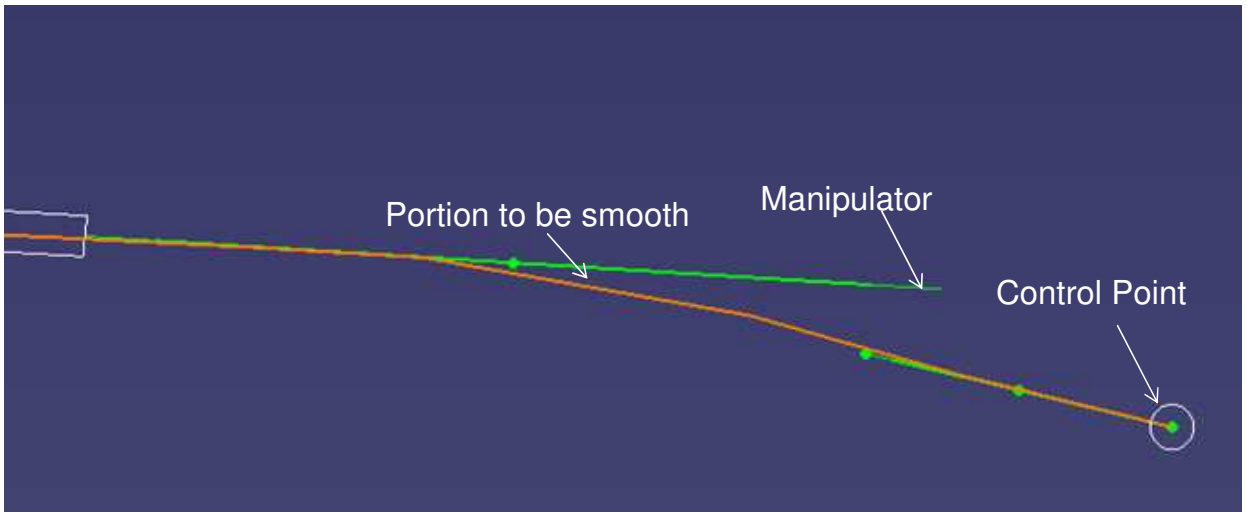


Student Notes:

Filleting a Curve (2/2)

If the modification area includes an extremity of the curve, the handle allows the manipulation of the position of this limit and the orientation of the tangent





Student Notes:

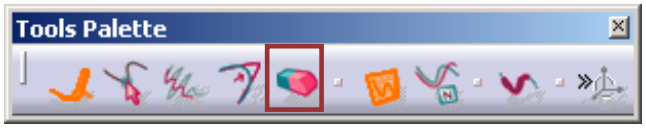
Student Notes:

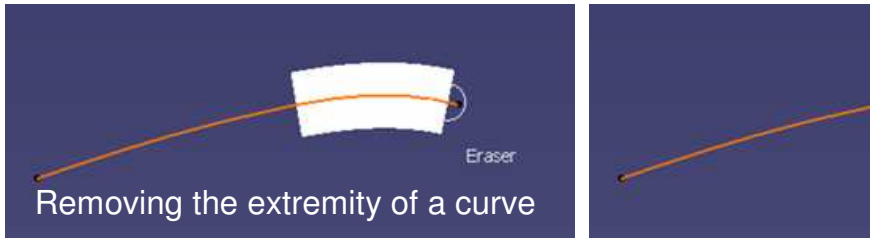
Erasing a Curve

The Erase option allows you to erase a portion of the curve

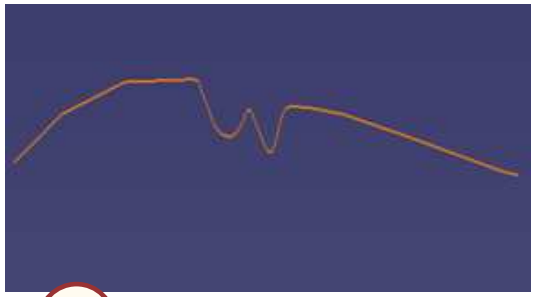
- **Select the curve**
- **Select the Erase option**
- **Press and keep the left mouse button pressed**
- **Move the mouse along the curve to select the area to erase**
- **Release the mouse button**
- **Special case:**

  Erasing an inner portion of the curve removes the details and creates a “nice” shape

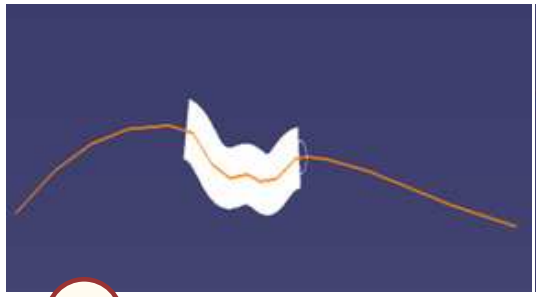




Removing the extremity of a curve



1



2

Removing the internal part of a curve

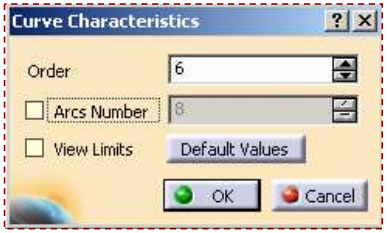
3

Student Notes:

Defining Curve Characteristics

The Curve Characteristics option allows you to display and modify curve characteristics.

- **Select the curve**
- **Select the Curve Characteristics icon**
- **Change the value of Order field. (The greater the order, the tighter the curve)**
- **Check Arc Number and change the value to modify the maximum number of arcs**
- **Check View Limits to display the limit arcs in 3D area**

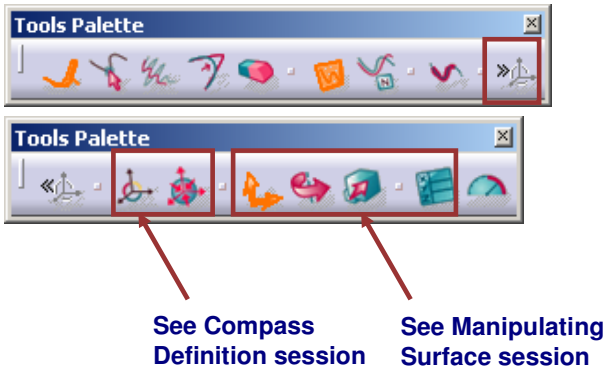


Student Notes:

Curve Transformations

The Curve Transformation option allows you to access transformation icons while modifying a curve.

- **Select the curve**
- **Select the Transformation icon**
- **The tools Palette containing the transformation icon is displayed**



Student Notes:

Deforming a Curve in 3D Space

To deform the curve in 3D space deactivate the Curve Planarity option.

- **The Curve Planarity option is ON by default.**
- **Unselect the option to work in 3D space.**

Student Notes:

Surface Modeling

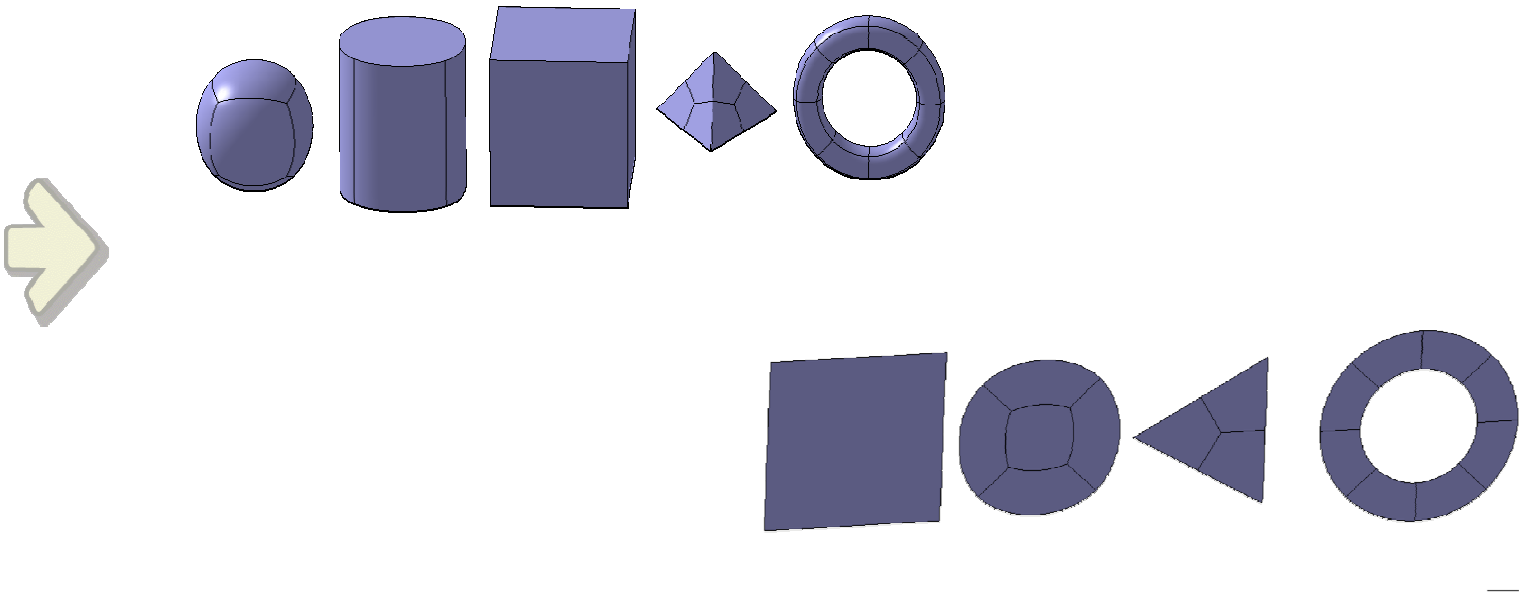
You will learn how to create and modify subdivision surfaces.

- Creating Basic Surfaces
- Manipulating Surfaces
- Modifying the Topology

Student Notes:

Creating Basic Surfaces

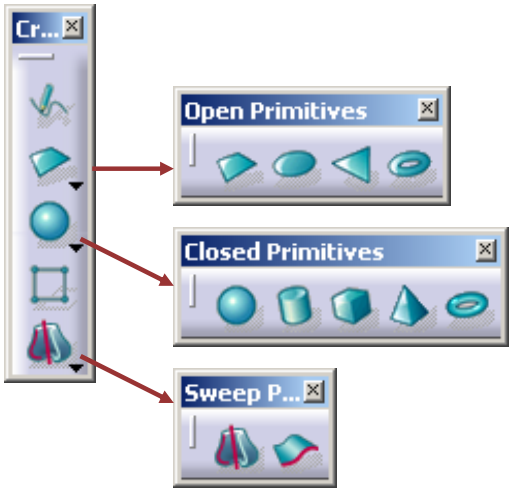
You will be introduced to the basic surfaces and learn how to create and manipulate them using Imagine and Shape tools.



About Basic Surfaces

You have the possibility to create these kinds of shapes:

- **Creating Open surfaces**
  - **Creating a Circular Surface**
  - **Creating a Triangular Surface**
  - **Creating a Ring-Shaped Surface**
- **Creating Closed surfaces**
  - **Creating a Cylinder**
  - **Creating a Box**
  - **Creating a Pyramid**
  - **Creating a Taurus**
- **Creating Sweep Primitives**
  - **Creating a Revolve**
  - **Creating an Extrude**

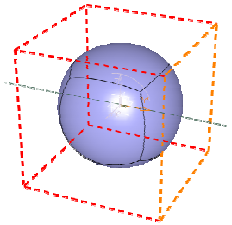


Student Notes:

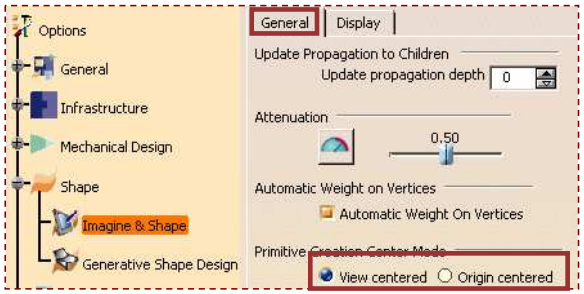
Student Notes:

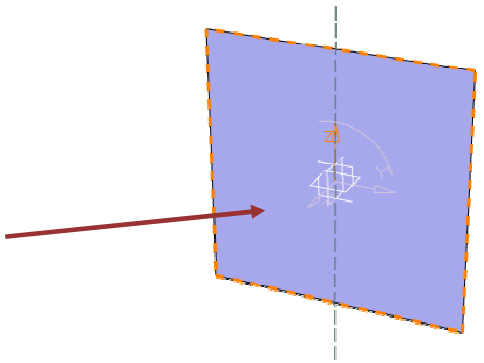
How to Create Surfaces (1/3)

- Use one of the three dedicated icons to create a first surface.
  - Open surfaces
  - Closed surfaces
  - Sweep Primitives



- Surfaces are created using the current viewpoint information:
  - It can be at the center of the screen or at the origin of the part, depending on the CATIA settings.
    - View Centered: Creates a surface at the center of the screen
    - Origin Centered: Creates a surface at the origin of the part
  - The size is a ratio of the window size (independent of the zoom factor)
    - The size of the mesh is equal to ¼ of the screen size
    - Note: to manage accurately the size of the surface refer to “Scaling” section



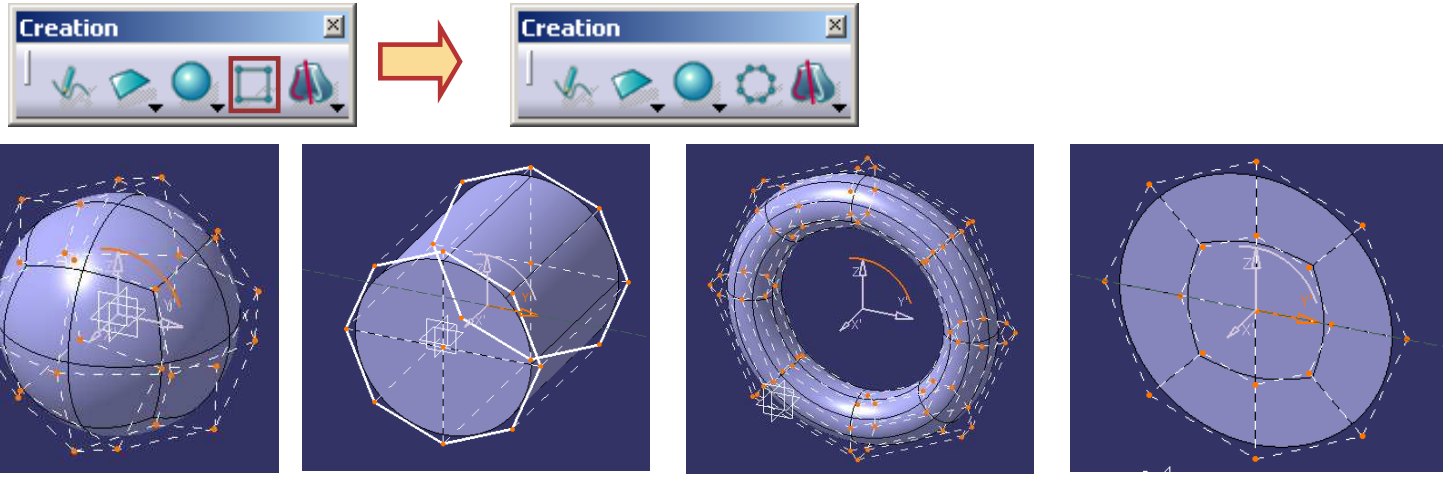


- The model axis orientation is used to define the surfaces.
  - The mesh is aligned along the model axis.
  - Open surfaces are created on the plane which is parallel to the screen.

Student Notes:

How to Create Surfaces (2/3)

- The Number of Sections icon can be used to add sections to make open and closed primitives closer to the real shape.
  - You can apply this effect on Sphere, Cylinder, Torus and Circle.
  - This option is OFF by default
  - Click the option to enable it

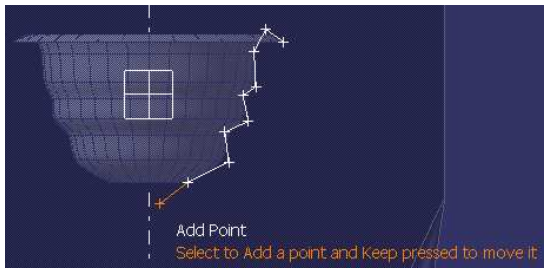


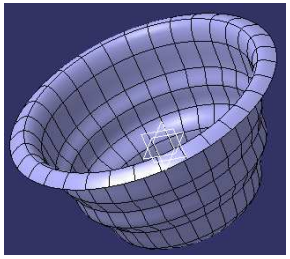
- The modification function is automatically opened after the creation and the entire mesh is selected (allows to quickly position or scale the element).

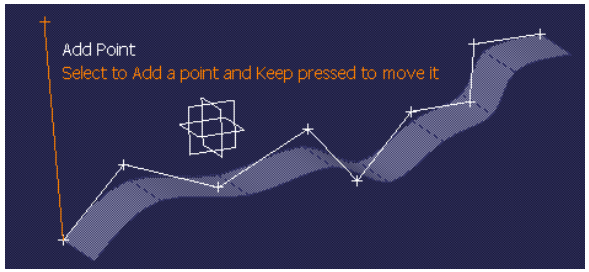
Student Notes:

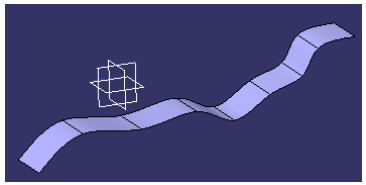
How to Create Surfaces (3/3)

- **Use the Sweep Primitives to create the Surfaces.**
  - **You can define a surface by the rotation of a curve around an axis**
  - **You can define a surface by the extrusion of a curve along a direction**







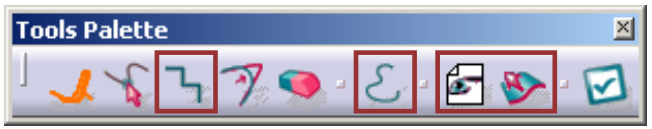


- **The modification function is automatically activated after the creation of surface and the entire mesh is selected (allows to quickly position or manage the points of the curve).**

Student Notes:

Manipulating Surfaces

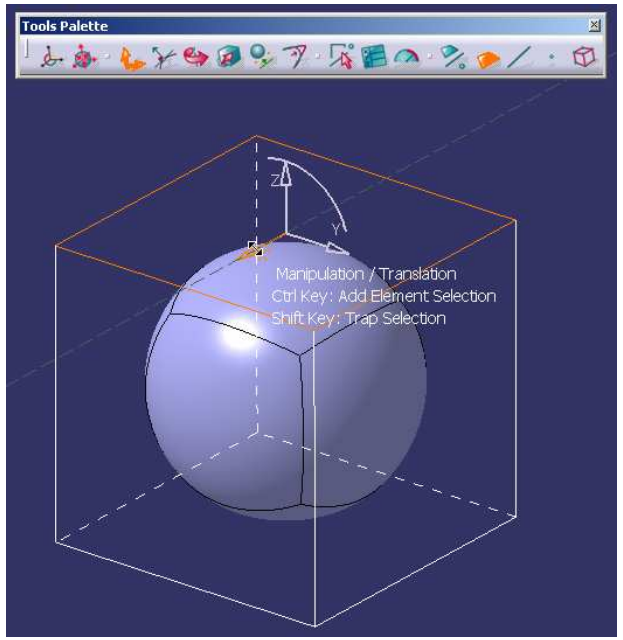
You will learn how to deform surfaces using the surface manipulation functions.



About the Surface Manipulation

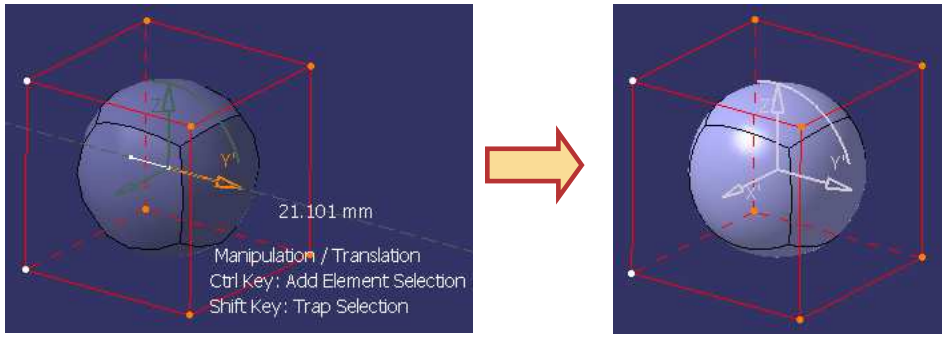
Student Notes:

Manipulation functions enable you to control the mesh that drives the surface.



- **The compass is used to select handles that show the allowed manipulations. The pointer does not need to be on the handle to manipulate it.**
- **The handle origin is by default positioned at the middle point of the selected elements. To specify another location use the Compass Definition option if needed.**

- **During the manipulation, the surface is roughly pre-visualized.**
  - **The impacted area is displayed in a darker shade.**
  - **The surface is exactly computed at mouse release.**



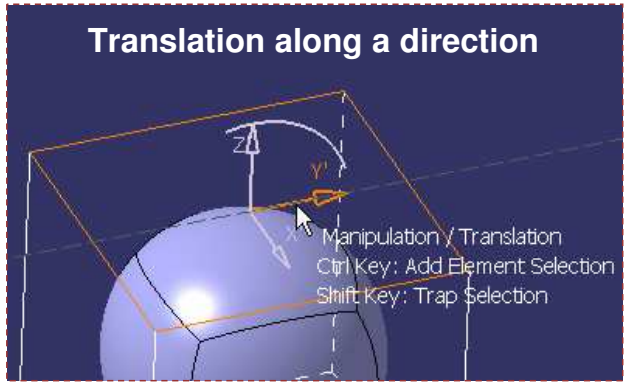
Student Notes:

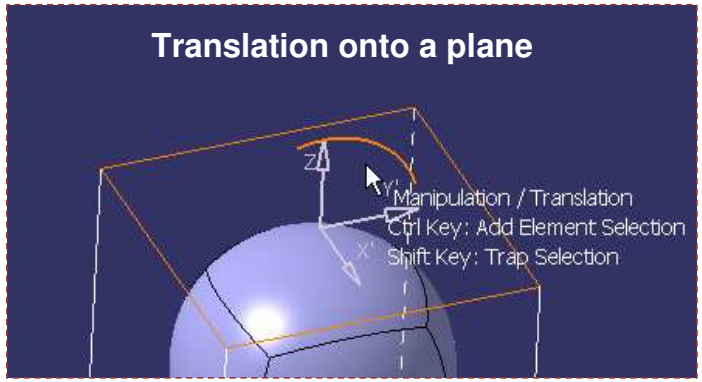
Applying Translation (1/3)

You can perform translations along 3 directions or onto 3 planes (defined by the directions), depending on the mouse pointer position

- **To move selected elements, select the Translation icon. The icon is displayed as shown.**

- **To perform the translation:**
  - **Move the mouse to highlight the required axis or plane (no need to be on the element)**
  - **Click and keep the left mouse button pressed**
  - **Move the mouse to translate the elements**
  - **Release the mouse button**

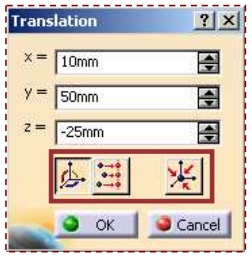




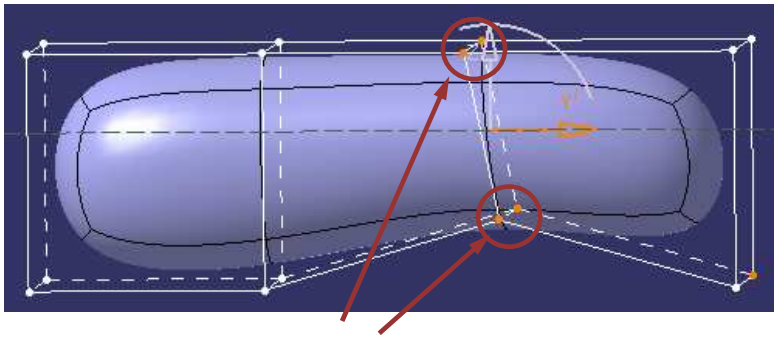
Student Notes:

Applying Translation (2/3)

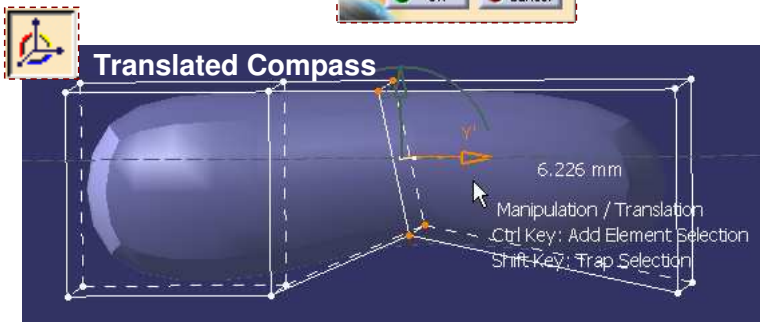
- You can translate the selected elements by required value using Data Definition icon.



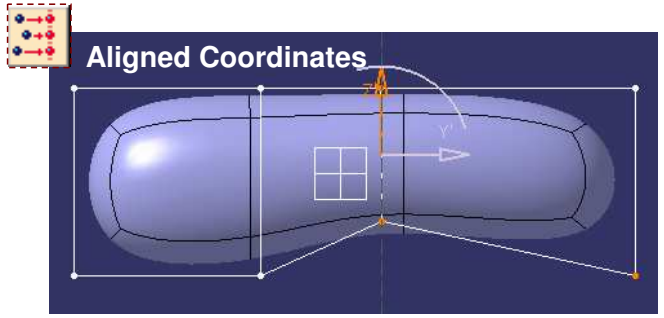
- Three options are available for translation using Data Definition.



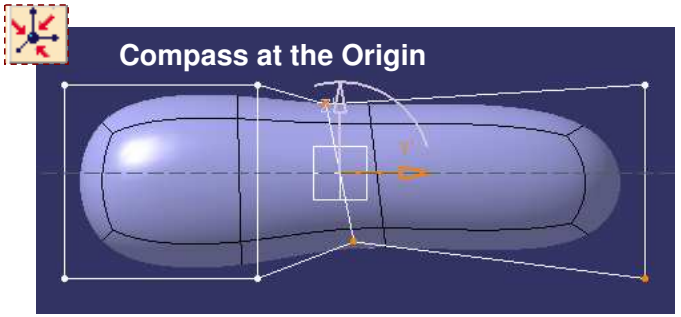
Selected elements for Translation



Compass and selected elements get translated.



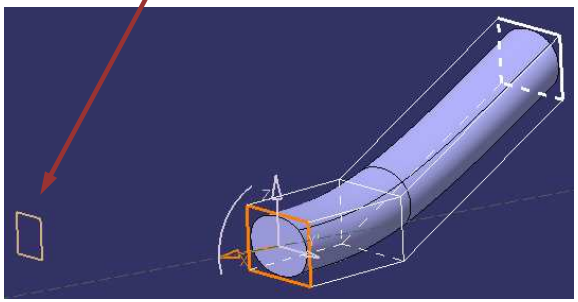
Compass gets translated and selected elements are aligned on compass plane

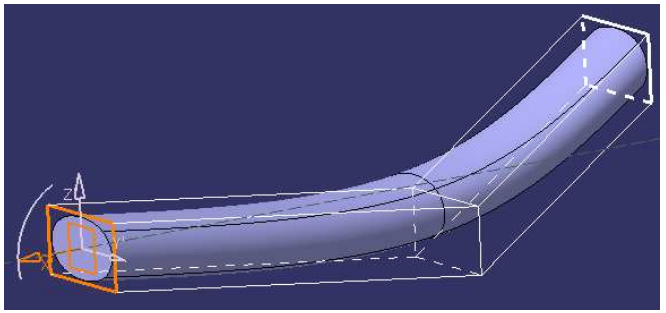


Compass and selected elements get translated to the origin of the surface.

Applying Translation (3/3)

- You can translate the selected elements with the help of 3D elements using the Pick icon.
  - Select the Pick icon. 
  - Select a 3D element





- To have a better control during the translation, use the Attenuation command
  - Option on 
  - Option off 

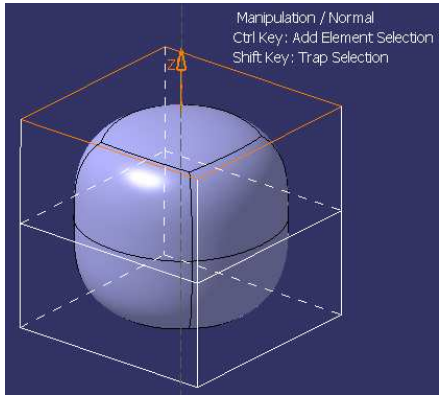
Student Notes:

Student Notes:

Applying Translation along Normals

You can perform translations along the normal to the selection as if performing a local offset.

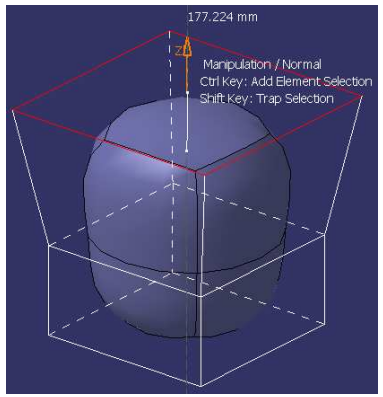
- **To translate normal to the selection, select the Local Normals icon. The icon is displayed as shown.**



- **To perform the translation:**
  - **Select the elements - vertices, edges or faces.**
  - **Move the mouse to drag selected elements along their own local normals.**
  - **Release the mouse button**

- **To have better control during translation use the Attenuation command**
  - **Option on** 
  - **Option off** 

Translation along Normal

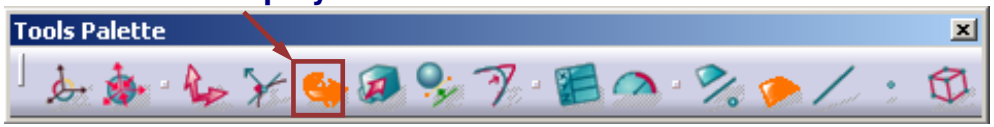


Student Notes:

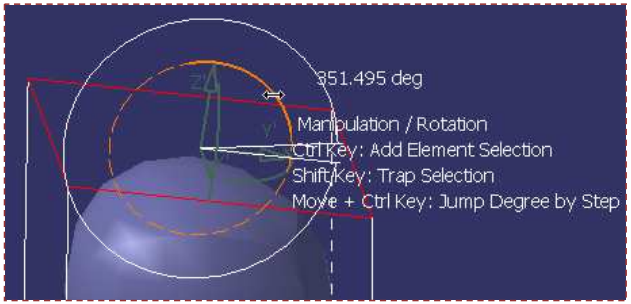
Applying Rotation

You can perform rotations around one of the three axes of the handle.

- **To rotate the selected elements, select the Rotation icon. The icon is displayed as shown**



- **To perform the rotation:**
  - **Move the mouse to highlight the required rotation axis**
  - **Click and keep the left mouse button pressed**
  - **Move the mouse to rotate the elements**
  - **Release the mouse button**

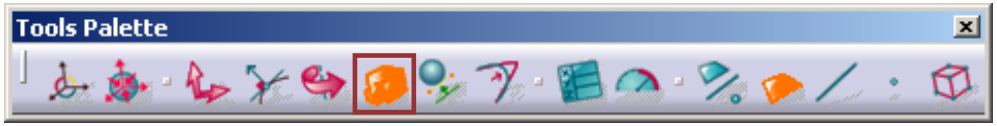


- **A graphical display informs you of the angle value**
- **During manipulation, use the control key to enable a 5° step.**
- **If needed, use the Compass Definition option to specify the origin of the rotation and the orientation of axis (see the corresponding section).**
- **To have better control during translation, use the Attenuation command**
  - **Option on** 
  - **Option off** 

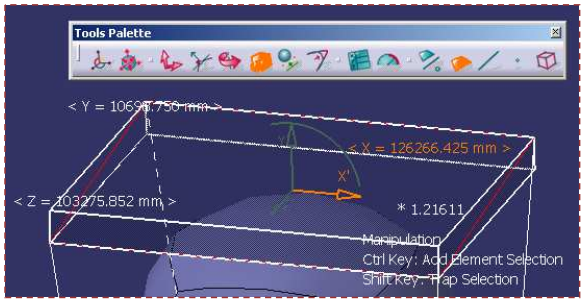
Scaling

You can perform scaling along a single axis, along two axes or a full 3D scaling.

- **To scale selected elements, select the Affinity icon. The icon is displayed as shown.**

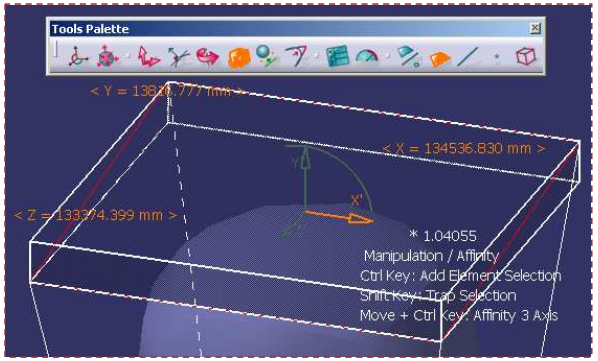


- **To stretch in a single direction:**
  - **Move the mouse to highlight the required axis or plane**
  - **Click and keep pressed the left mouse button**
  - **Move the mouse to scale the elements**
  - **Release the mouse button**



- **Use the control key to perform a 3D scaling (along the three directions):**
  - **Press the control key**
  - **Click and keep pressed the left mouse button**
  - **Move the mouse to scale the elements**
  - **Release the mouse button**

Scaling along three directions



- **If needed, use the Compass Definition option to specify the origin of the scaling and the orientation of axis.**

- **To have a better control during the translation, use Attenuation command**

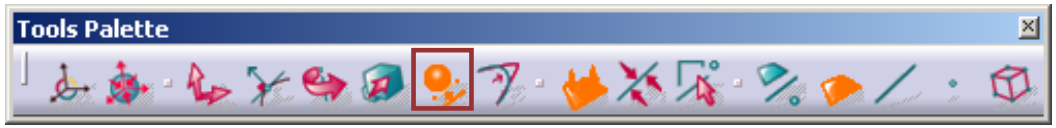
The corresponding dimensions of selected manipulator get highlighted.

Student Notes:

Student Notes:

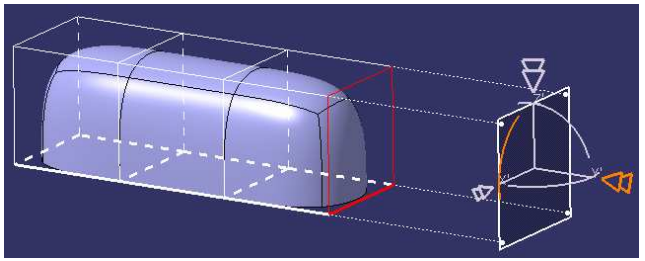
Aligning (1/2)

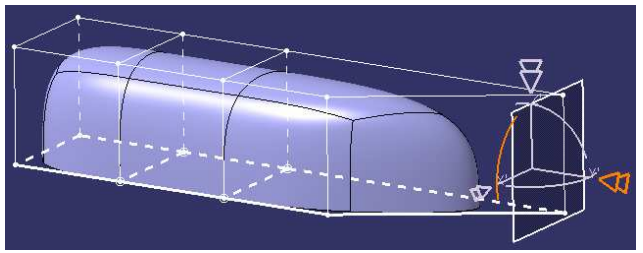
You can align selected elements on a chosen support. The support can either be a plane or an axis.



To perform the alignment:

- Define the compass origin and orientation
- Select the type of alignment
  - On Plane: Projects vertices onto the compass plane
  - On Axis: Projects vertices onto the compass axis
  - Pick: Projects vertices onto selected edge, or plane
- Select the elements to be aligned, which can be vertices, edges or faces.
- Click the manipulator arrow depending on the direction where you want to align the elements.



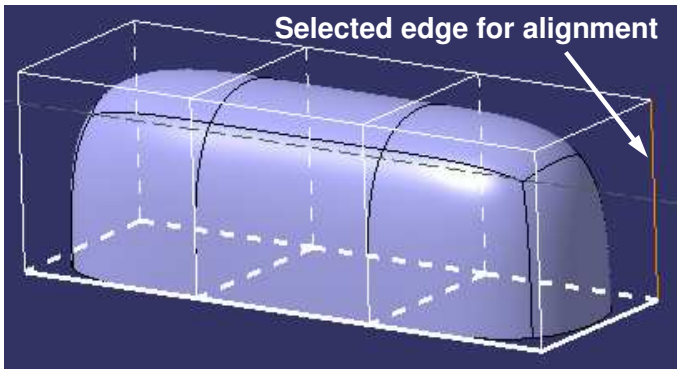


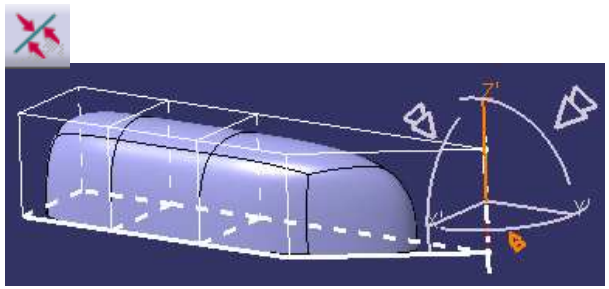
Student Notes:

Aligning (2/2)

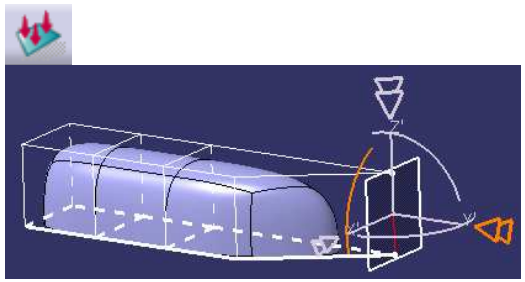
Alignment of selected elements on an axis, plane or 3D element can be managed using three options.

- **On Plane: Used for aligning the elements with compass plane.**
- **On Axis: Used for aligning the elements with compass axis.**
- **Pick: Used for aligning the elements with 3D element.**

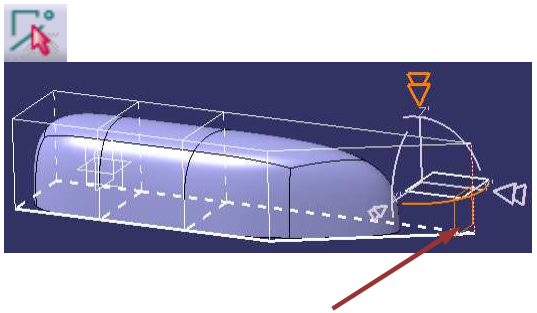




Projection on compass axis



Projection on compass plane



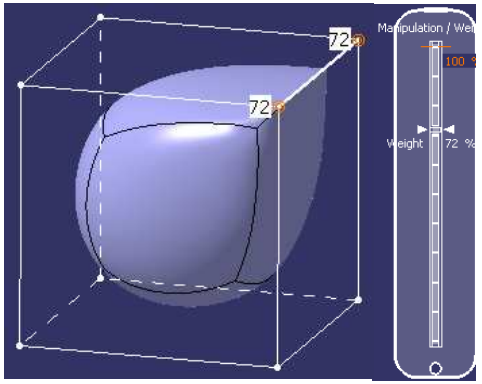
Projection on 3D element selection

Student Notes:

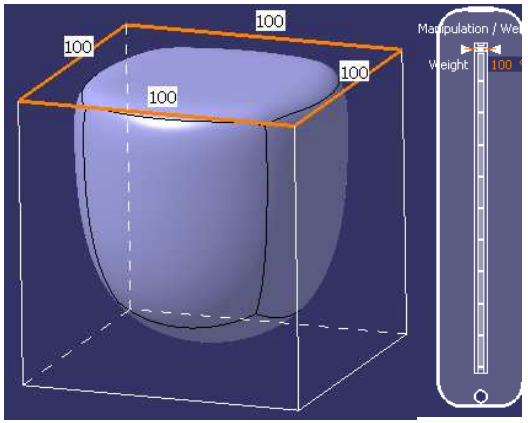
Applying Weights (1/2)

- **Use the Attraction icon to modify weights**

- **Use the selection filters to enable edges or vertex selection and then modify their attributes.**
- **The value of the weight is displayed on the bar. (value between 0 and 100%).**
- **To modify a weight value:**
  - **Select the elements to modify.**
  - **In the 'Manipulation / Weight' manipulator select the required percentage.**
- **If the weight is applied to an edge or a vertex, its look is different from the others (the edge is thicker, the line is not dotted, the vertex is a bigger circle).**



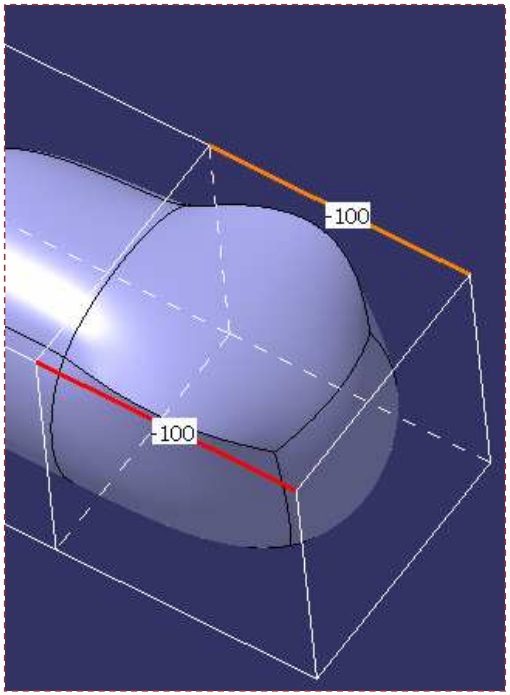
Vertex weight modification

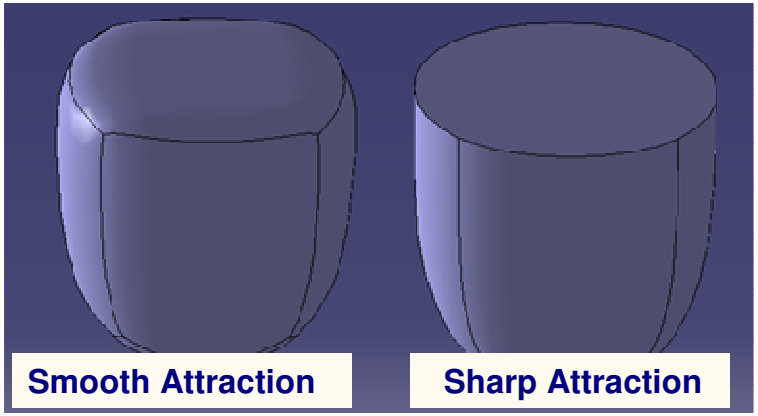


Applying Weights (2/2)

When you select a surface or an edge two options are available, both provided by the same function:

- **Smooth Attraction**
- **Sharp Attraction**





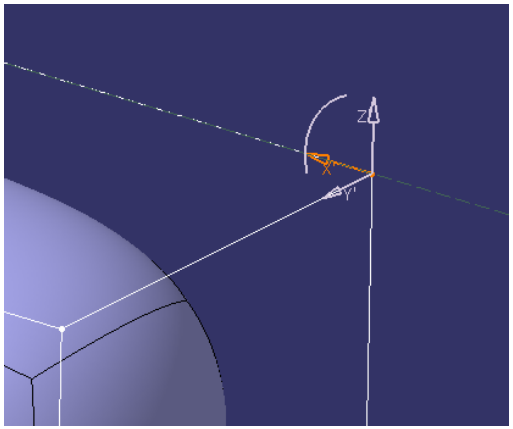
The value of the weight is indicated with a "minus" sign for sharp edges.

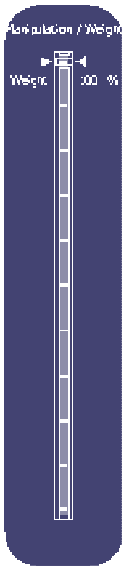
Student Notes:

Defining Precise Parameters for Manipulation

Student Notes:

When you manipulate vertices, edges or faces, you can precisely define parameters using the Data Definition icon. This displays a contextual dialog box which enables the specification of precise values.

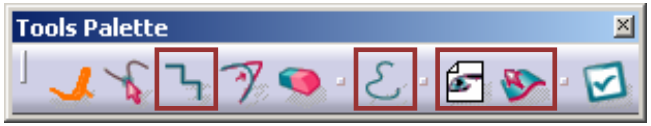




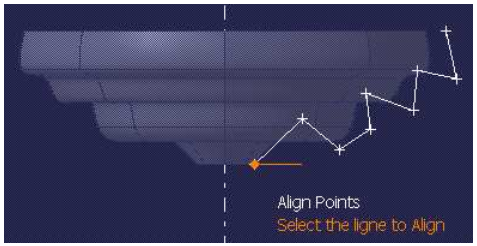
Student Notes:

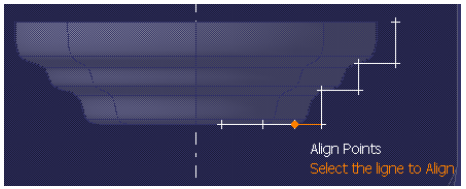
Surface Manipulation for Sweep Primitives (1/2)

When you select the Revolve or Extrude command, the manipulation functions enable you to control the input curves that are required to generate sweep surfaces.

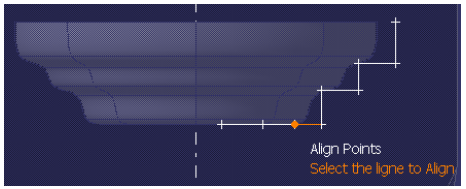


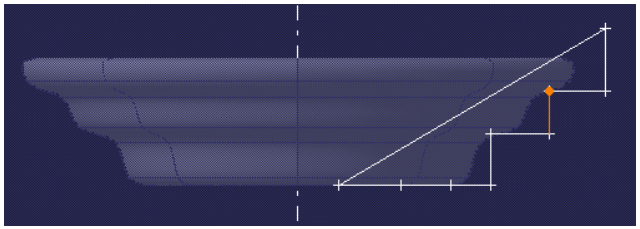
- **The 'Align Point' tool is used to align the point either horizontally or vertically.**





- **The 'Close Curve' tool is used to join the two endpoints of the curve in order to close it.**

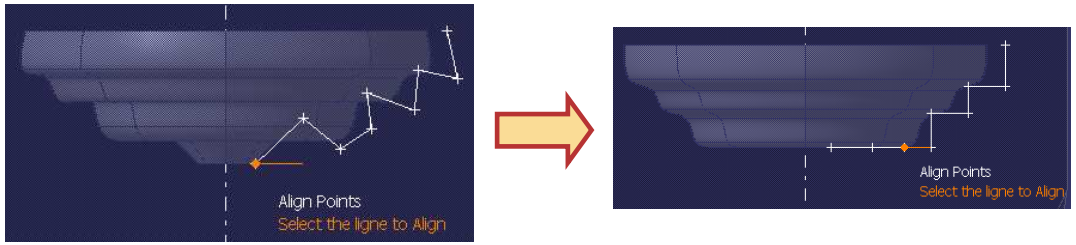




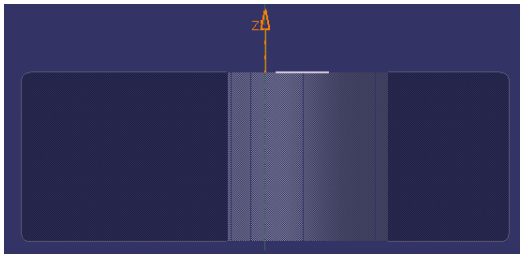
Surface Manipulation for Sweep Primitives (2/2)

Student Notes:

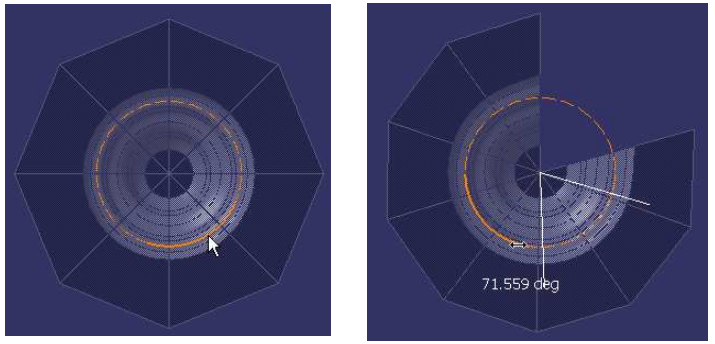
- **The 'Drawing View' tool is used to view the plan view.**



- **The 'Length' tool is used to position the view laterally so that the length of extrusion can be changed.**



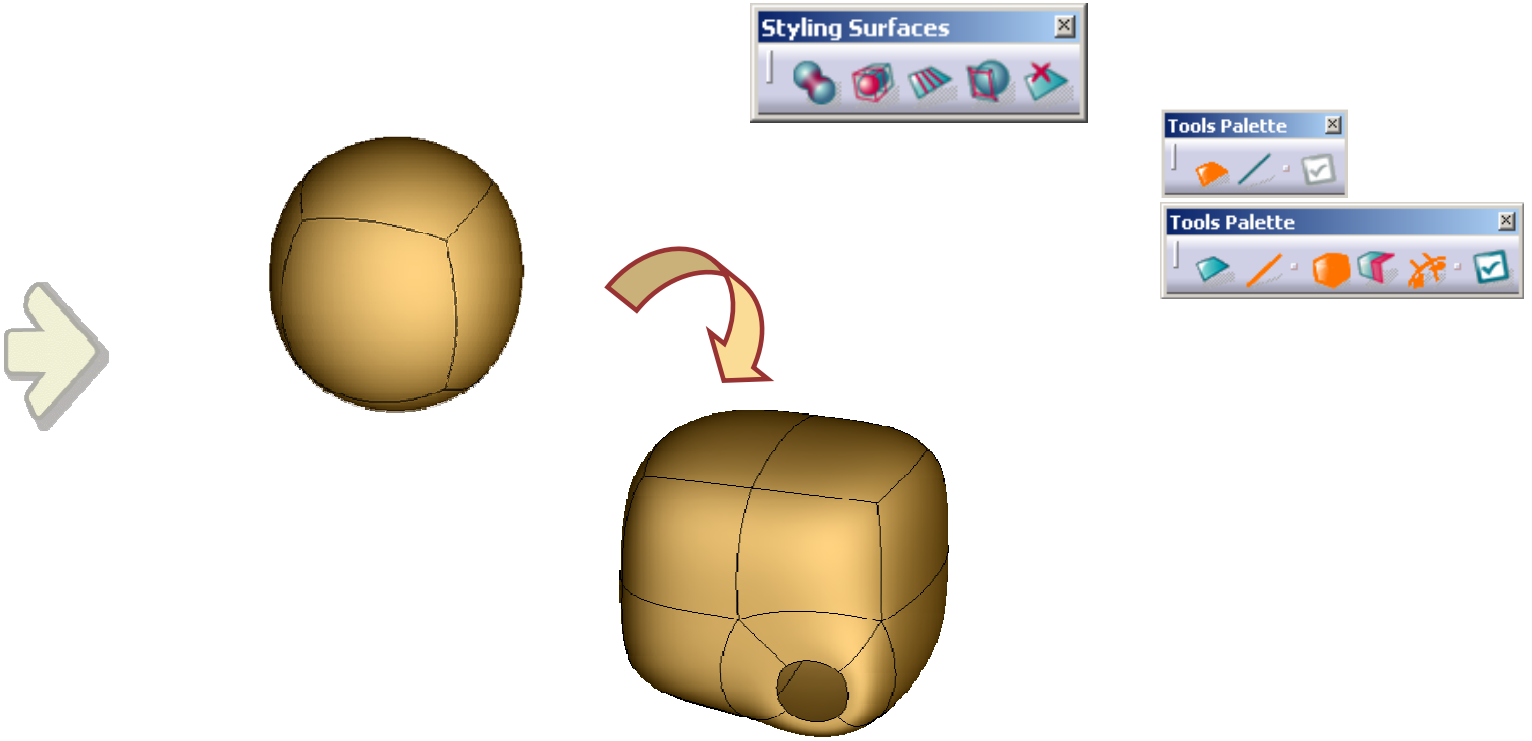
- **The 'Angle' tool is used to position the view laterally so that the angle of rotation can be changed.**



Student Notes:

Modifying the Topology

You will learn how to modify the topology of the subdivision surfaces.



Student Notes:

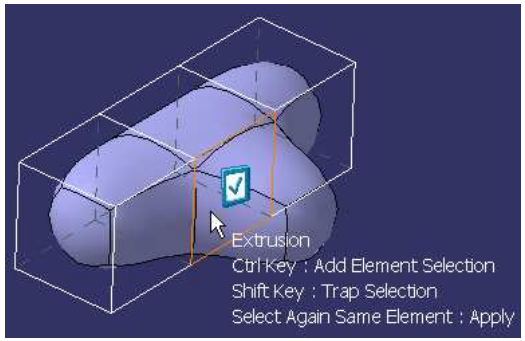
What is Topology Modification?

You can modify the basic surfaces using the five dedicated icons from styling surfaces toolbar. For these edition commands, the result with current selections is first previewed, then executed by clicking the Apply button.

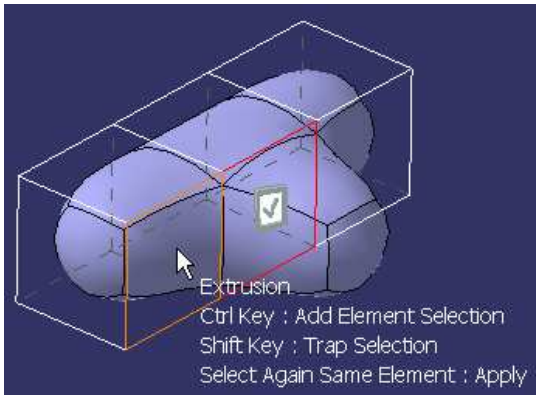
Modification is previewed

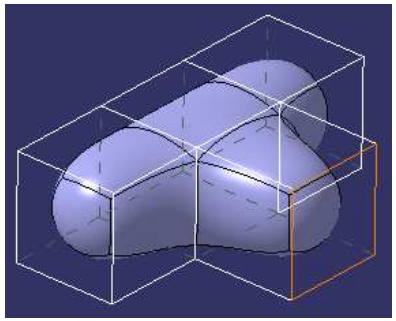
Pre-selection at the level of the other element

Modification is applied



The icon of the validation is visible on the selected element.





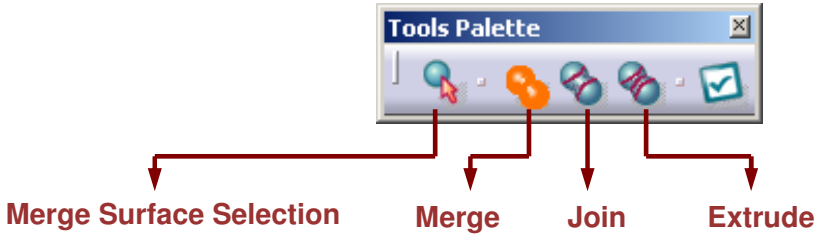
You can double-click the selection to modify the mesh. The first click will select the element and the second click will modify it.

Student Notes:

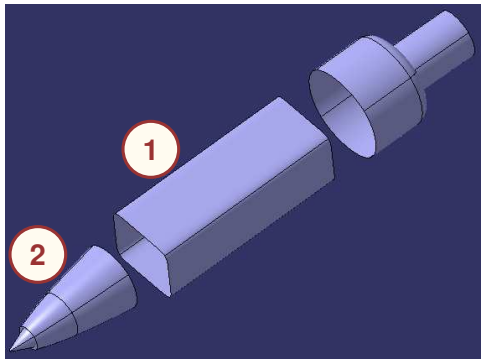
Merging the Surfaces (1/2)

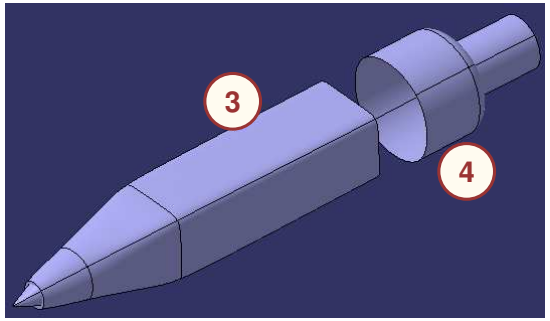
The Merge function creates a surface between the open edges of two subdivisions in order to assemble them.

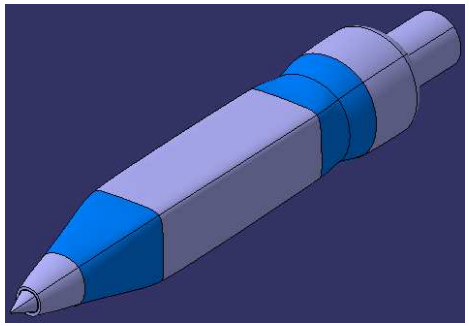
The following options are available in the Tools Palette which shows different merging results.



- **Select surface 1 and surface 2 to create the merging surface**
- **Select surface 3 and surface 4 to create the next merging surface**





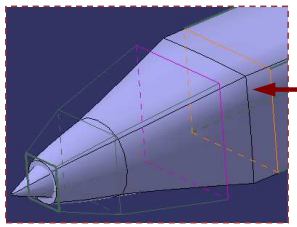


Student Notes:

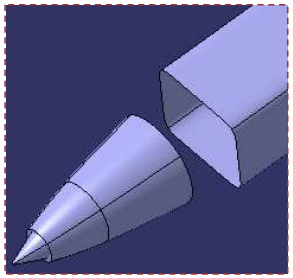
Merging the Surfaces (2/2)

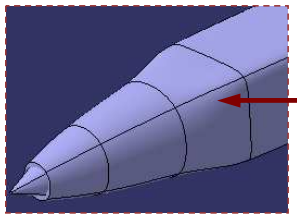
You can use three merging options from the Tools Palette to see different results.

This option allows you to reselect the surfaces

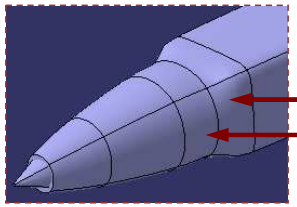


The merged edge is created in the middle of the two sections

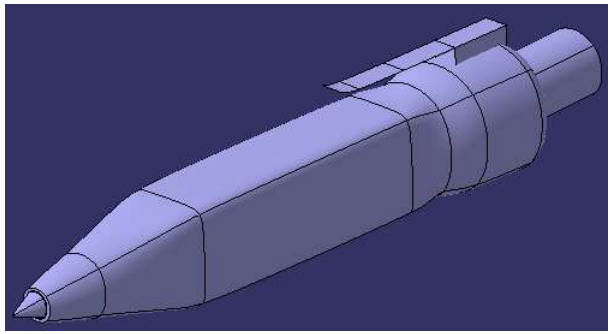




The two sections are joined by one common surface



The two sections are joined by two extruded surfaces

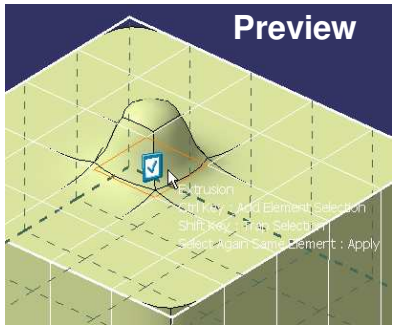


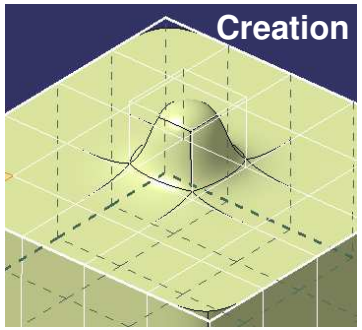
Student Notes:

Extruding a Face (1/7)

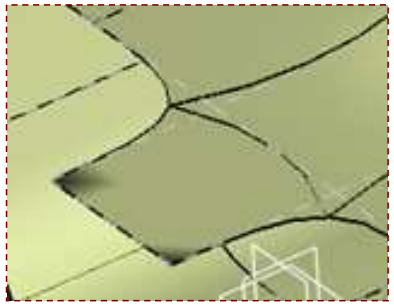
The extrusion function creates faces depending on the selected element.
The Tools Palette helps you to specify the selection filter (face or edge)

A face selection creates an extrusion made of 5 faces, the extrusion direction is normal to the selected face





An edge selection operates only on the border of open surfaces.
It creates a single face on a plane defined by the mean plane of the face connected to the edge.

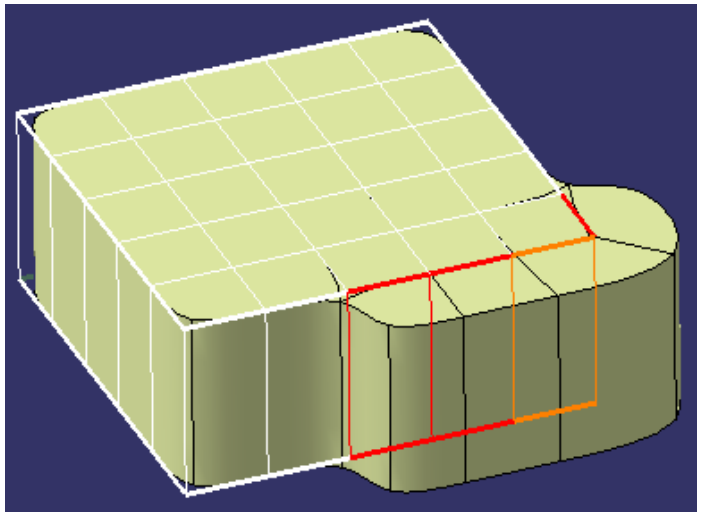


Extruding a Face (2/7)

Student Notes:

You can use multi-selections to create a set of extrusions, join faces or fill holes.

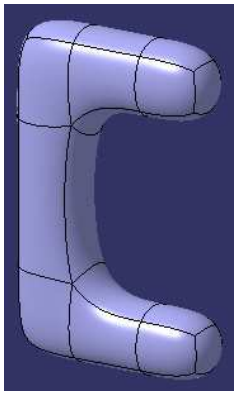
- **Use the control key to add a selection** 
- **Use a trap (with shift key) to create extrusions of a set of elements**

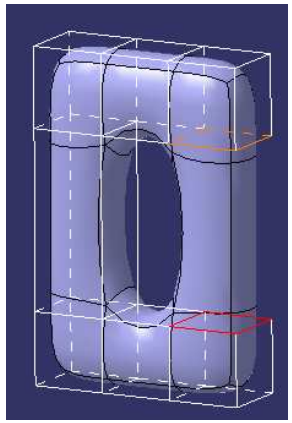


Extruding a Face (3/7)

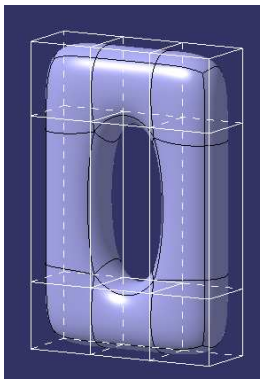
Use the control key to create a junction between 2 unconnected faces.

Select 2 unconnected faces or edges to create a junction

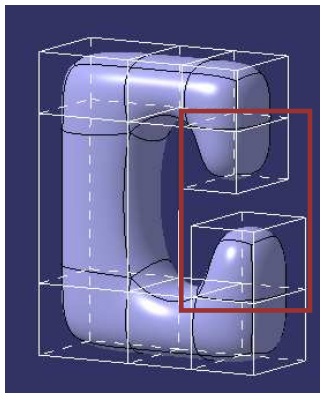


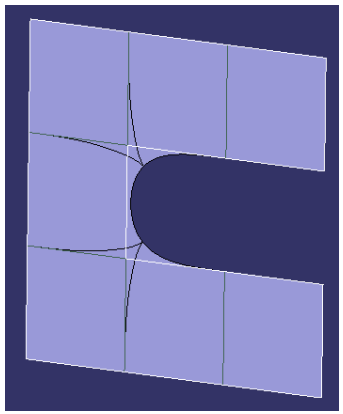


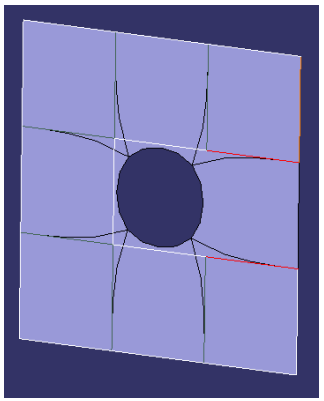
With Ctrl command



Without Ctrl command



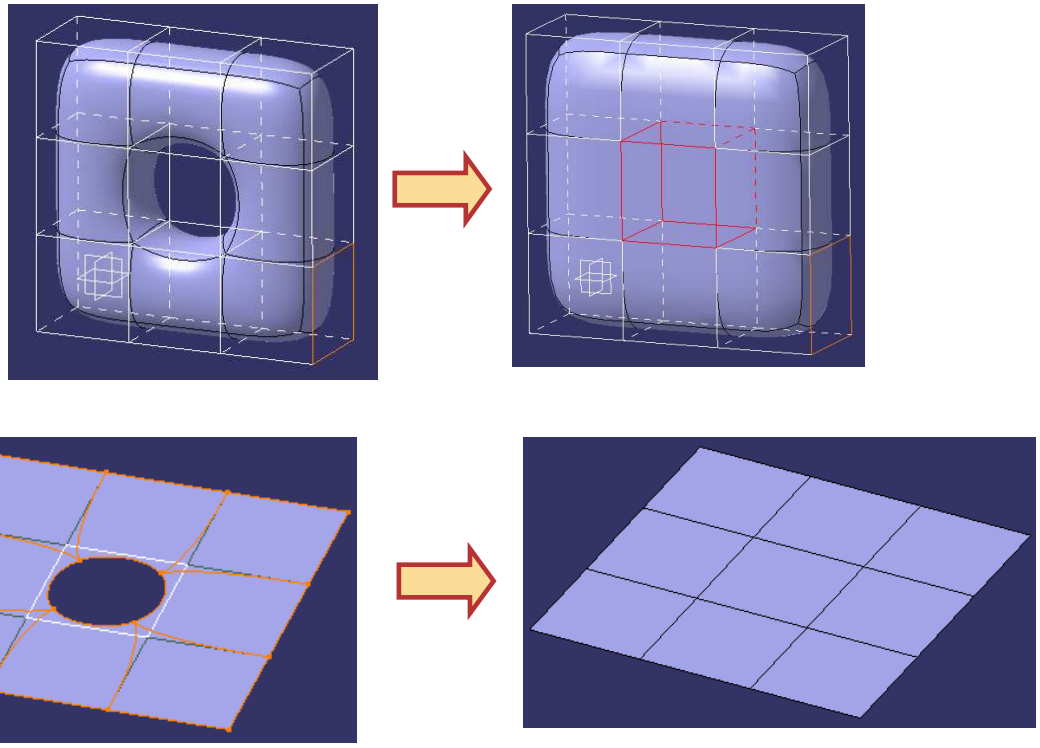




Student Notes:

Extruding a Face (4/7)

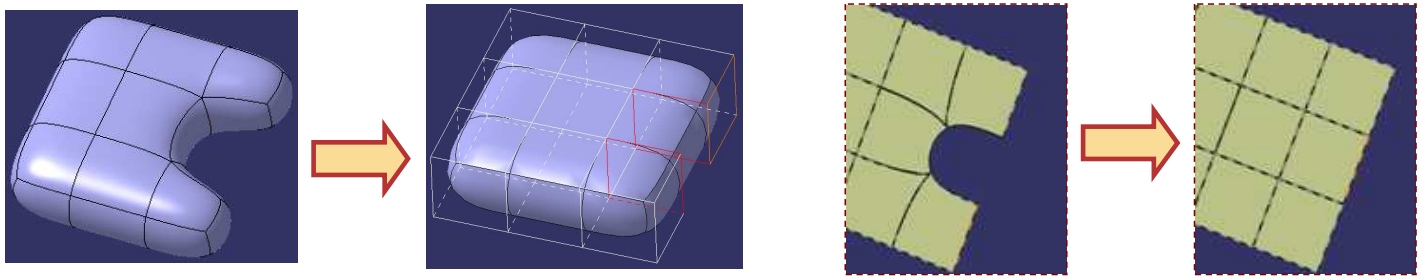
- **Use the Control key to fill holes** 
  - **Select 4 connected faces or edges to fill a hole (using a trap or multi-selection)**



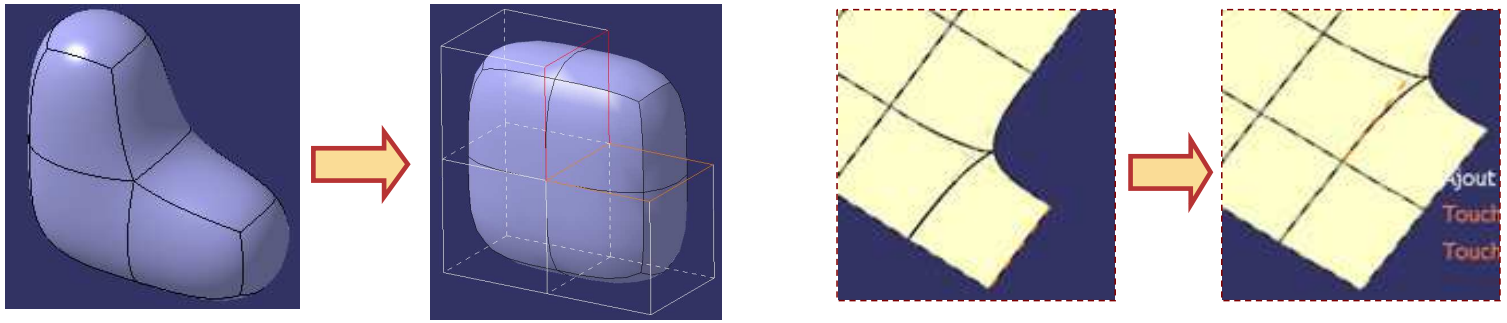
Student Notes:

Extruding a Face (5/7)

- **Use the Ctrl key to create combinations** 
  - **Select 3 connected faces or edges to fill the space between those faces**



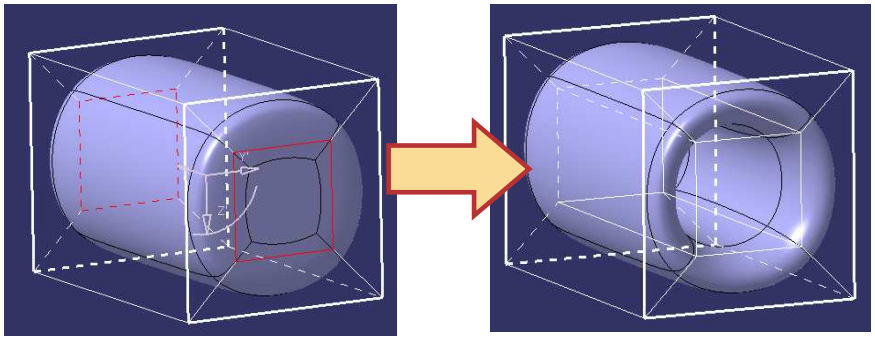
  - **Select 2 connected faces or edges to combine an extrusion**

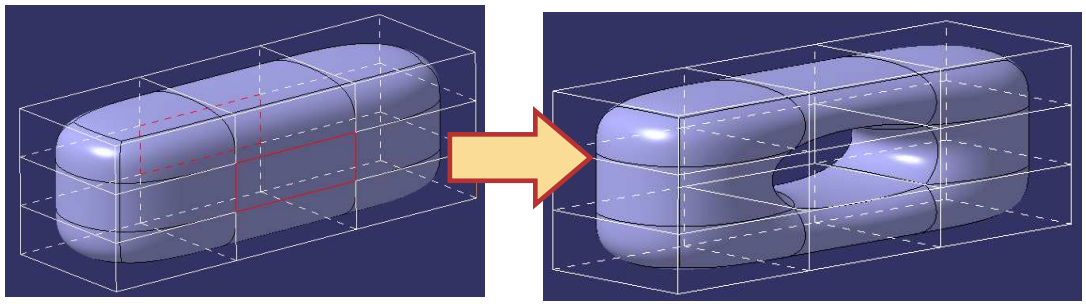


Student Notes:

Extruding a Face (6/7)

- **Use the control key to create holes** 
  - **Select two faces to create a hole. This works if the faces are not directly connected and if the tangencies of the faces are about the same. See next slide for details.**

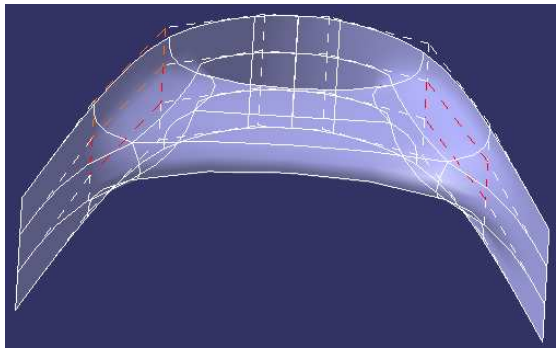


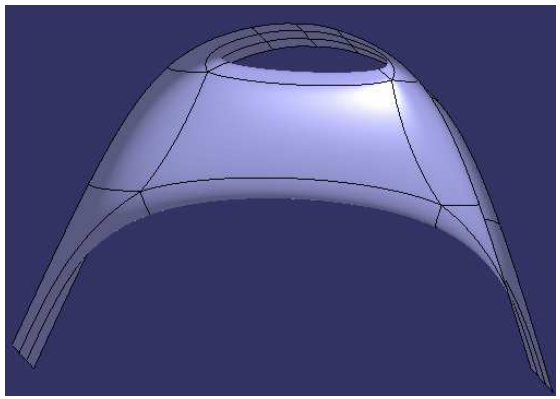


Student Notes:

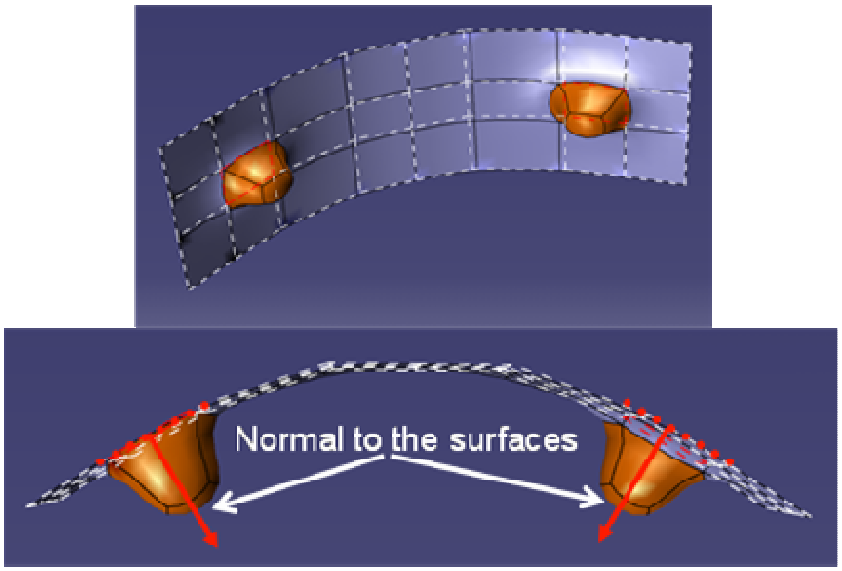
Extruding a Face (7/7)

- **Cases of hole creation** 
  - **If the angle between the normal of the two selected faces is less or equal to 90 degrees, the operation will result on a join of the two faces.**





Case with result



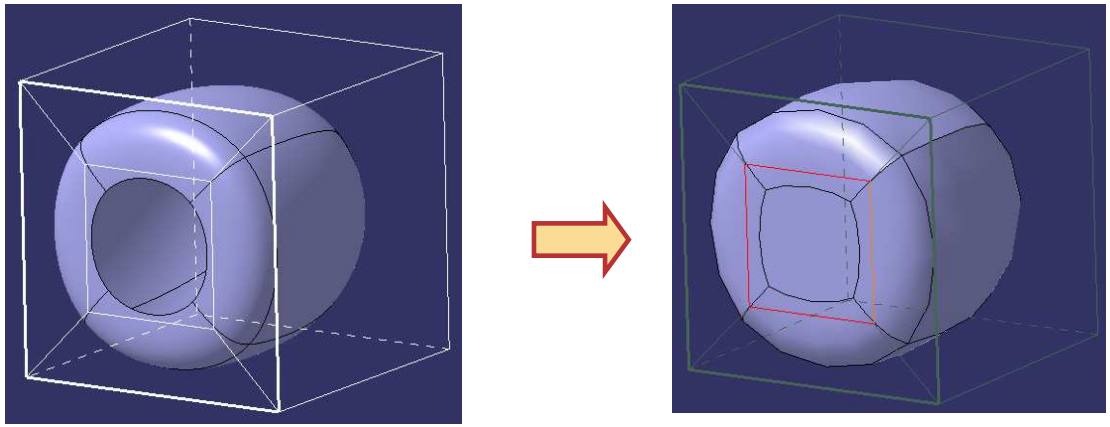
Case with no result

Student Notes:

Extruding an Edge (1/4)

- **Edge extrusion** 
  - **Options:**
    - **Fill**
    - **Extrusion**

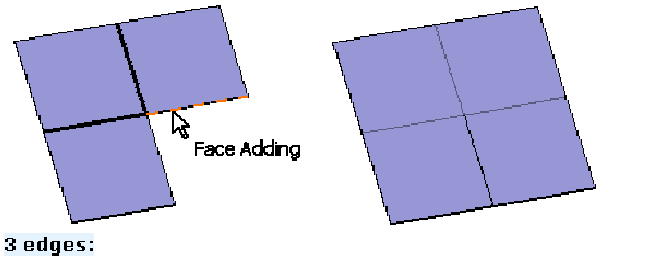
- **Examples**
  - **Fill option with propagation**

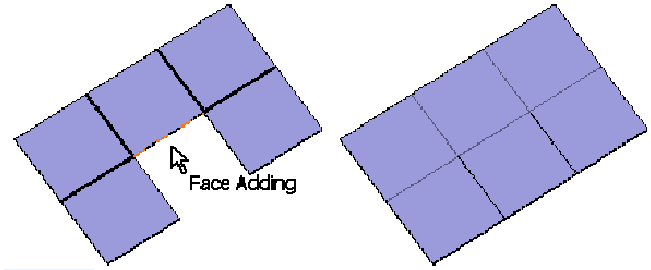


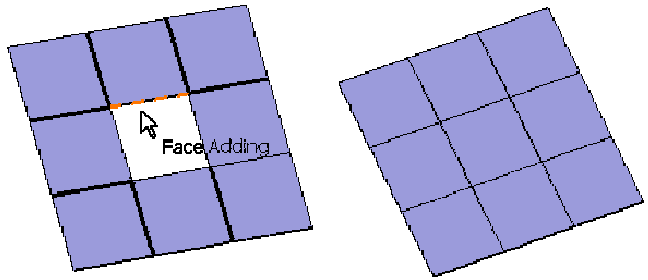
Student Notes:

Extruding an Edge (2/4)

Extruding an edge of a flat surface using the Fill option.



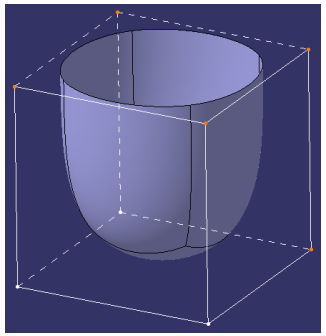


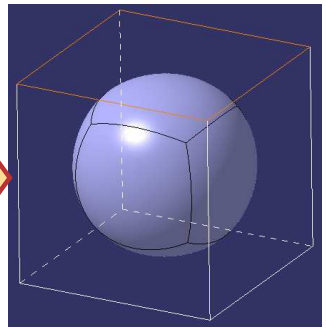


Student Notes:

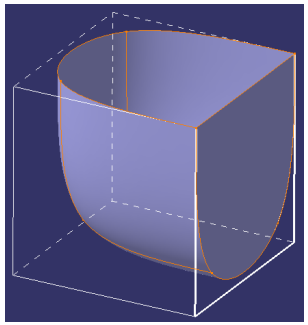
Extruding an Edge (3/4)

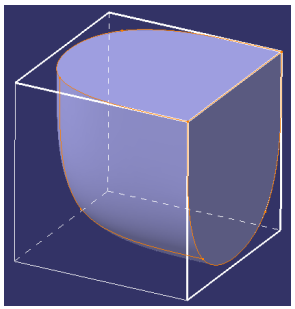
Extruding an edge of a flat surface using the Fill option. 



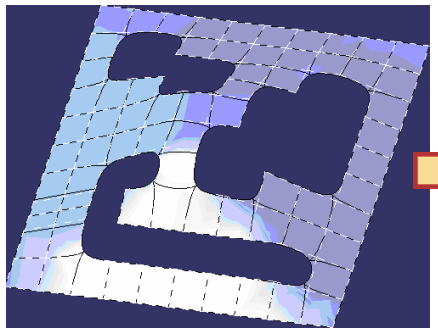


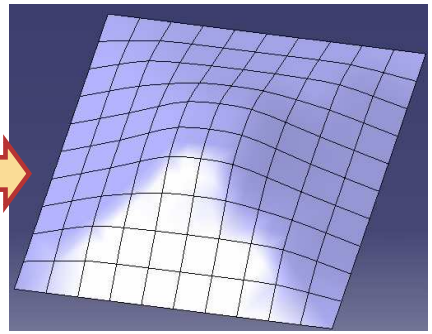
Generated faces are created without weight on joined edges





If a sharp edge is present on the boundary to be filled then the edge between the original shape and the new faces will be sharp.



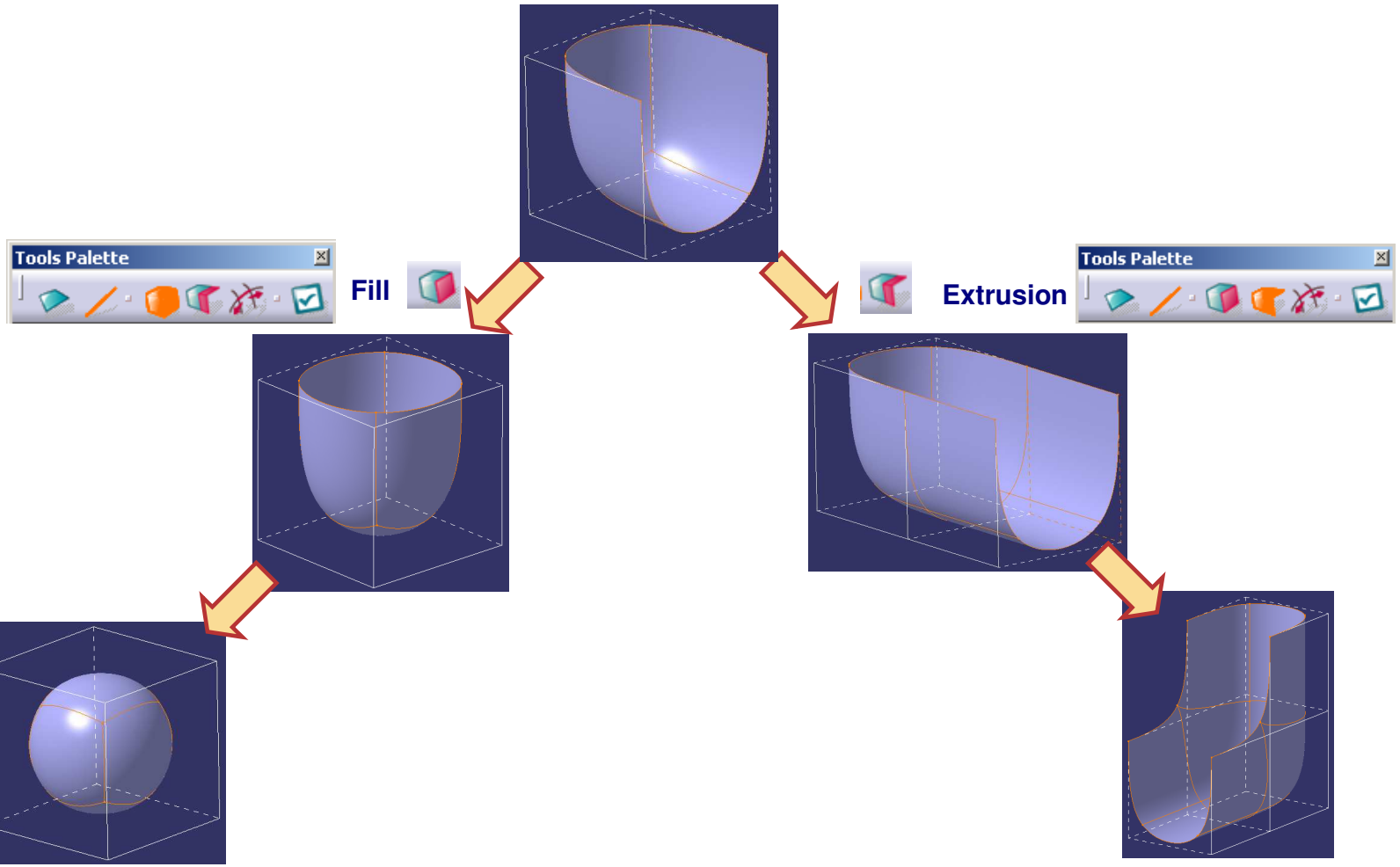


It is possible to fill several zones in a single operation, using multi selection (CTRL Key or SHIFT key) to select all edges defining different zones.

Student Notes:

Extruding an Edge (4/4)

Extruding an edge of a surface using the Fill option.

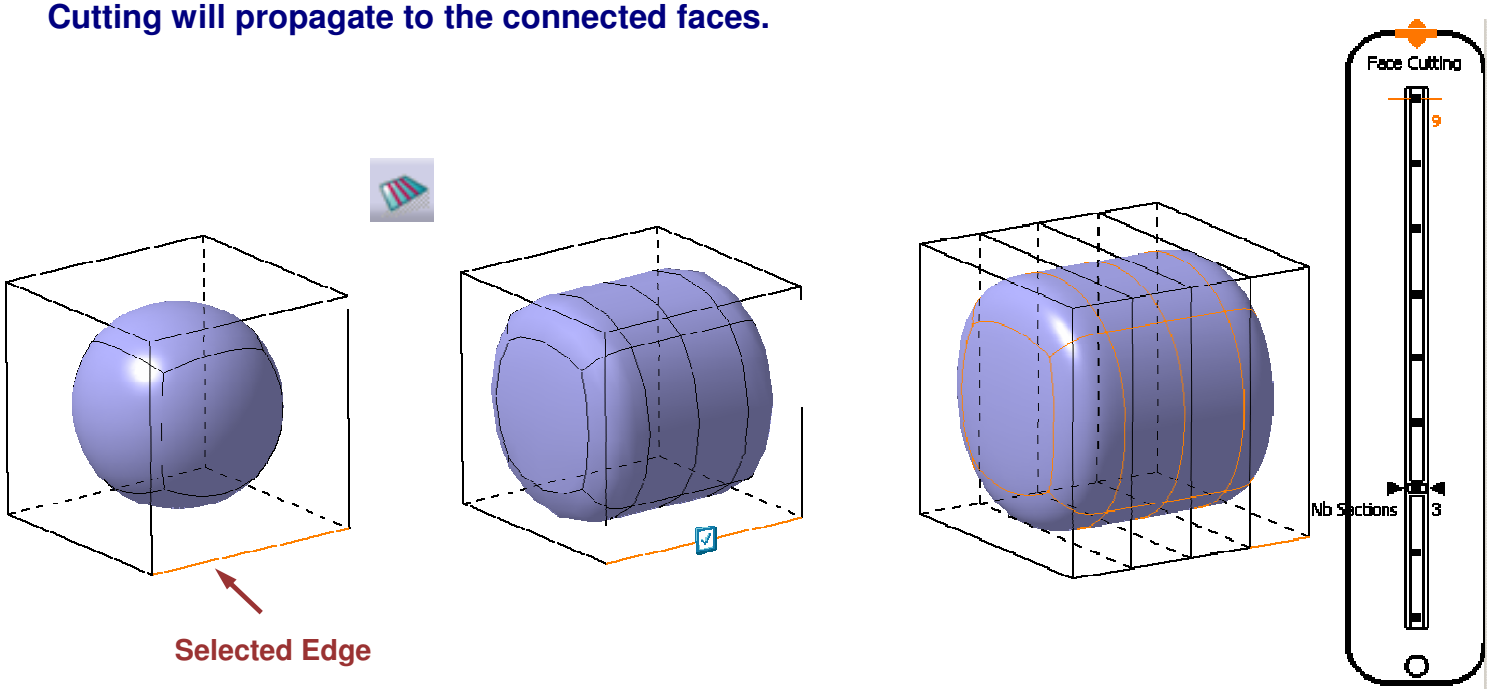


Student Notes:

Inserting Sections

The Section Insertion function adds a number of sections to the mesh which will cut faces in a number of parts. The number of cuts can vary from 1 to 9. The slider on the right of the screen is used to define number of cuts.

Cutting will propagate to the connected faces.



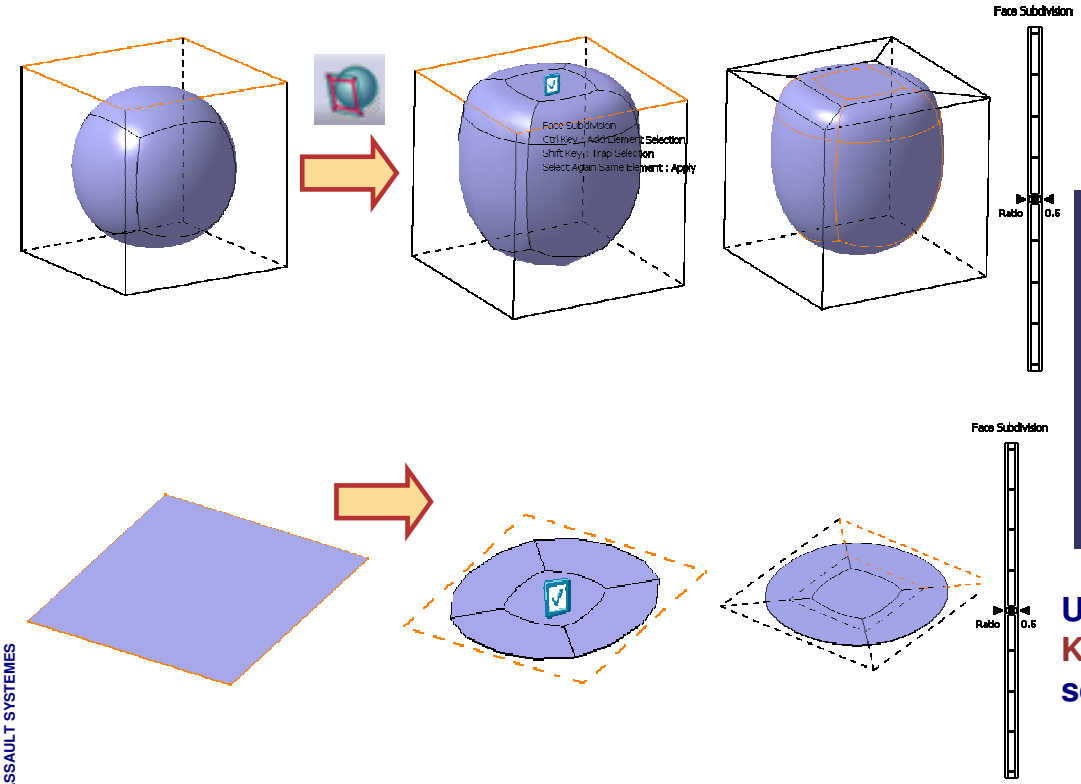
Selected Edge

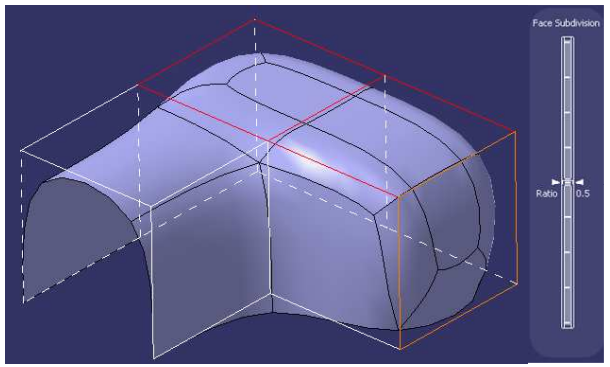
Slider

Student Notes:

Subdividing Faces

The Subdivision function creates a set of faces inside the selected faces. The slider on the right of the screen is used to define the ratio between 0.1 to 0.9.





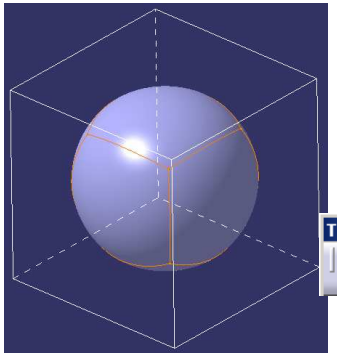
Use the control key or a trap using Shift Key to add elements and subdivide the selection.

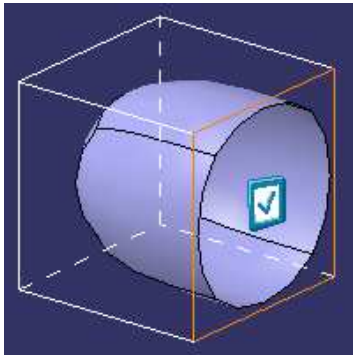
Student Notes:

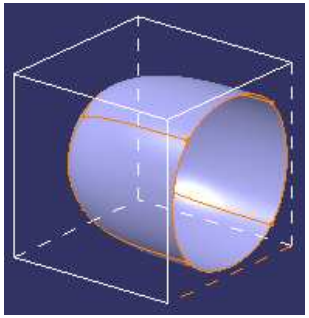
Deleting Faces

Student Notes:

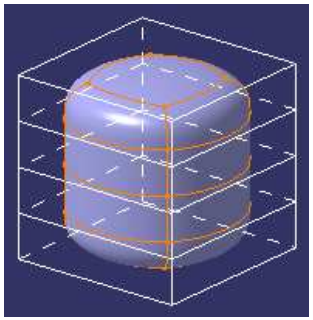
Use this function to erase faces or edges. A closed surface will be changed to an open surface.

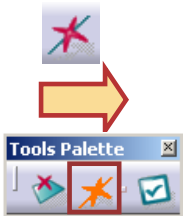


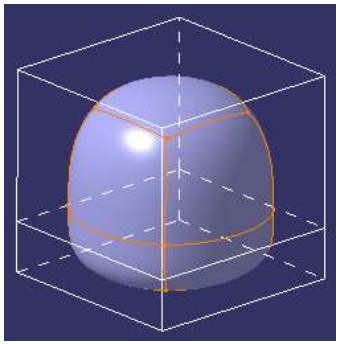




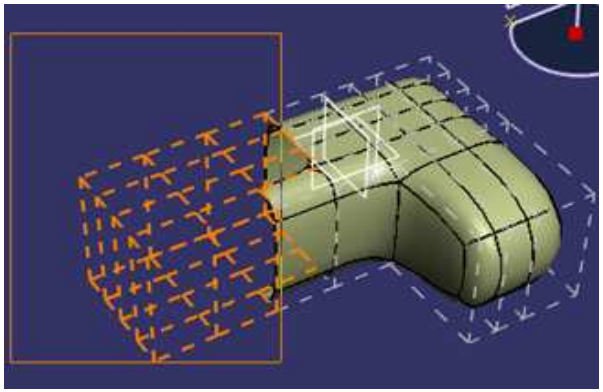
Face erasing







Edge erasing



Use the control key or a trap using Shift Key to add elements and subdivide the selection.

Student Notes:

Operations

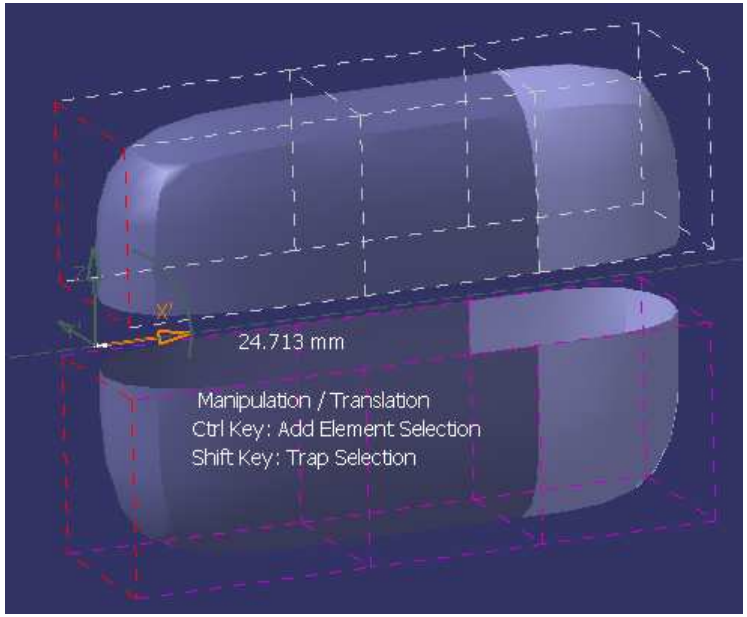
In this lesson you will go through the following operations on subdivision surfaces.

- Editing Multiple Surfaces
- Dimensioning a Surface
- Associating Elements
- Other Operations

Student Notes:

Editing Multiple Surfaces

You will learn how to select multiple surfaces and perform the same modification on them and use a surface to modify another.

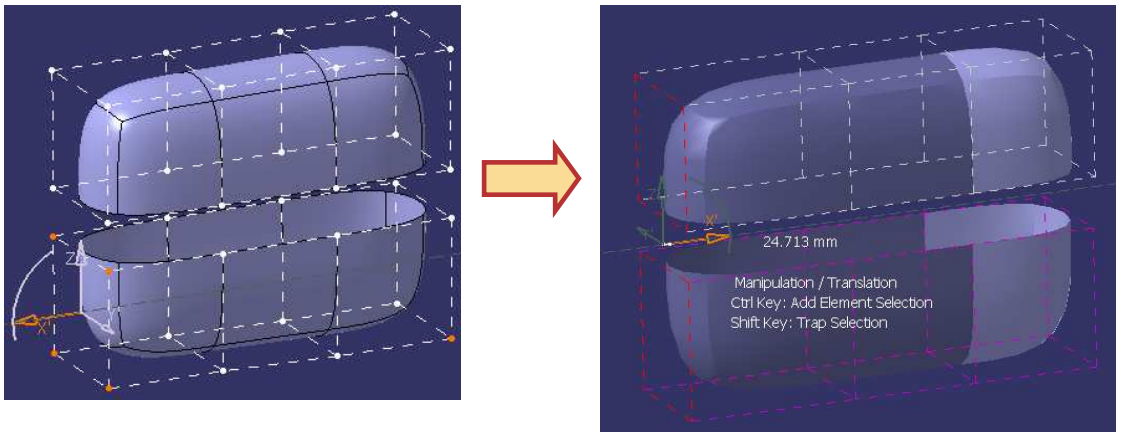


What is Multi-Surface Edition

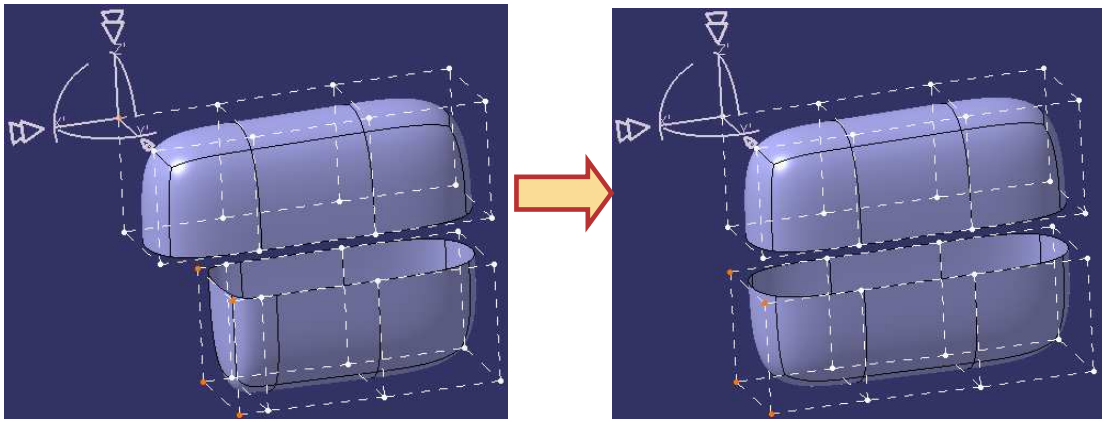
Student Notes:

- **This function allows you to:**

  - **Perform the same action on several subdivision surfaces**



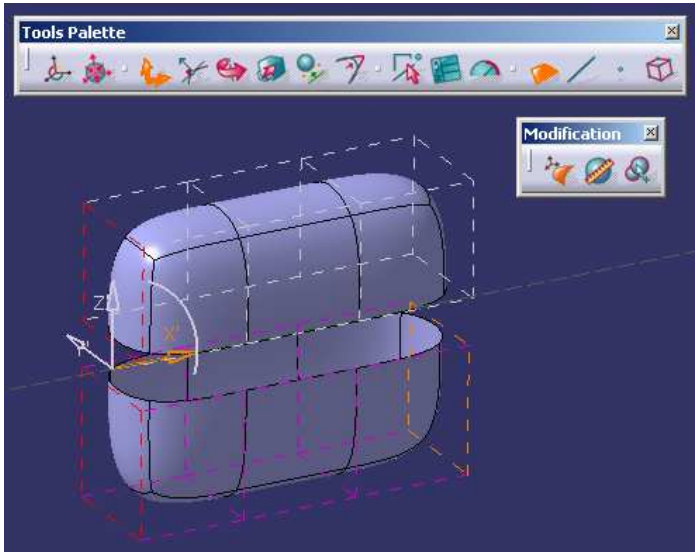
  - **Modify a subdivision surface using another**



Student Notes:

How to Edit Multiple Surfaces (1/2)

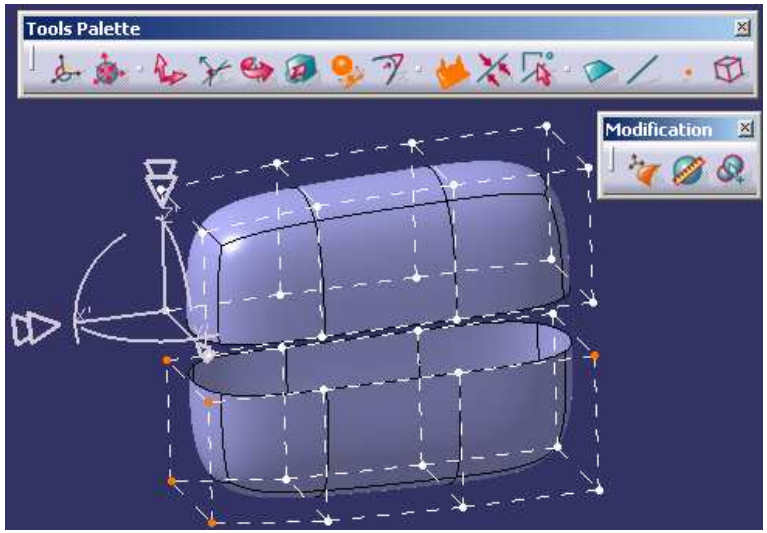
- To multi select:
  - You must be in the modification command.
  - You need at least two surfaces.
- To perform the same action on several subdivision surfaces:
  - Select the Modification icon
  - Select the surface
  - Select the Multi Selection icon
  - Press the Ctrl key and select another surface(s)
  - You can change (Add, Remove) the set of selected surfaces using Ctrl key
  - Select the Multi Selection icon which brings you back to the Modification command
  - Select edges, faces or vertices of the surfaces and apply transformation (translation, rotation, affinity, alignment, attraction)



Student Notes:

How to Edit Multiple Surfaces (2/2)

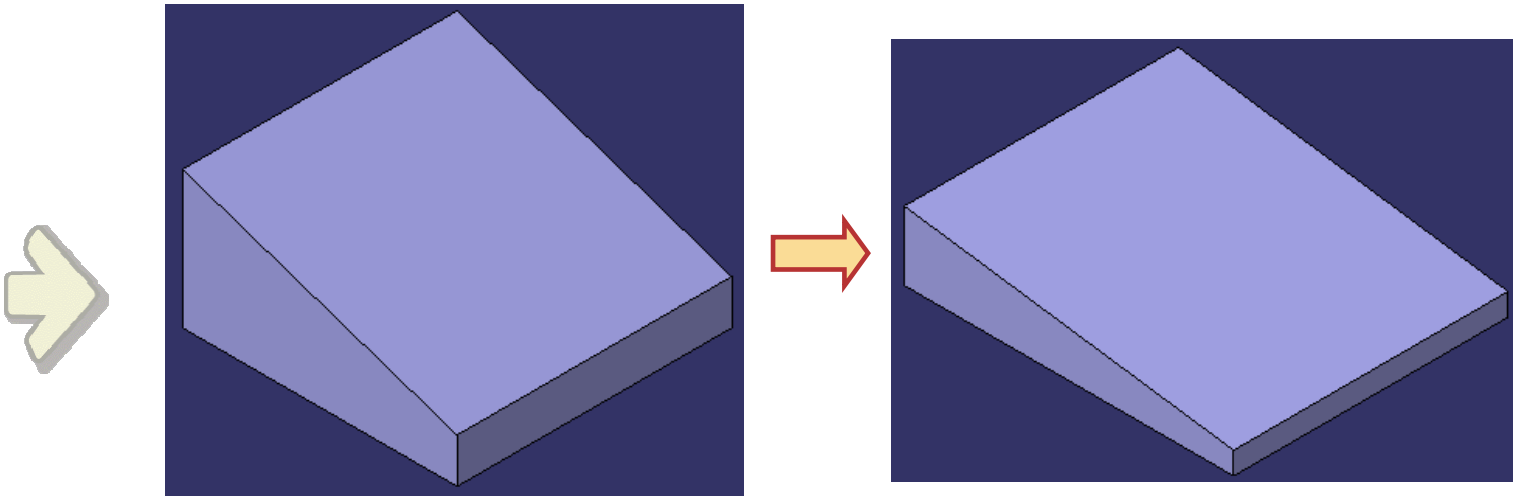
- To modify a subdivision surface using another
  - When working on the first surface you can define the compass with a second surface, and perform operations such as a rotation or an alignment on the first surface.
  - Select the Modification icon
  - Select the first surface
  - Select the Multi Selection icon
  - Press the Ctrl key and select the other surface
  - Select the Multi Selection icon to return to the Modification command
  - Define the compass on the vertex of the second surface
  - Select edges, faces or vertices of the first surface and apply the transformation (rotation, affinity)



Student Notes:

Dimensioning Surfaces

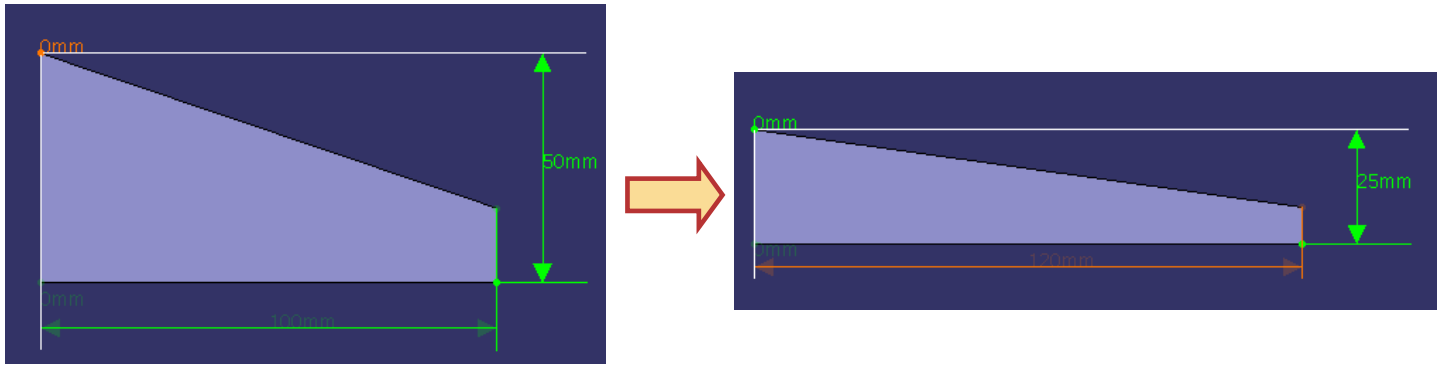
You will learn how to control the dimensions of a subdivision surface.



Student Notes:

What is Surface Dimensioning?

- The main constraint of a stylist is the size of the product bounding box. This function allows you to:
  - Specify the exact dimension of the subdivision surface



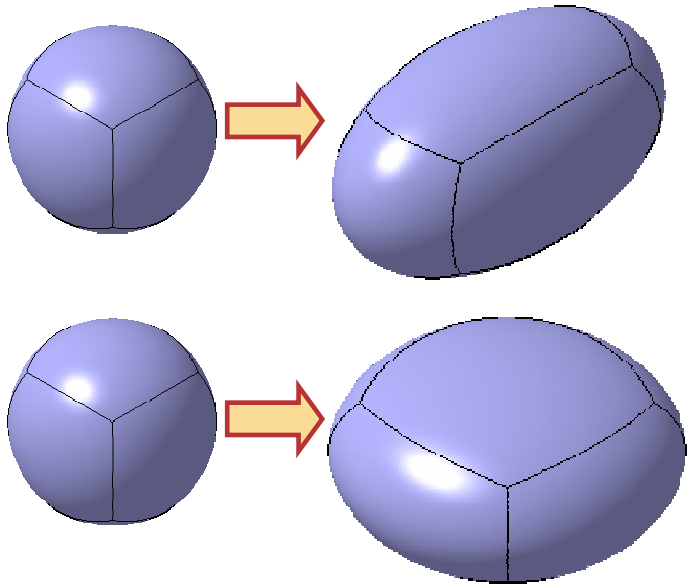
- A toolbar contains a set of dedicated options

Toolbar	Name	Icon	Description
Tools Palette (For Dimension)	Type of Modification		Transform vertices along the direction of selected dimension
			Transform vertices along the two displayed directions
			Transform vertices along the three displayed directions
	Orthogonal View Change		Automatically changes the view point to the closest view plane
	Compass Definition		Modifies the origin and orientation of the compass to define new axis system

Student Notes:

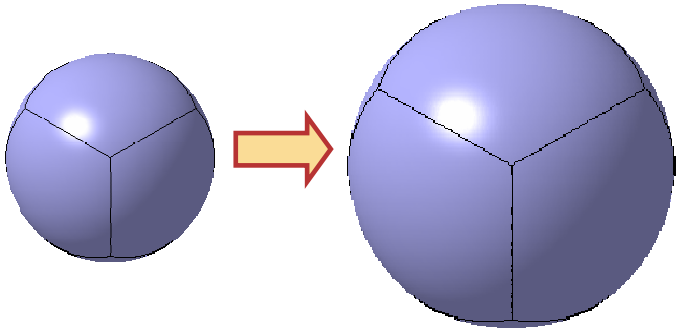
How to Control Surface Dimensions (1/3)

- The function operates either in object-action or action-object mode
  - You can select elements before using the function
  - You can use the function and select elements
- Select the function icon 
  - Select the surface
  - The view point automatically changes to the closest view plane
- Transform the surface in one direction using this icon 
  - Edit the dimension to change
  - The transformation is applied in the direction of the selected dimension.
- If the Type of Modification is set as shown, and the dimension is edited the transformation will be applied in two directions. 

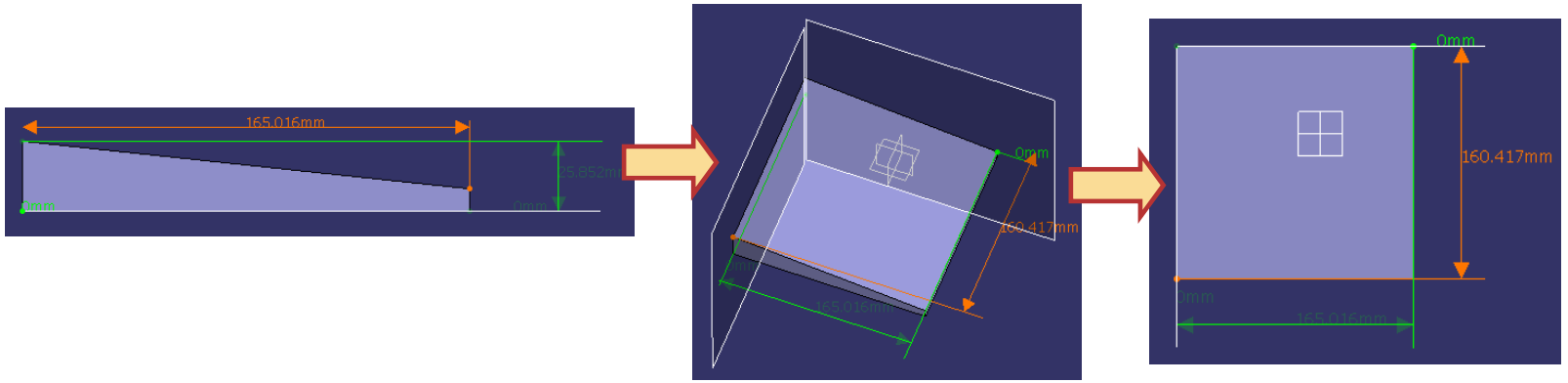


How to Control Surface Dimensions (2/3)

- Transform the surface in three directions using this icon 
  - Edit the dimension to change
  - The transformation is applied along the three displayed directions



- You can change the view point to the closest view plane using this icon 
  - Rotate the surface
  - Select this icon to change the view point.



Student Notes:

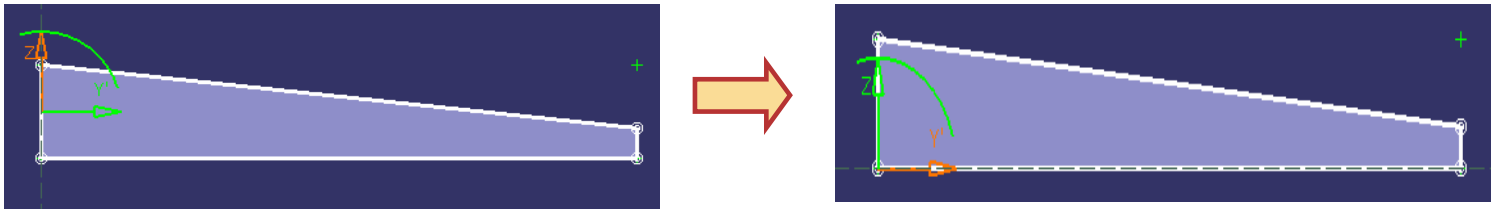
Student Notes:

How to Control Surface Dimensions (3/3)

- You can modify the origin and orientation of the compass using this icon
  - Select this icon to change the compass definition

  - The compass position can be modified using the compass definition options available in the tools palette

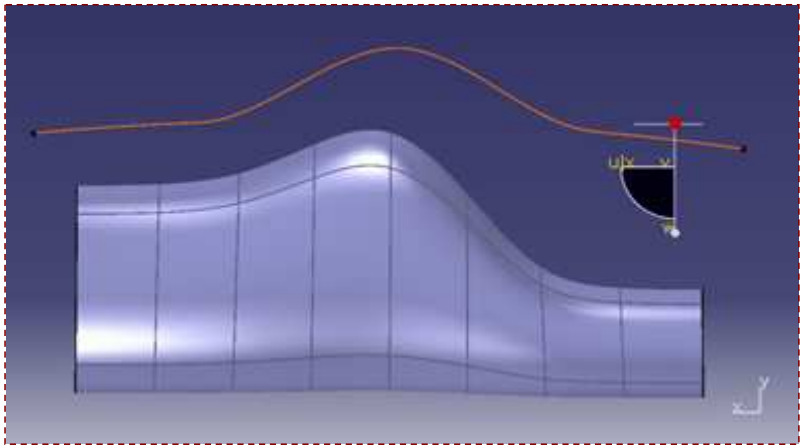
  - Select the Compass Definition icon to go back to the Dimension command.



Student Notes:

Associating Elements

You will learn how to link an existing subdivision surface to a point, line, curve or another surface.



Student Notes:

What Is Associating elements?

This function allows you to associate a point, line, curve or surface to the mesh and then deform the surface by deforming the associated element.

- **Any kind of curve/surface can be used:**
  - **IMA Curve/Surface**
  - **FreeStyle Curve/Surface**
  - **GSD Curve/Surface**
  - **Sketcher Curve**
- **A toolbar contains a set of dedicated options**

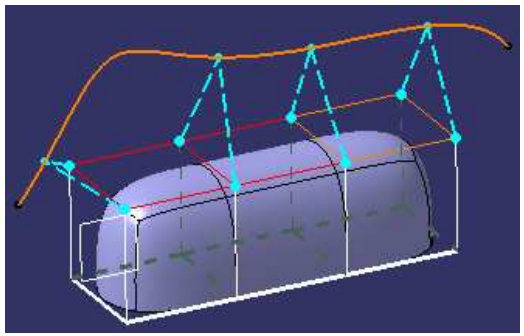
See Selection Tools section

Toolbar	Icon	Name
Tools Palette (For Alignment)		Curve Selection
		Association Removal
		All Association Removal

Student Notes:

How to Create Associativity

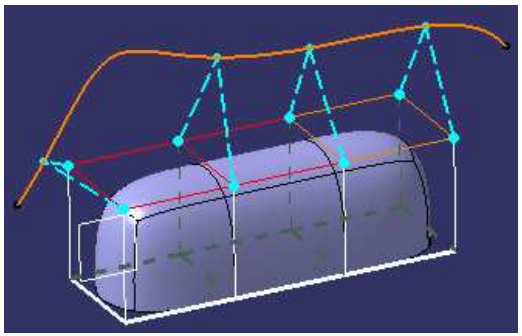
- You need to have an additional point, line, curve or surface in addition to the IMA surface.
- The function operates either in object-action or action-object
  - You can select elements before using the function
  - You can use the function and select elements
- Select the function icon
  - Select the surface
  - Select the curve
  - Select the elements to associate to the curve, a cyan line linking the selected vertices and the curve shows the association
  - You can add or remove associated vertices using selection management (see corresponding section)
- You can add a new curve to the association using the first icon
  - Select a curve
- You can remove the current curve association using this icon
  - Select the first icon to select a curve and then select a curve
- You can remove all the associated curve using the third icon

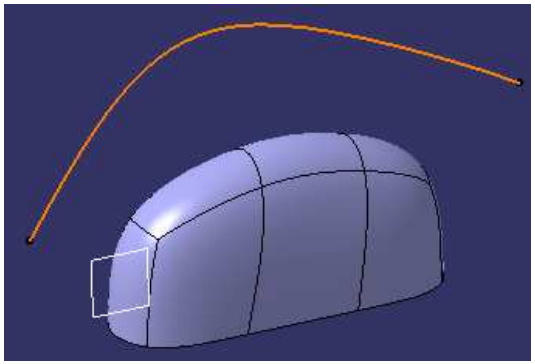


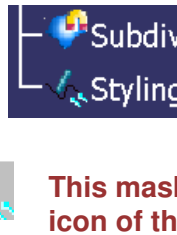
Student Notes:

More About Associativity (1/4)

- If a curve is deformed then the surface will also be deformed
  - To deform a curve use the Curve Deformation tools palette
  - The mesh elements linked to the curves are automatically moved
  - The surface is then recomputed
- The vertices are still movable using either the Modification function or by Vertex alignment
- You can find out the association between the elements by referring to the specification tree. Two masks will get added to the icons







This mask gets added to the icon of the feature which is handling another feature.

This mask gets added to the icon of the feature which is handled by another feature.

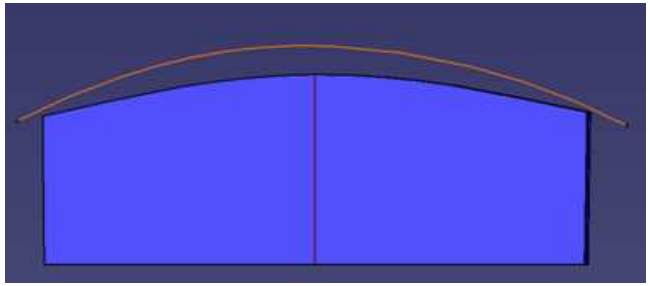
More About Associativity (2/4)

- **Warning: The surface will never exactly follow the curve shape!**
- **To optimize the « morphing » between the curve and the surface, you first have to create the curve as close as possible to the surface and ensure that the mesh is sufficiently dense to follow the curve during deformation.**

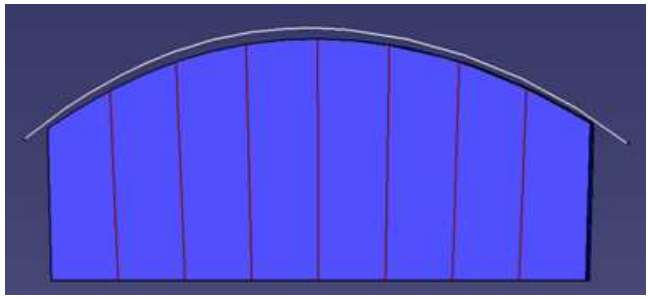
Example 1: (Surface associated to Curve)

Curve close to the initial surface

Low mesh density



High mesh density

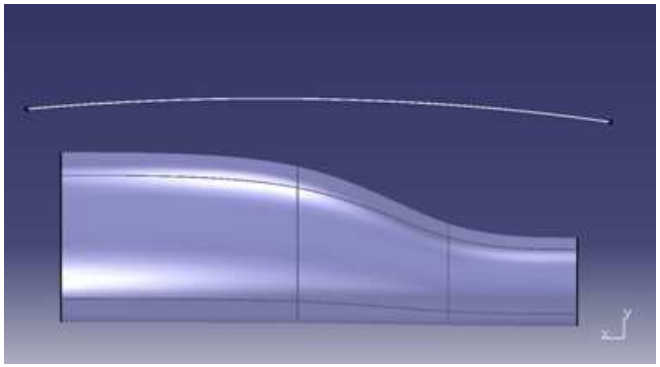


Student Notes:

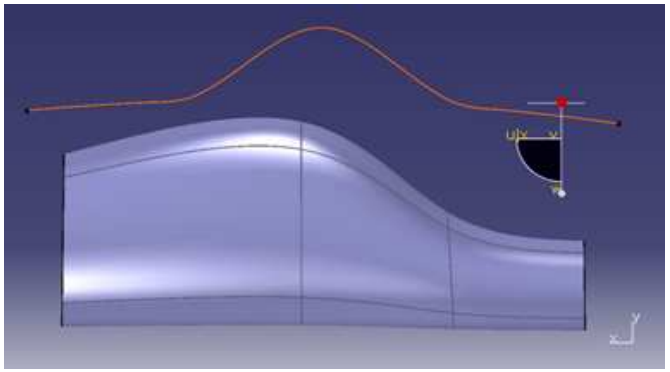
More About Associativity (3/4)

Example 2: (Surface associated to Curve)

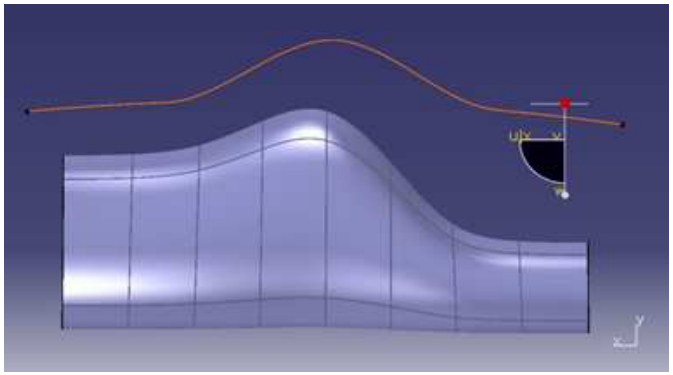
Curve far from the initial surface



Low mesh density



High mesh density

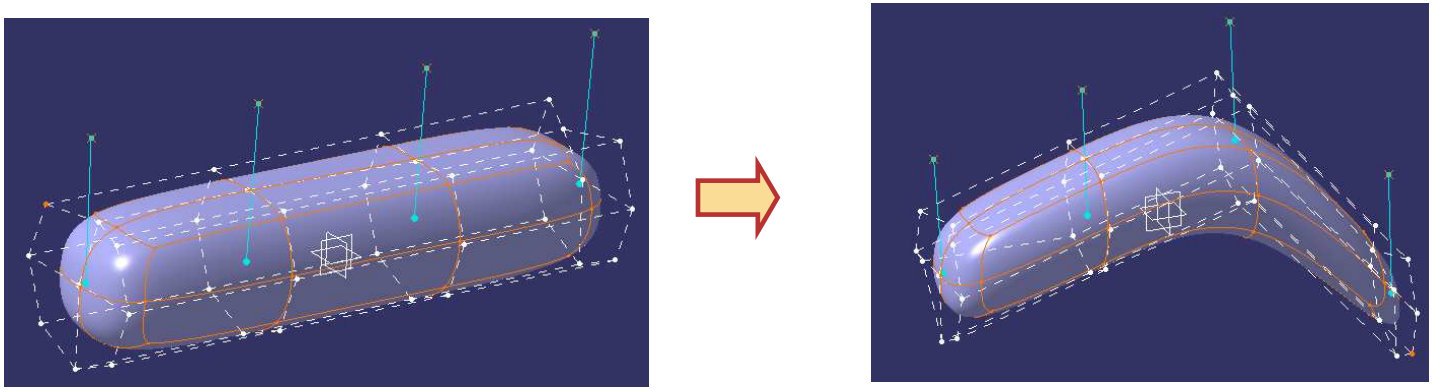


Student Notes:

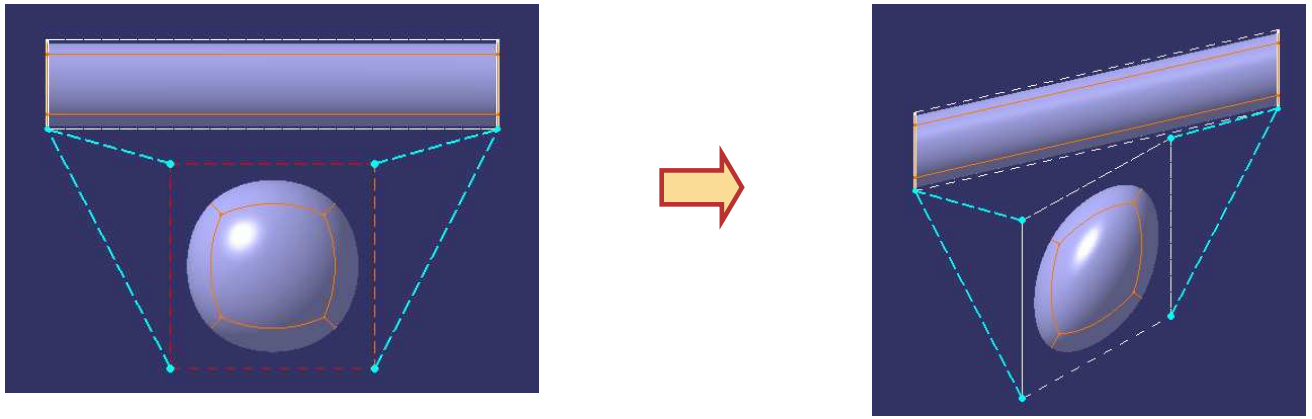
More About Associativity (4/4)

Student Notes:

Example 3: (Surface associated to Points)



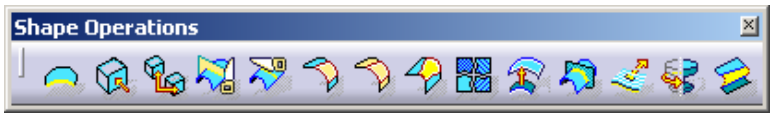
Example 4: (Surface associated to Surface)



Student Notes:

Other Operations

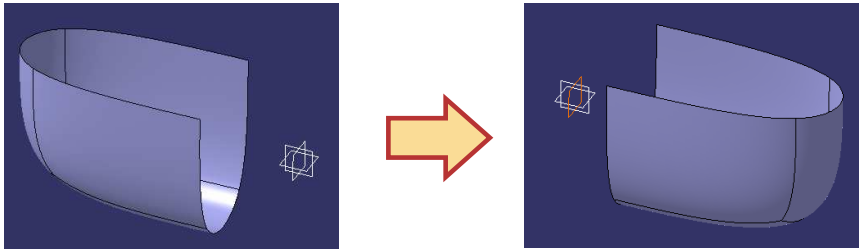
You will learn how to create a symmetry of a subdivision surface, how to define the working zone and how to use Generative Shape Design functions in the Imagine and Shape workbench.



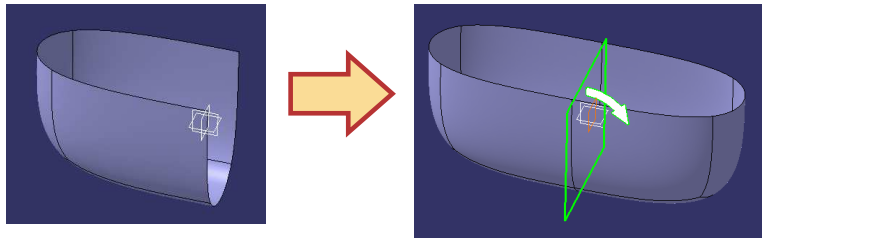
Student Notes:

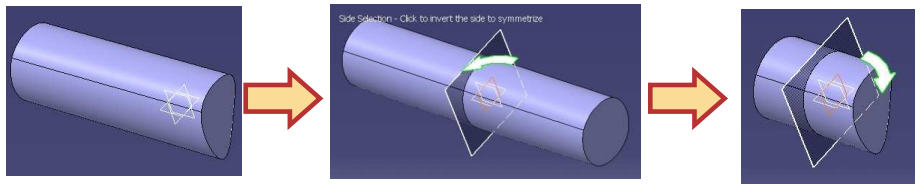
How to Create a Symmetry

- In order to create a symmetry you need a subdivision surface and a symmetry plane.
- Select the Symmetry icon 
  - Select the surface
  - Select the symmetry plane (The order of selection may be reversed)
  - If the surface and symmetry plane do not intersect, the result is a mathematical symmetry.



  - If the surface and symmetry plane intersect, you have the option to select one of the two solutions.





What is Defining the Working Zone

- This function allows you to define a working area on a mesh in order to modify only this part of the mesh. 
- A toolbar contains a dedicated option 

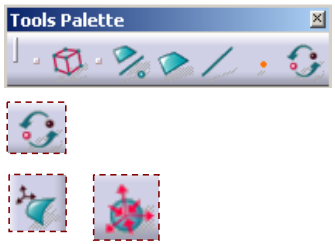
Toolbar	Icon	Name
Tools Palette (For Working Zone)		Swap selection

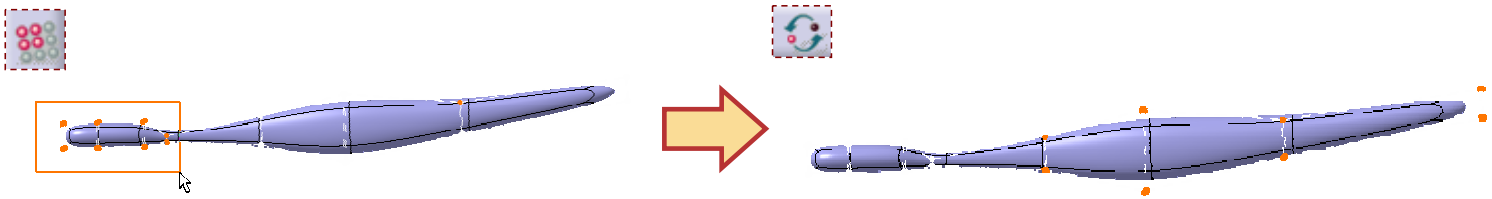
Student Notes:

Student Notes:

How to Define the Working Zone

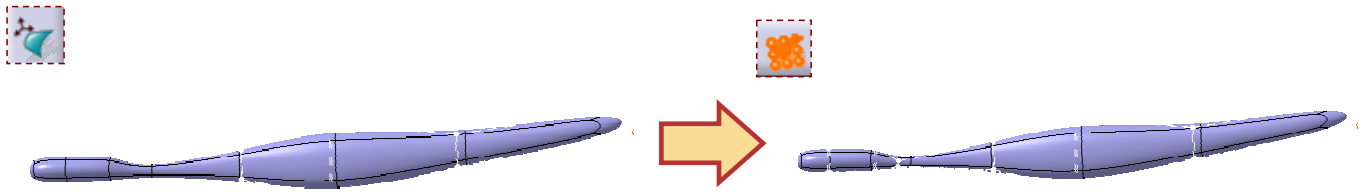
- Select the function icon
  - Select the surface
  - Select the elements that you want to modify using the selection tools
  - You can swap the element selection. All protected elements become unprotected and vice-versa
  - Select the Modification icon and modify the elements in the working zone.





Working Zone definition

Swap selection



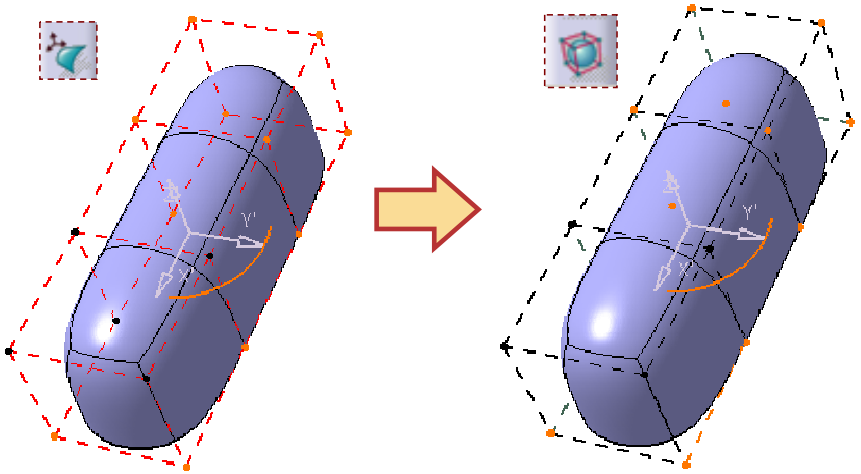
Modification of Surface

- In the Modification Tools Palette, click De/Activate Working Zone to reset the protection of selected elements.

Student Notes:

What is View and Selection Mode?

- This function allows you to restrict modifications to the visible mesh elements only. Follow the procedure to change the mode.
  - Select the Modification icon.
  - Select the surface that you want to modify.
  - Select the View and Selection Mode icon. All the hidden edges are no longer visible within the subdivision surface and the hidden elements visible in the mesh can not be picked.
  - Modify the visible elements.



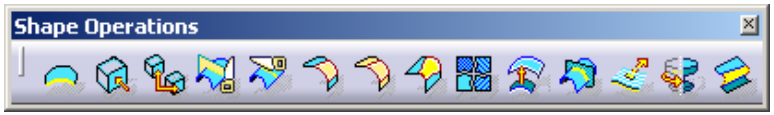
View and Selection All:
All the edges of the mesh are visible and can be picked

View All and Selection Front:
All the edges of the mesh are visible but only the front edges can be picked

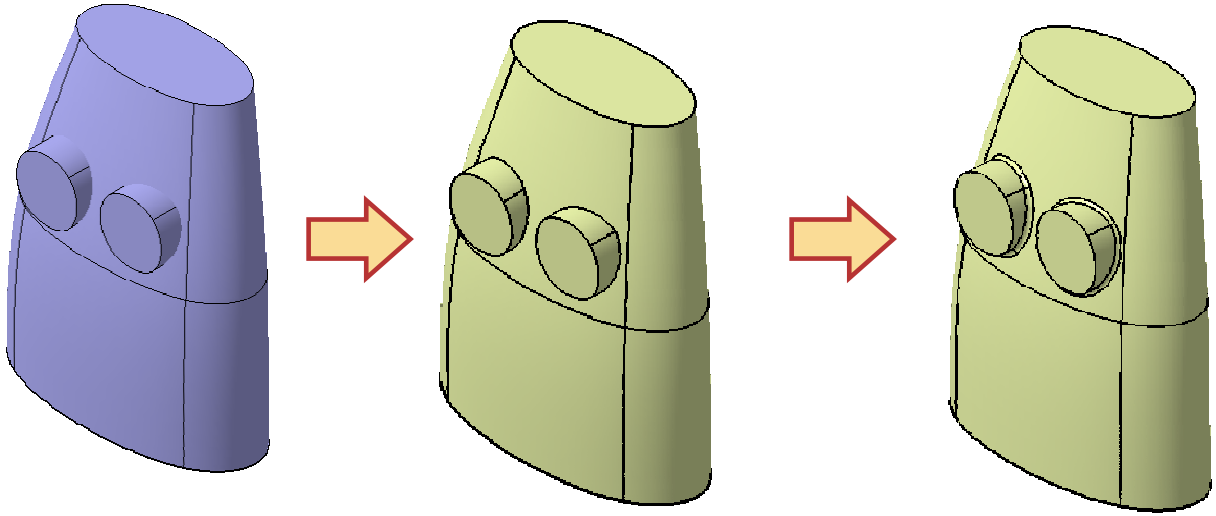
View and Selection Front:
Only front edges are visible and can be picked

What are Shape Operations?

- The Shape operations toolbar lets you access a set of functions belonging to the Generative Shape Design (GSD) workbench



- These functions can be used to create or modify curves and surfaces.
- It avoids frequent switching from the IMA to GSD workbenches.



Trim

Fillet

Student Notes:

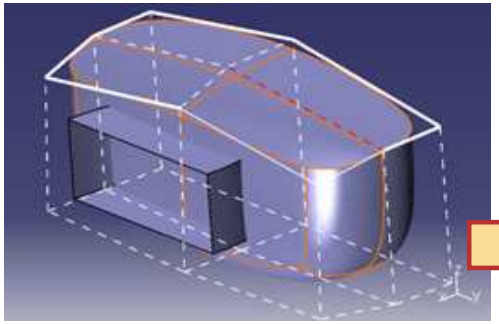
Student Notes:

Imagine and Shape Recommendations

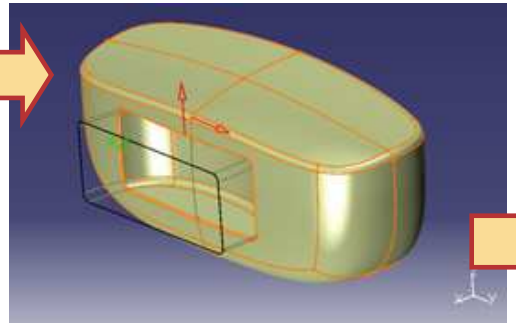
You will learn about general methodology and settings management.

General Methodology (1/7)

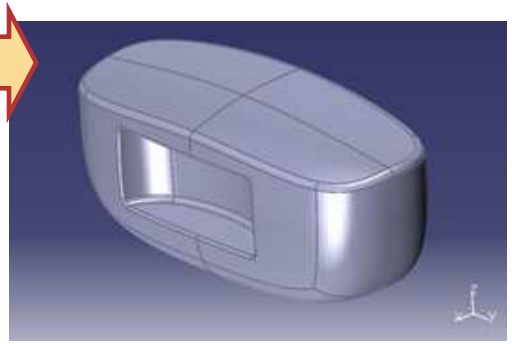
Student Notes:



1 Create Subdivision surfaces



2 Split/Trim/Fillet in IMA Shape operations



3 Create the Solid and add Dress-Up in Part Design

General Methodology (2/7)

Use Shift-trap as much as possible for mesh selection combined with views management (F4).

Do not hesitate to use and customize Shortcuts to functions
Example:
F10 – Hide/Show
Space – Modify

Use the Escape key to exit a function as much as possible and a shortcut to Modification function, for example the Space bar.

Ergonomic advice:
Put your left hand on the left side of the keyboard for a quick access to:
Control / shift
Escape
Space
F4
F2

Student Notes:

Student Notes:

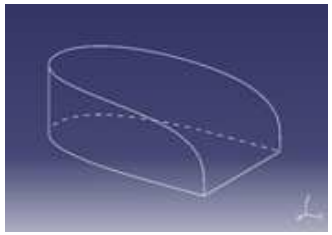
General Methodology (3/7)

- Create your model using several Subdivision surfaces. Where possible avoid creating a complex shape with only one surface.
- Try to « think » how to break down the shape into elementary blocs. This is the key to speed-up the creation. See corresponding (General Methodology 4/7, 5/7 and 6/7).
- Keep the Subdivisions as light as possible by limiting the mesh density, to ensure a better surface quality and easy manipulation of surface.
- Combine the subdivision surfaces with GSD or other operations (trim, split, fillet) to finalize the shapes.
- Benefit from Sharp Edges modeling which gives a better feeling for the shape. The sharp edges are then similar to styling curves. Then use GSD fillets on these edges.

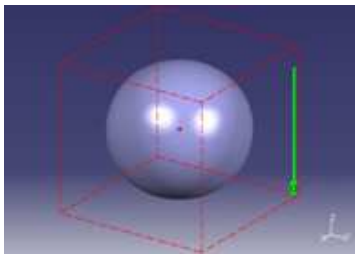
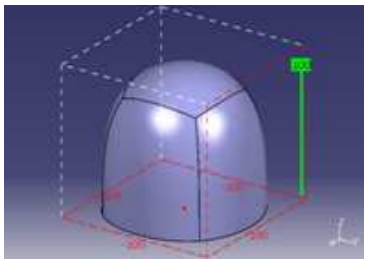
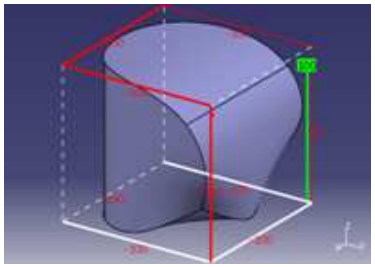
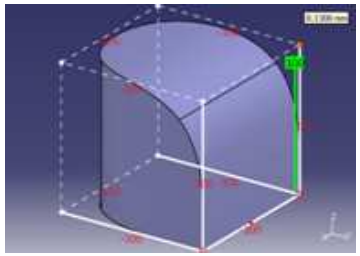
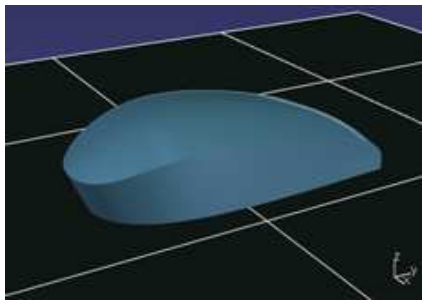
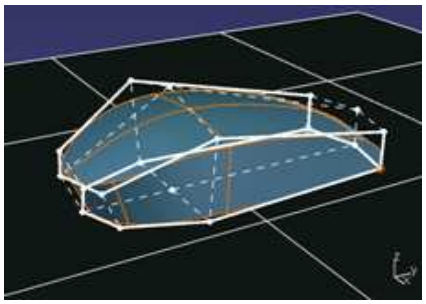
General Methodology (4/7)

Student Notes:

The mesh structure as well as the topology has to be carefully managed. This is the key to obtain the target shape.
Before starting to create a shape, it is recommended to analyze the topology structure of the shape you have in mind.
Start then by creating a very light mesh structure corresponding to this shape, then by refining this mesh you will progressively get the final shape.
A good way is to determine the virtual sharp edges which are filleted afterward with GSD.

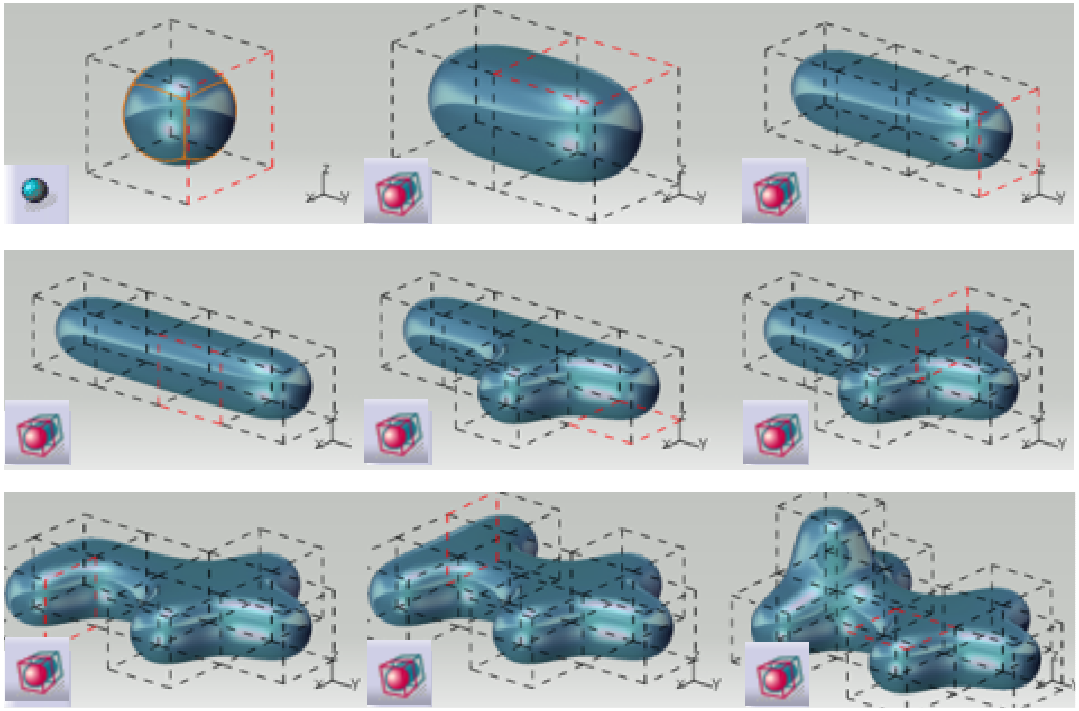


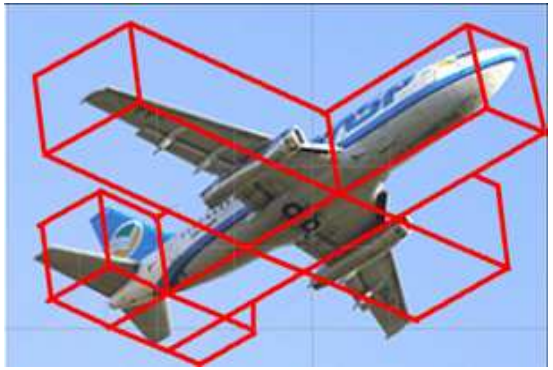
Example 1: Modeling a mouse
In most cases this has the following structure
To create the model start with a basic closed surface

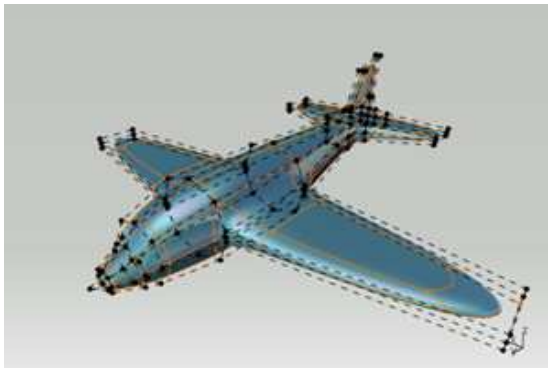







General Methodology (5/7)

Example 2: Modeling a toy plane
The main structure of the shape can be described as a set of blocks as shown in the picture
Those blocks are of course refined to obtain the final shape (insertion of sections, local subdivision, etc.





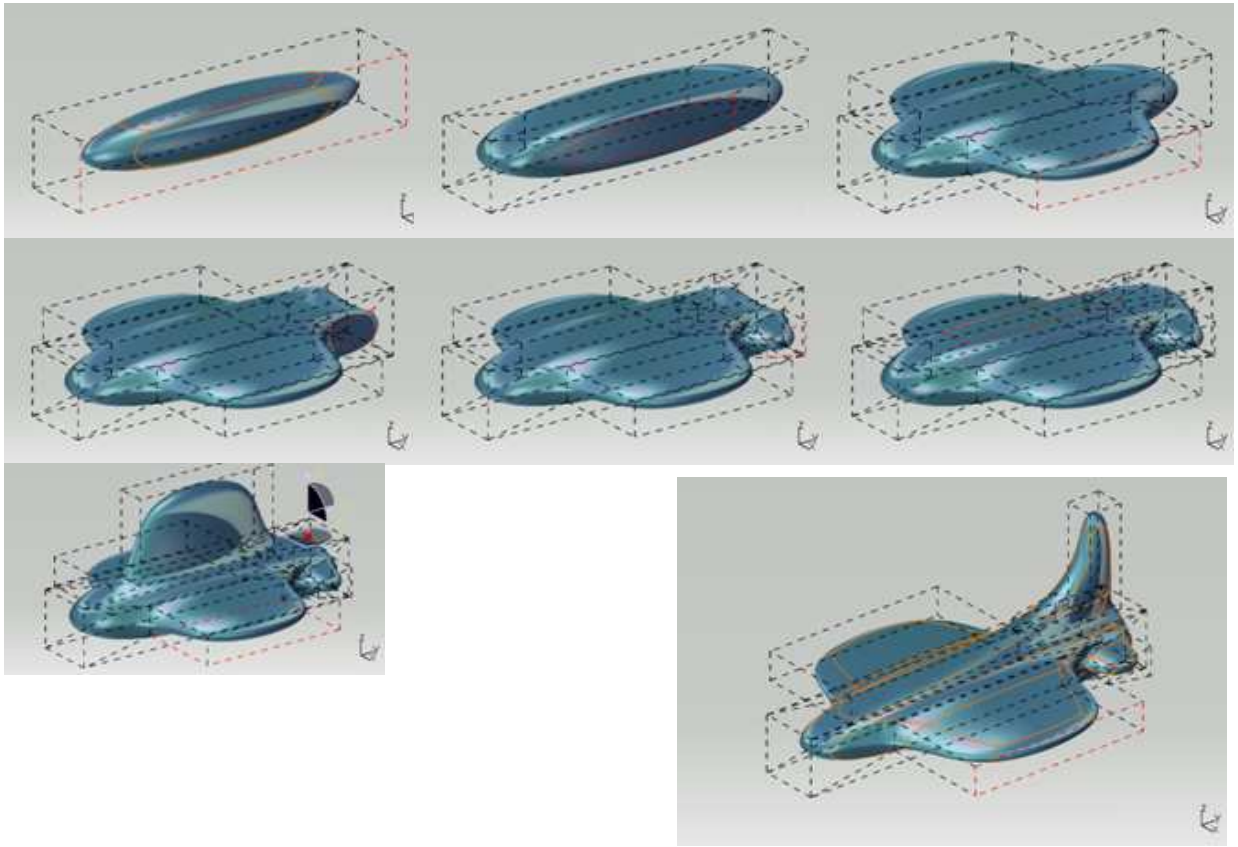


Student Notes:

General Methodology (6/7)

Student Notes:

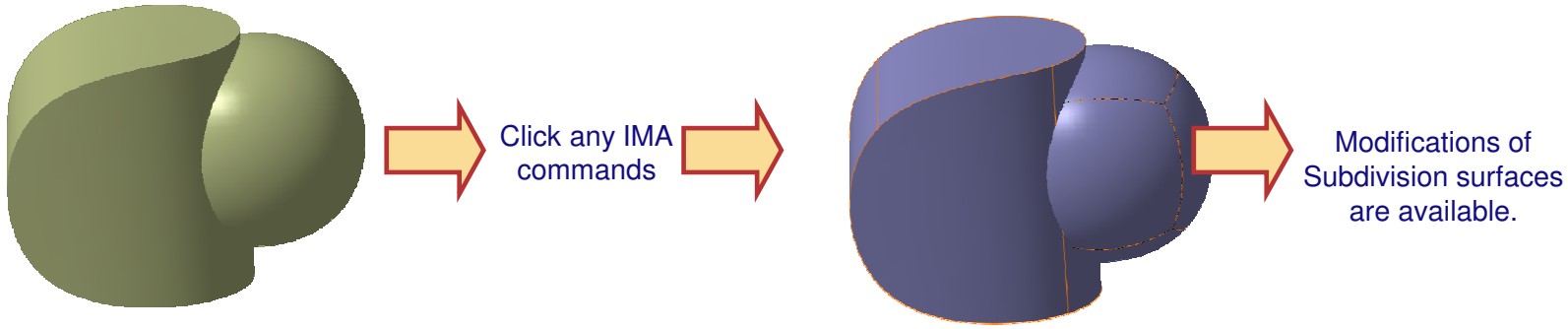
Example 3: Modeling a toy plane / Bad topology
This example shows a bad structure and the importance of this in the final shape.
The main body of the plane is made of one basic shape and subdivision and extrusion are used to add material. Since the main body is not divided into separate blocks it will be impossible to achieve the correct shape.



General Methodology (7/7)

Student Notes:

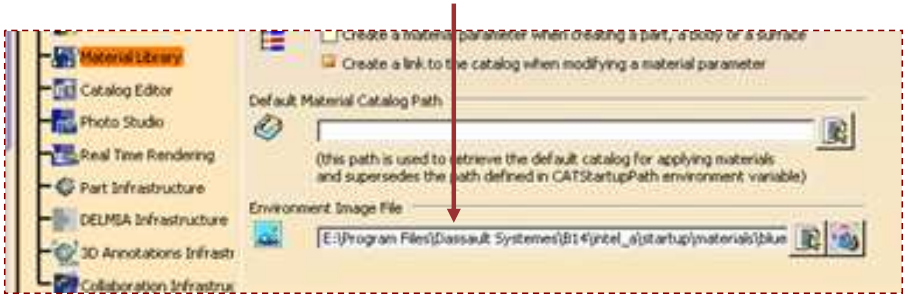
Smart selection
When selecting a feature and opening a command, all the feature's fathers (subdivision surfaces or styling curves) are temporarily highlighted to enable easy selection. The selected feature is also temporarily hidden. With this new behavior, you do not need to edit the subdivision surface in the specification tree.
Example:

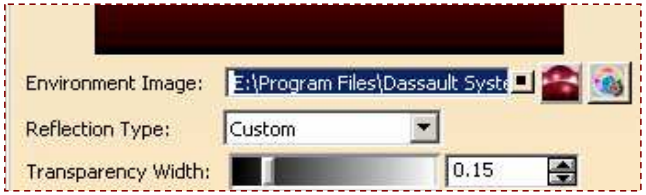


Student Notes:

Settings Management (1/2)

- Use materials with reflections, for example Painting.
- To have a nice reflection image on the material do the following:
  - Open Apply Materials catalog
  - Select Painting tab
  - Right-click « DS Dark Red » material
  - In Rendering tab click this icon
  - Copy the address
  - Close all dialog boxes
  - In Tools/Options/Infrastructure/Material Library paste the address in Environment Image File field



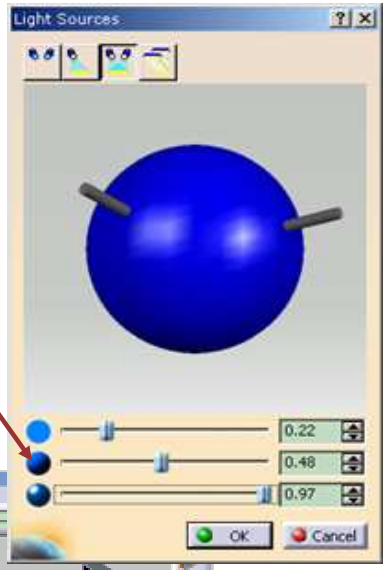


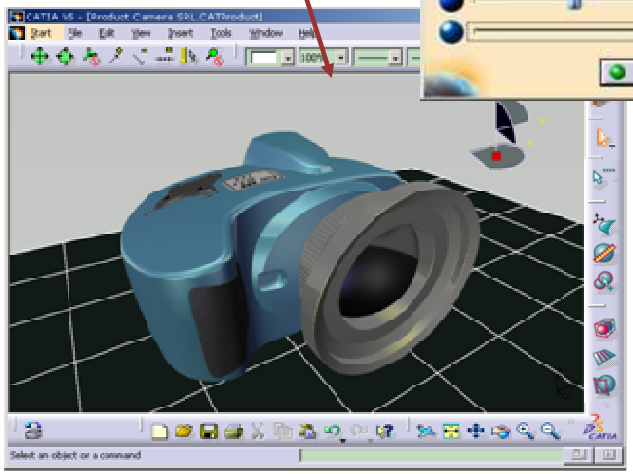
- Now apply any materials to the shape and if necessary increase the reflectivity value

Student Notes:

Settings Management (2/2)

- To improve the environment set the following:
  - Use two light sources with parameters similar to those shown.
  - Use a perspective view with an angle higher than 15° (default value) to inspect the geometry and to get a better feel for the shapes.
  - Use the ground in perspective view to get a better feel for the vanishing lines.





  - Use two windows if possible, one in parallel view and the other one in perspective and with the ground.
  - You can switch from one to the other one rapidly using Control-Tab keys.

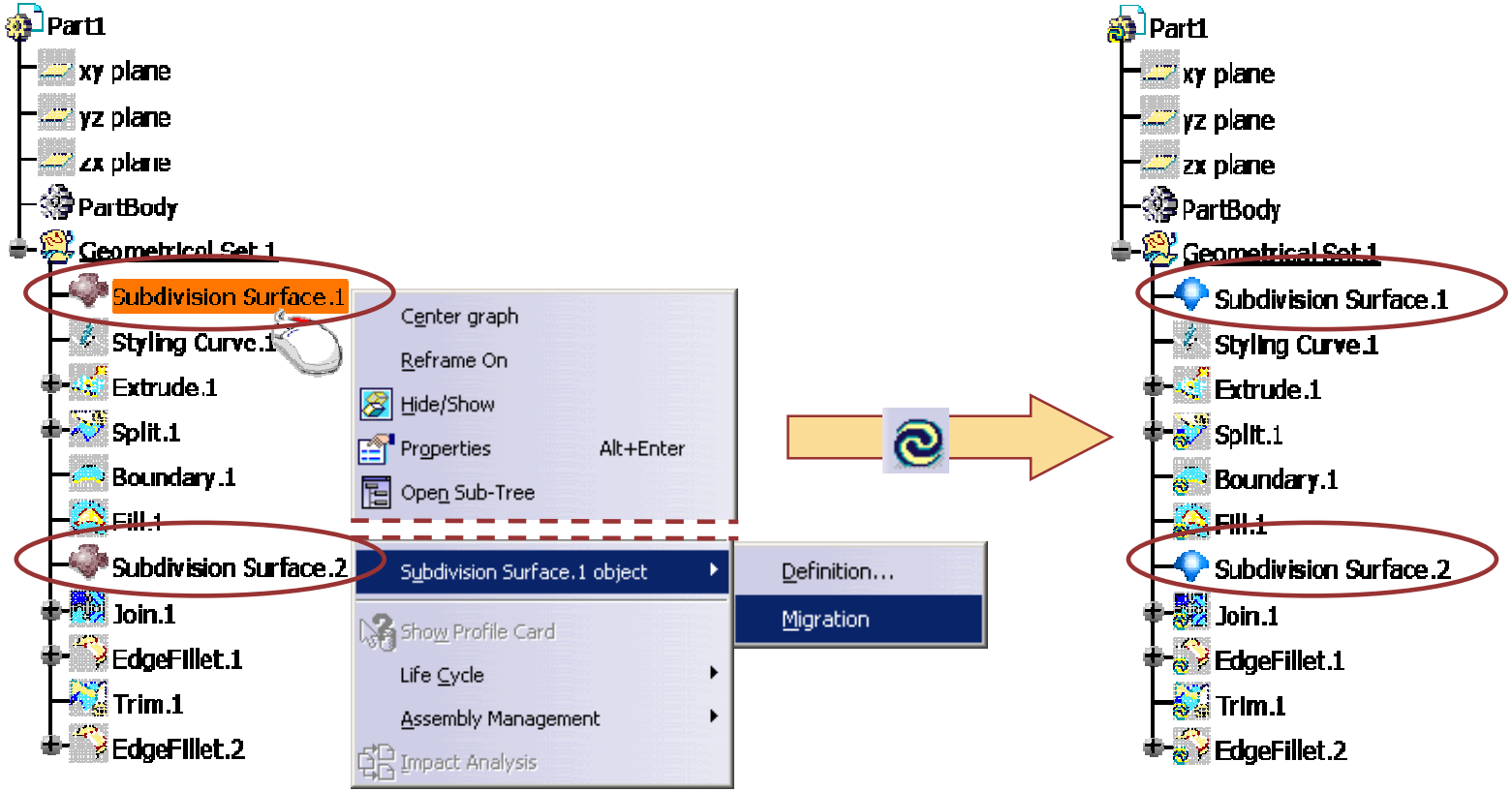
Student Notes:

Data Migration

In order to edit the subdivision surfaces created using CATIA level prior to R18, you need to migrate these surfaces. This can be achieved using the Migration command available in the contextual menu.

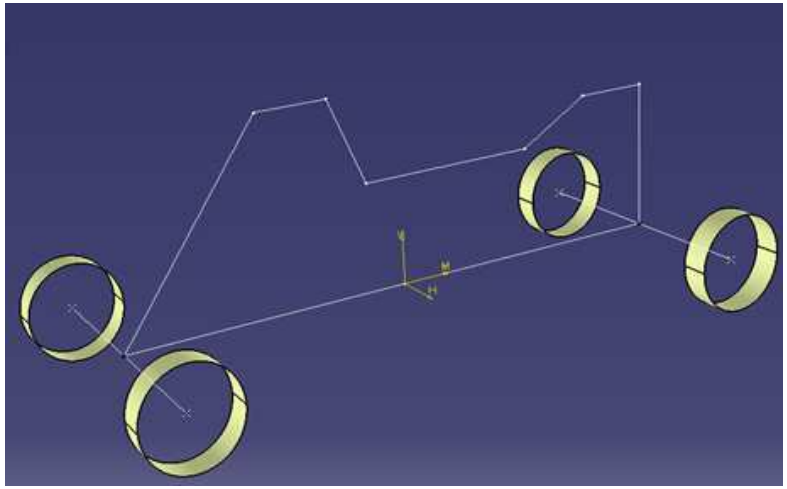
The old subdivision surfaces that need to be migrated are highlighted in brown color in the specification tree.

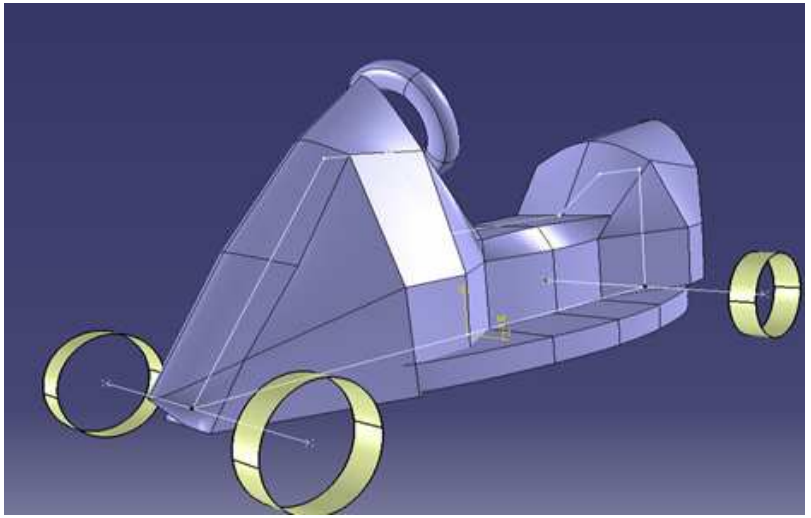
All the subdivision surfaces in the part are migrated to R18 level.



Size Management

- **To have a better indication of the size of your model you can create a light skeleton with some leading dimensions.**





Student Notes:

Tree Structure Management (1/4)

In order to simplify data management, store Styling surfaces in one Geometrical Set and perform operations in another. The styling surfaces are then easier to find and modify.

Avoid if possible the use of Ordered Geometrical Sets and PartBody containers to create Subdivisions or Styling Curves

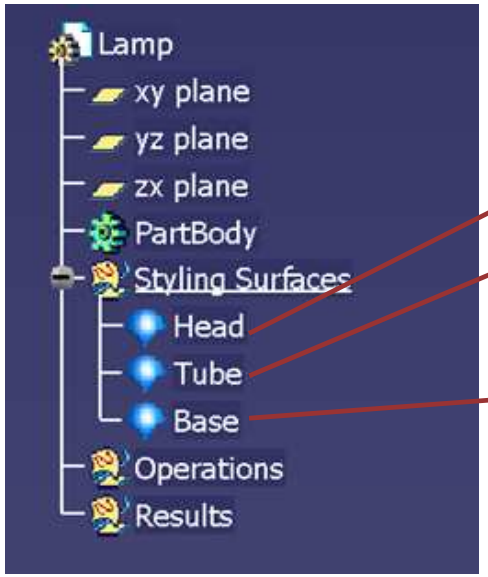
Example:

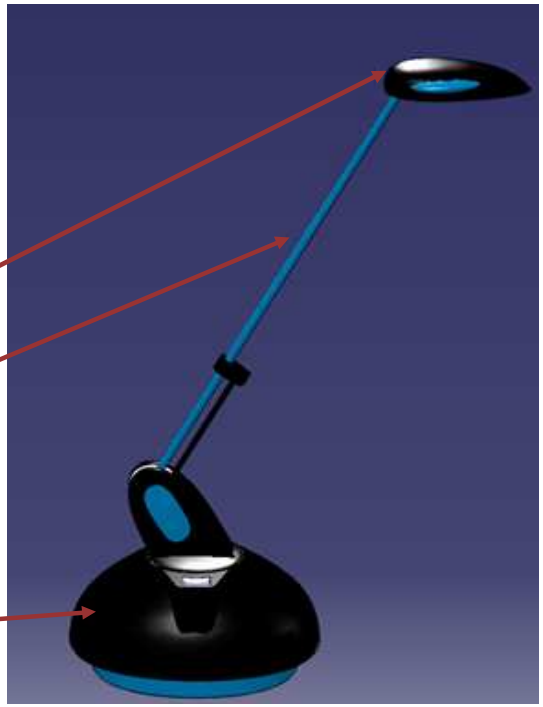
Create Three Geometrical sets: 

One for the Styling surfaces

One for the Shape operations

One to contain the results of the Shape operations



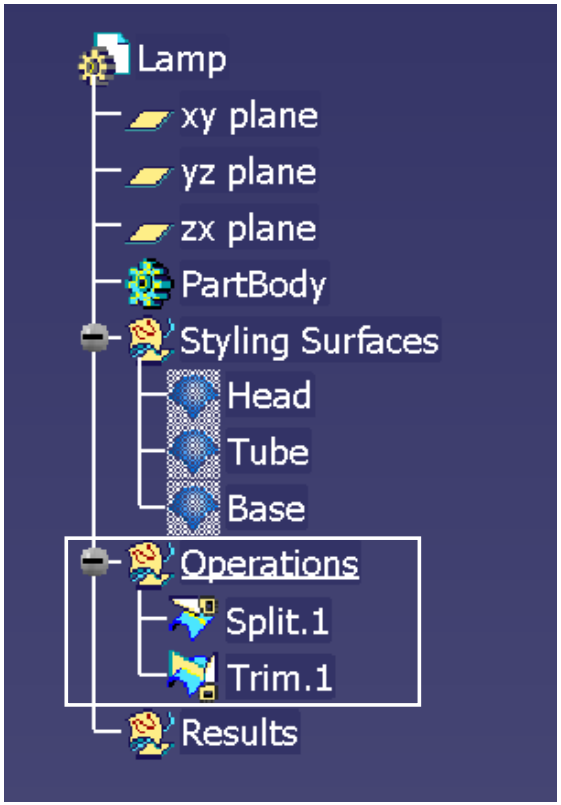


Student Notes:

Tree Structure Management (2/4)

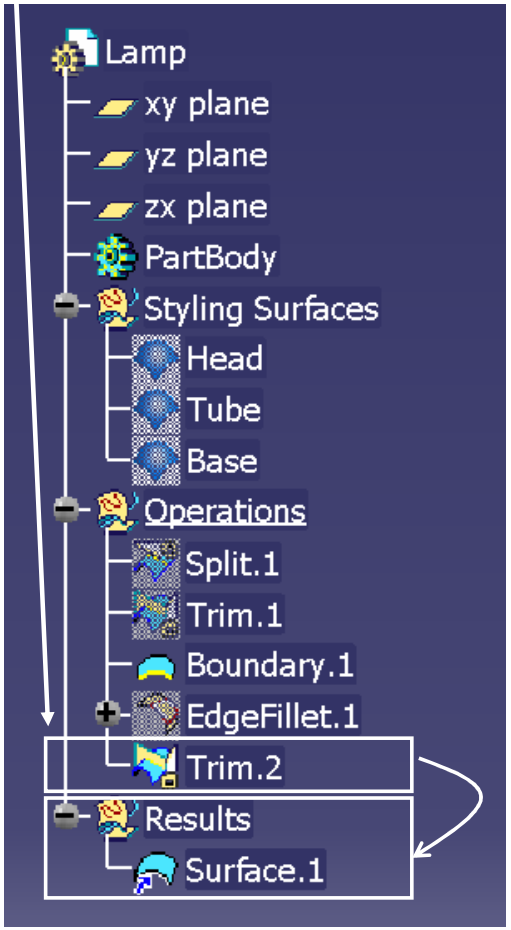
Student Notes:

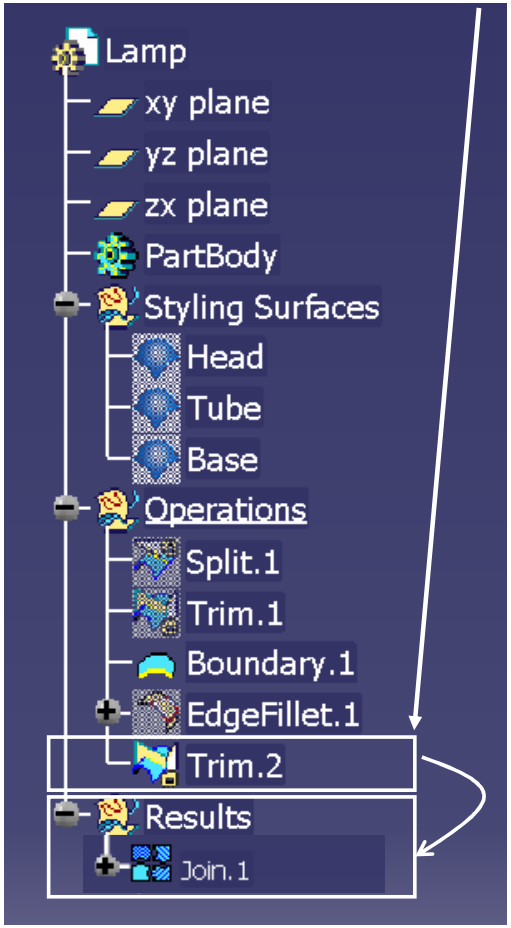
Do the Shape operations inside the Operations Geometrical Set



Tree Structure Management (3/4)

Copy the result with link of Shape operations inside the Results Geometrical Set, or create a Join containing the result. The access to key results is then faster and simple

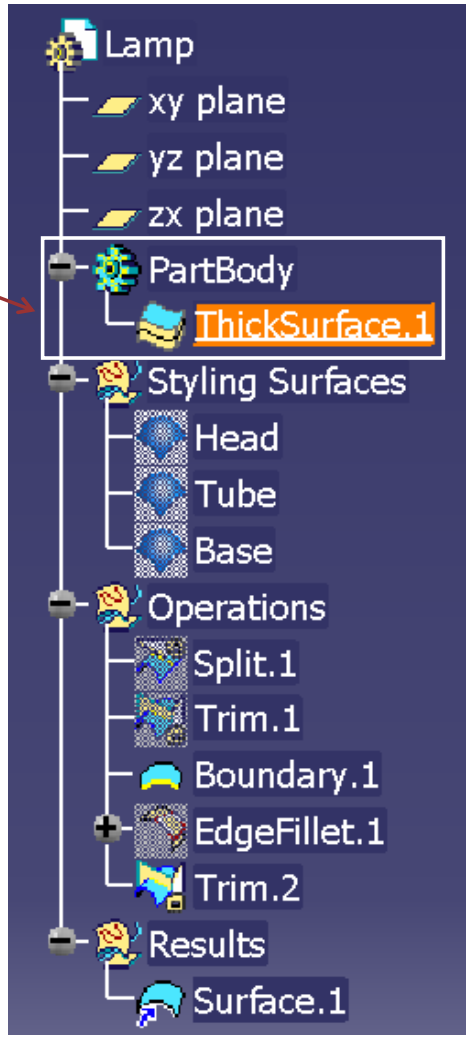




Student Notes:

Tree Structure Management (4/4)

“Solid” operations are created in the PartBody



Student Notes:

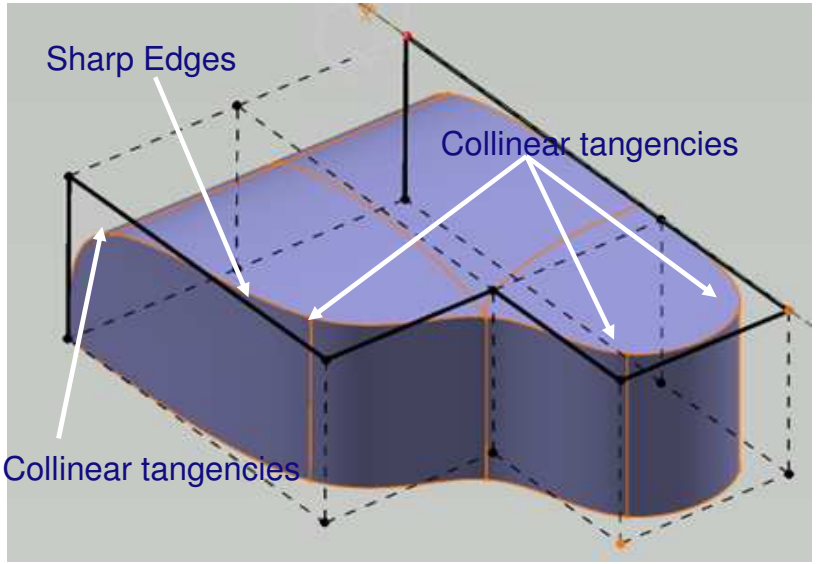
Quality management (1/4)

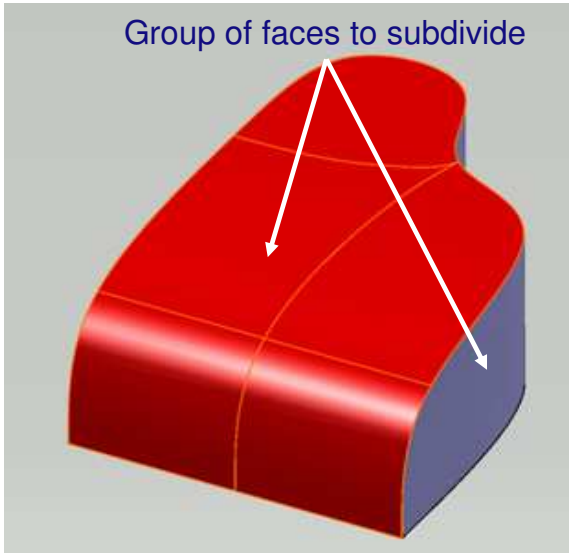
Student Notes:

There are a number of rules to apply in order to improve surface quality and ensure offset computation.

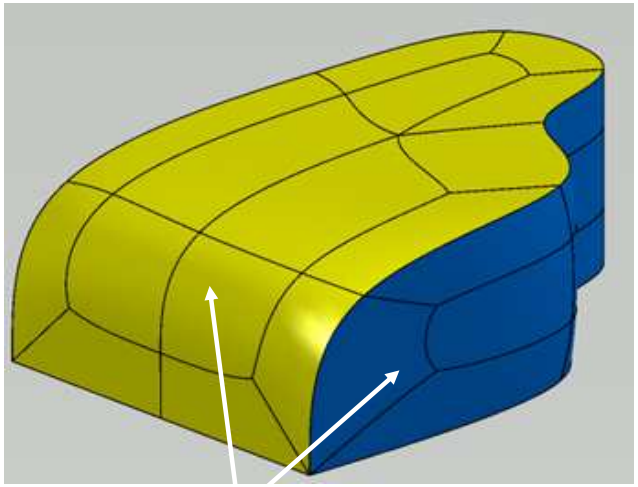
Subdivide sharp edged faces having collinear tangency corners.

In some cases and in order to simplify the mesh, delete unnecessary faces at the boundaries (see next slide)

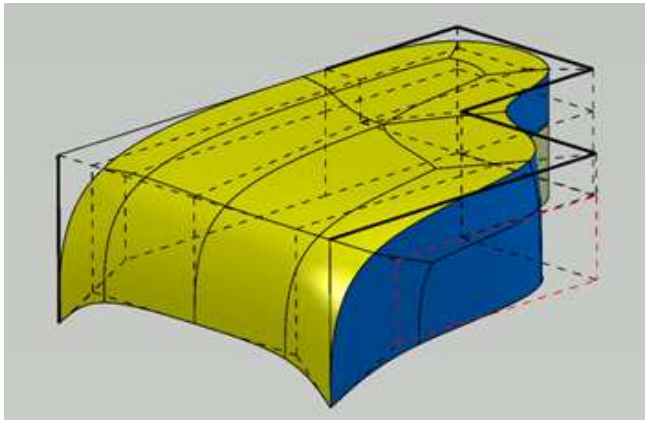




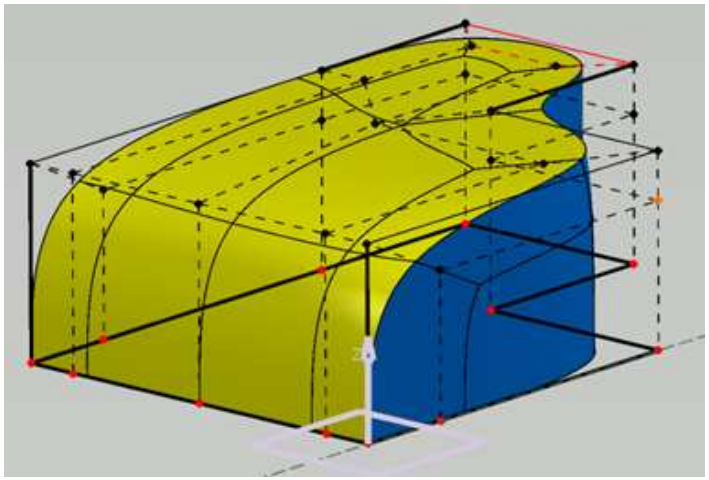
Quality management (2/4)



1 Subdivided group of faces



2 Suppression of unnecessary faces at the boundaries (in order to simplify the mesh)



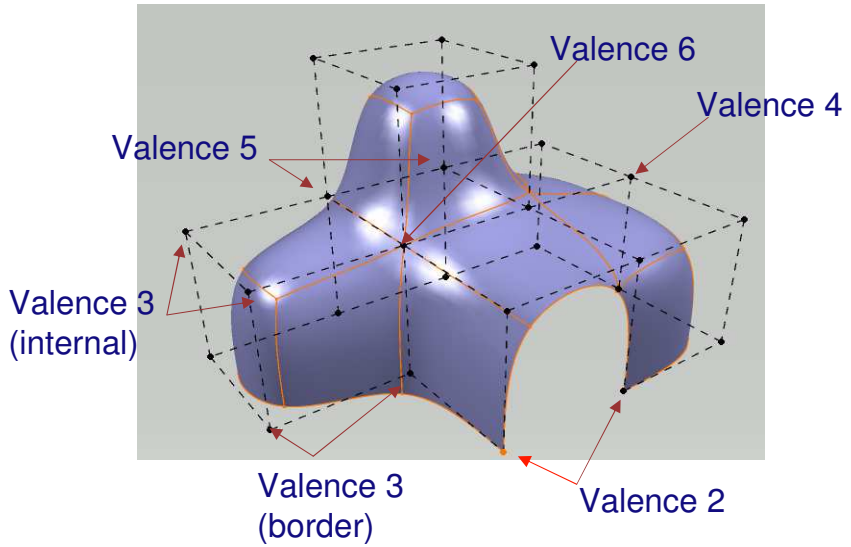
3 Refinement of boundaries (points alignment)

Student Notes:

Quality management (3/4)

Student Notes:

The Valence of a vertex corresponds to the number of connected edges
Example:

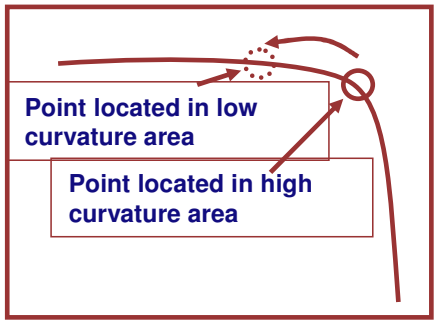


If Valence = « 4 internal » or « 2 border » or « 3 border » surface quality = C2
If Valence is different: the quality can be less (C1) but the surface can still be offseted.

Quality management (4/4)

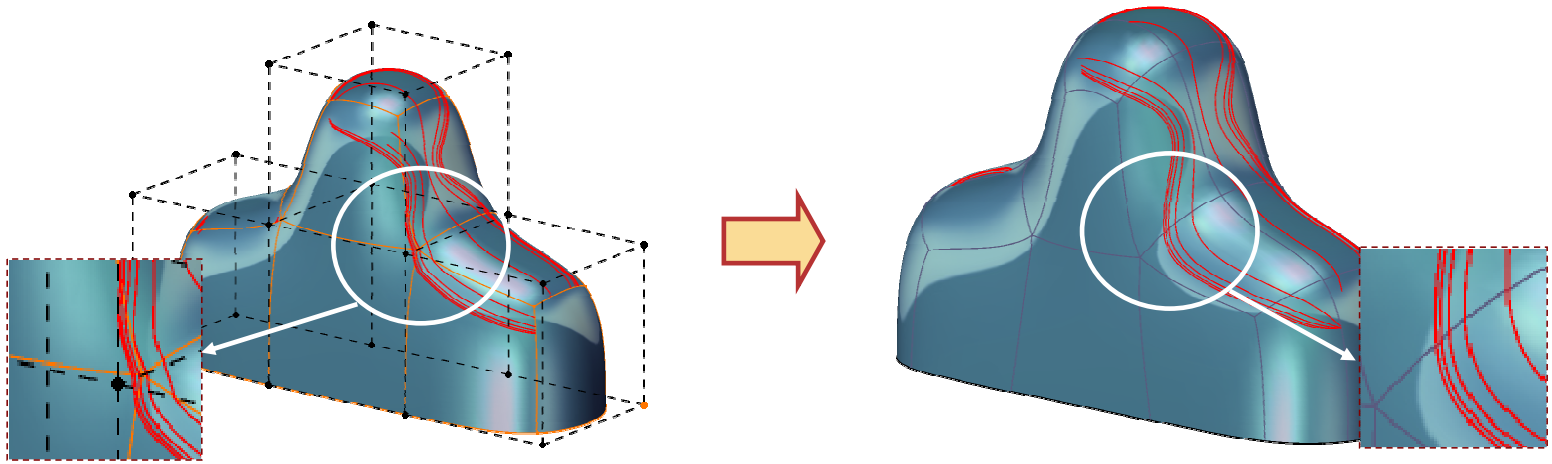
Example

The general idea is to move the « particular valence » points out of high curvature acceleration area



In a valence 5 case, very often managed in shapes, the shape located around the valence 5 vertices is not very good.

To improve this, subdivide the shape as illustrated and refine the mesh to get a similar shape. The surface quality is then better



Student Notes:

Student Notes:

Curvature

- An even distribution of points is necessary in order to obtain a good curvature.
- The first illustration shows a good mesh distribution, the shape is very smooth.
- The second illustration shows a non-homogeneous mesh distribution, the shape is wavy.