






Lesson 5: Surface Check Tools

In this lesson, you will learn to check a surface for its continuity and to repair its discontinuities. You will also learn about particularities of a molded surface and how to design an extractable part using the Generative Shape Design tools.

Lesson Contents:

-  **Case Study: Checking Surfaces**
-  **Design Intent**
-  **Stages in the Process**
-  **Surface Continuity Check**
-  **Surface Moldability Check**

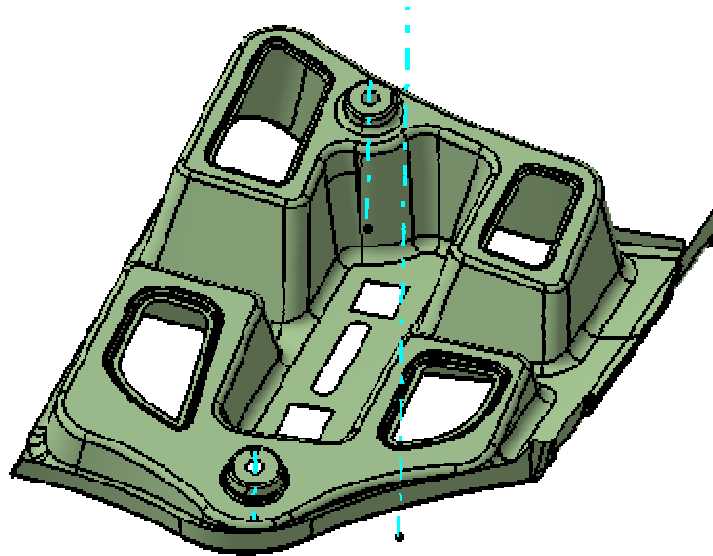
Duration: *Approximately 4 Hours*

Case Study: Surface Check Tools

The case study for this lesson is the Surface analysis of a plastic component. The focus of this case study is to analyze the geometric connections between the surfaces using different surface analysis tools. You will analyze the surface for its moldability using the draft analysis tool.

You will be given a set of CATIA V4 data, your goal is to make the part available for manufacturing. You will have to check the surface discontinuities, heal the surface and rectify the negative drafts to achieve the extraction of the part from the mold.

The focus of the case study in this lesson is to understand how to check and rectify the surface connections.

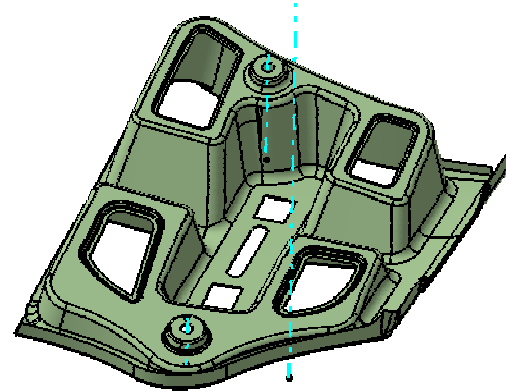


Student Notes:

Design Intent

The intent is to check the given V4 data for surface connections and analyze the draft on the surface for better moldability.

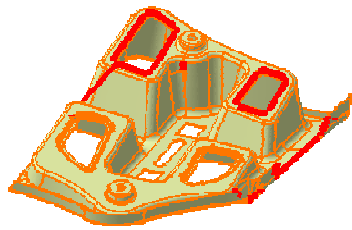
- ✓ Check the surfaces for gaps to ensure easy machinability.
 - Use surface connect checker.
- ✓ Check the surface for tangency and curvature continuity.
 - Use the Tangent and Curvature analysis options of surface connect checker.
- ✓ Check the draft on the surface for better extraction of the part from the mold.
 - Use draft analysis tool to measure the draft angle on the part features.
- ✓ Heal the discontinuities between the surfaces.
 - Use the heal tool to rectify the gaps and continuities between the tools.
- ✓ Replace the undercut faces by positive draft angle.
 - Create the drafted surface using suitable surface creation tools and replace the defective surface.



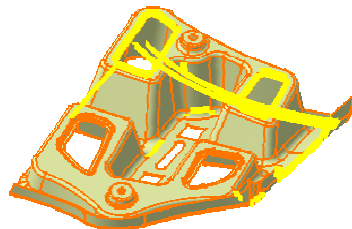
Stages in the Process

The following steps are used to perform the case study:

1. Check the surface for surface gaps
2. Check the surface for tangency discontinuities
3. Check the surface for curvature discontinuities
4. Perform the draft analysis
5. Heal the surface from discontinuity problems
6. Replace the undercut defective surface by a drafted surface



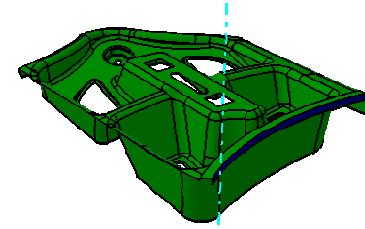
**Distance
Analysis**



**Tangency
Analysis**



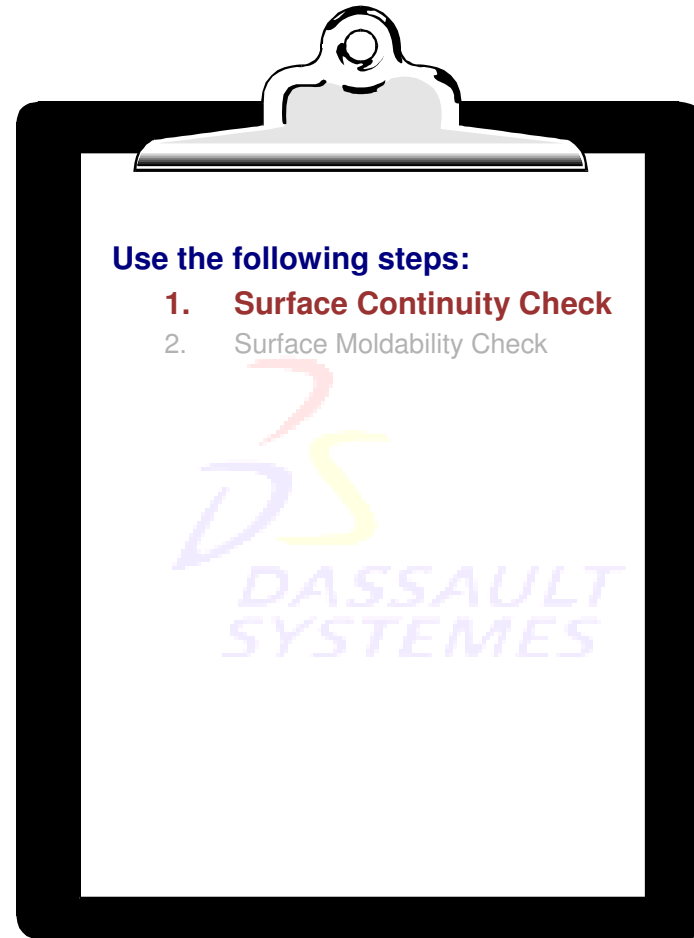
**Curvature
Analysis**



**Draft
Analysis**

Step 1: Surface Continuity Check

In this section, you will learn how to analyze the surface continuity using the Generative Shape Design tools.

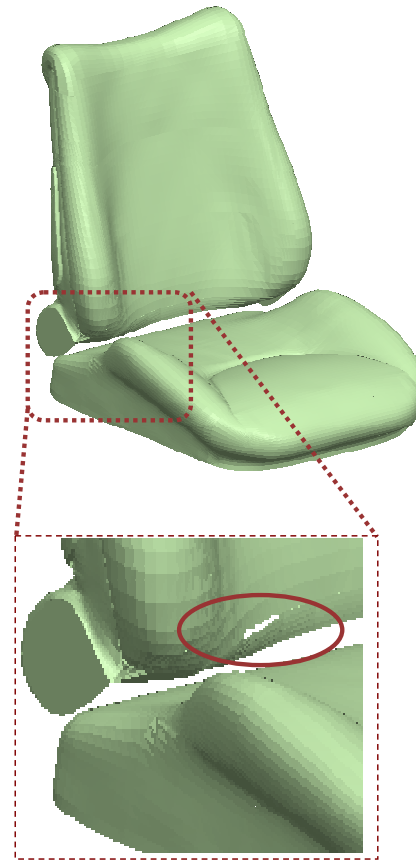


Why Do We Check Surface Continuity? (1/2)

Surfaces generated in CATIA V5 are likely to be good continuity surfaces. Surface continuity should be checked when you work with surfaces that are not created in CATIA V5. When Surfaces from CATIA V4 or other CAD packages are imported into CATIA V5, there could be some loss in geometry. All the surfaces may or may not get imported into CATIA V5, or may contain some defects after import.

So, you need to perform *surface connection* analysis between these surfaces, to check whether these surfaces are connected with the desired continuity and whether they have any gaps between them.

Also, when you use imported surfaces as parents to create new V5 surfaces, you need to ensure that there is a smooth transition between these surfaces and that there is no abrupt change or bump during transition, by performing *surface continuity* checks.

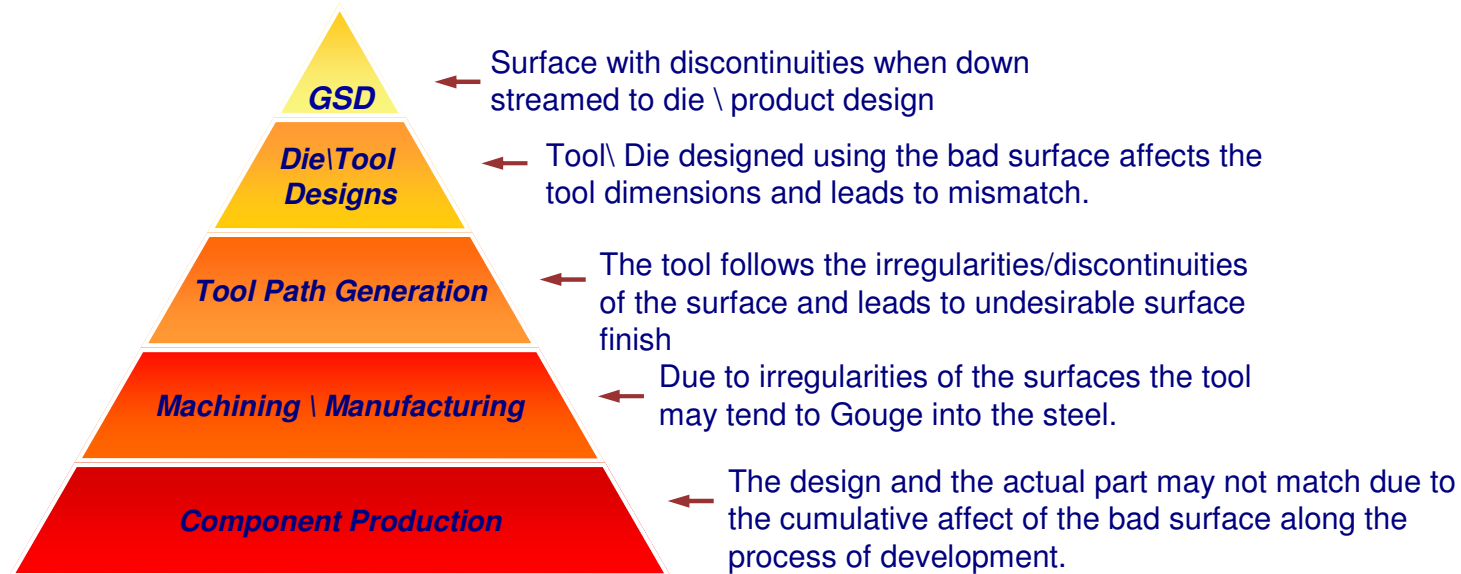


Student Notes:

Why Do We Check Surface Continuity? (2/2)

In an integrated CADD and Manufacturing system, the surfaces used to build the design models are processed at different stages of product development. The surfaces are used in Prototyping, NC Path Generation, Manufacturing, Quality Assurance and finally Production. The continuity of the surface has an impact over all these stages.

Let us take an example of a bad surface (having discontinuities) of automotive panel or a molded part surface being processed in manufacturing stream line.

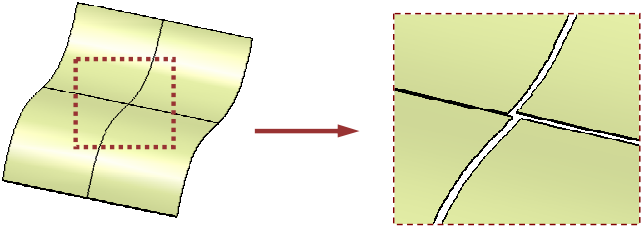
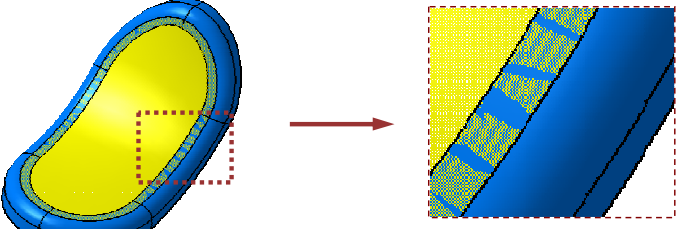
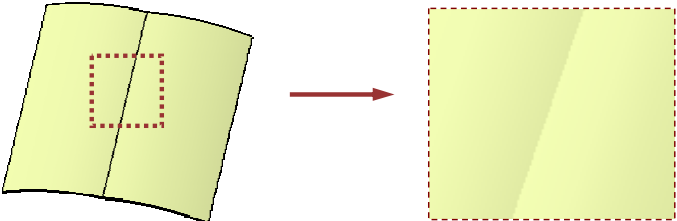


Thus, it is very important to check the continuity of the surface in any design. User has to understand the down stream applications of the surface and use proper tools to analyze the surface continuity.

Student Notes:

Flaws that can be Detected and Corrected (1/2)

The following table discusses the types of flaws which are commonly detected between surfaces.

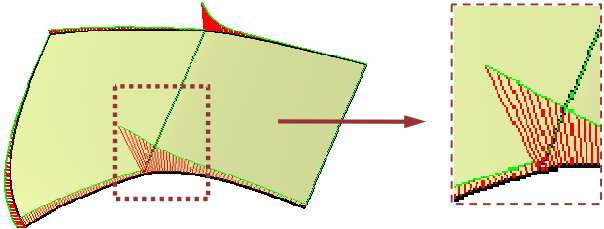
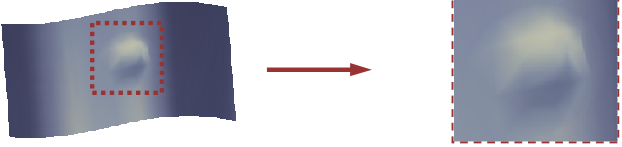
Fault Category	Description	Illustration
Surface continuity faults	Gaps between surfaces.	
	Overlapping surfaces.	
	Tangency and Curvature discontinuities.	

Student Notes:

Flaws that can be Detected and Corrected (2/2)

The following table discusses the types of flaws which are commonly detected between surfaces.

(continued...):

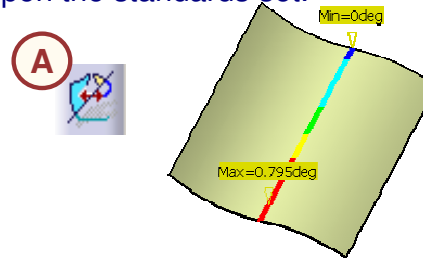
Fault Category	Description	Illustration
Irregular surface boundaries	Sharp variation in the surface boundaries.	
Surface Inflections	Formation of bump in the surface.	

Tools to Detect the Geometric Connection in Surfaces

The following analysis tools give you visual information, in the form of color codes, helping you to differentiate good areas from bad areas depending upon the standards set.

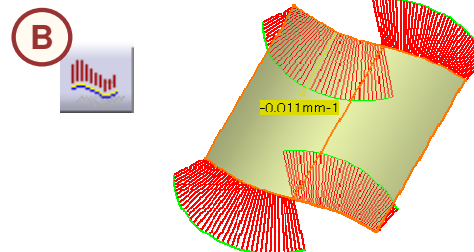
A. Tool to detect surface connection faults:

Connect Checker tool is used to check connections between two or more surfaces. The tool gives a measure of Distance (mm), Tangency (degrees), and Curvature (percentage) between the edges of the surfaces.



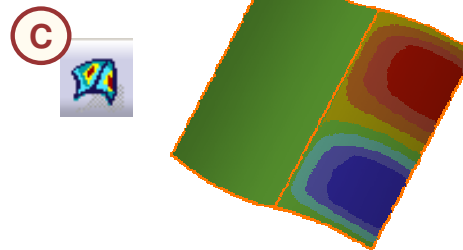
B. Tool to detect irregular surface boundaries:

Porcupine Analysis tool is used to detect the imperfections in the boundaries of a surface which cannot be seen with the naked eyes. The result is shown in the form of spikes.



C. Tool to detect surface inflections:

Surfacic Curvature analysis is used to detect curvature changes on a surface or group of surfaces.



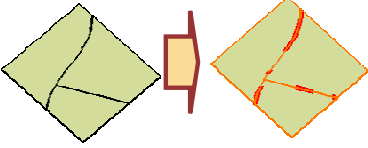
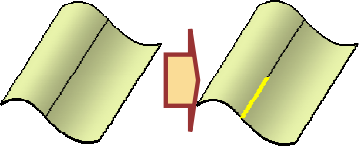
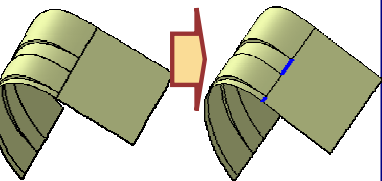
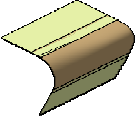
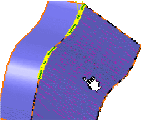
 **Let us see the Connect Checker and the porcupine analysis (L5.CATPart/CHECKS)**

Student Notes:

Introduction to Connect Checker Tool



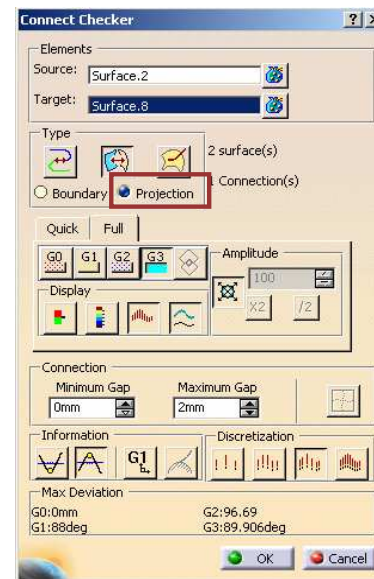
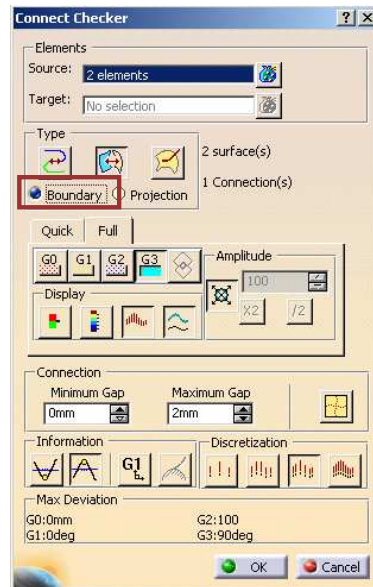
The following table describes the capabilities of the connect checker tool

Analysis Type	Description	Quick Analysis	Interpretation
Distance (G0)	The distance between the vertices of the surfaces is measured. If the distance is less than 1 micron, CATIA surfaces are considered continuous in Point.		The areas marked in RED highlight the gaps between 0.5 and Max value
Tangency (G1)	The angle between the surfaces at the connection is measured. If the angle is less than 0.5 deg, CATIA surfaces are considered continuous in Tangency.		The area marked in Yellow highlights the tangency discontinuities between 0.5deg and Max value
Curvature (G2)	The Curvature (1/R) difference at the connecting edges of the surfaces is measured. The curvature difference is measured using a formula and is expressed in percentage. The discontinuity range is between 0 – 200 %. Lesser the percentage, better the surface connection.		The areas marked in Blue highlight the curvature discontinuities of 200%
Overlap of surfaces	Checks overlap between surfaces.		An information saying '2 overlaps is detected' is displayed.
Internal Edges	Analysis can be done for the surfaces having internal edges (Two joined surfaces)		Analysis at the common edge in a single surface is displayed

Connection Analysis Using Connect Checker Tool

You can perform the following types of connection analysis using the Connect Checker tool:

- A. Boundary
 - a. Curve-Curve
 - b. Surface-Surface
- B. Projection
 - a. Curve-Curve
 - b. Surface-Surface
 - c. Surface-Curve



In 'Boundary' the connection analysis is performed between the boundary of elements.

In 'Projection' the connection analysis is performed between the boundary of one element and the projection of that boundary on another element.



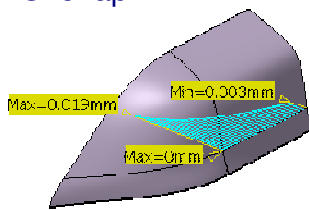
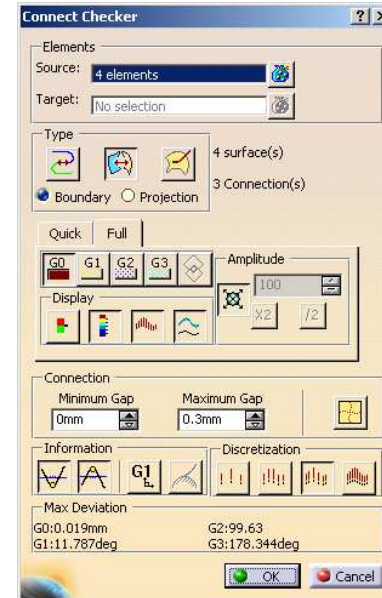
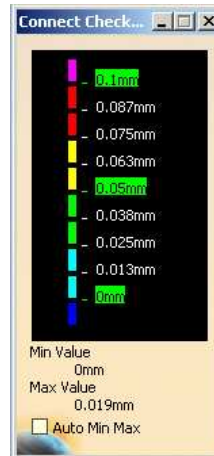
Target option is available only for 'Curve-Curve Connection' and 'Surface-Surface Connection' in Projection mode.

Connection Analysis in Boundary Mode

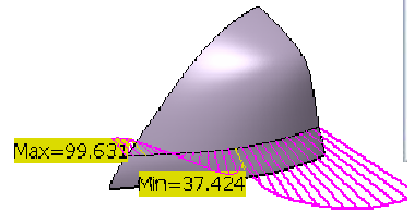
The Boundary mode of analysis allows you to perform the analysis between the edges of the surfaces.

The Connect Checker allows the user to examine:

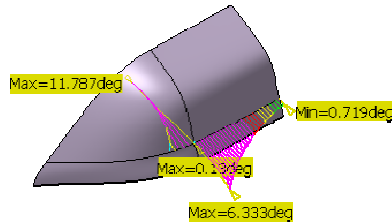
- Distance (G0 continuity) in mm
- Tangency (G1 continuity) in deg
- Curvature (G2 continuity) in deg
- Curvature-Tangency (G3) in deg
- Overlap



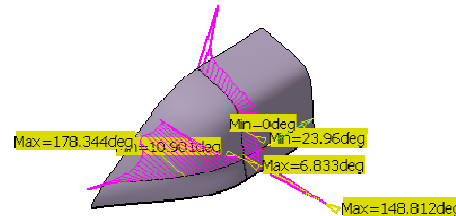
G0 analysis



G2 analysis



G1 analysis



G3 analysis

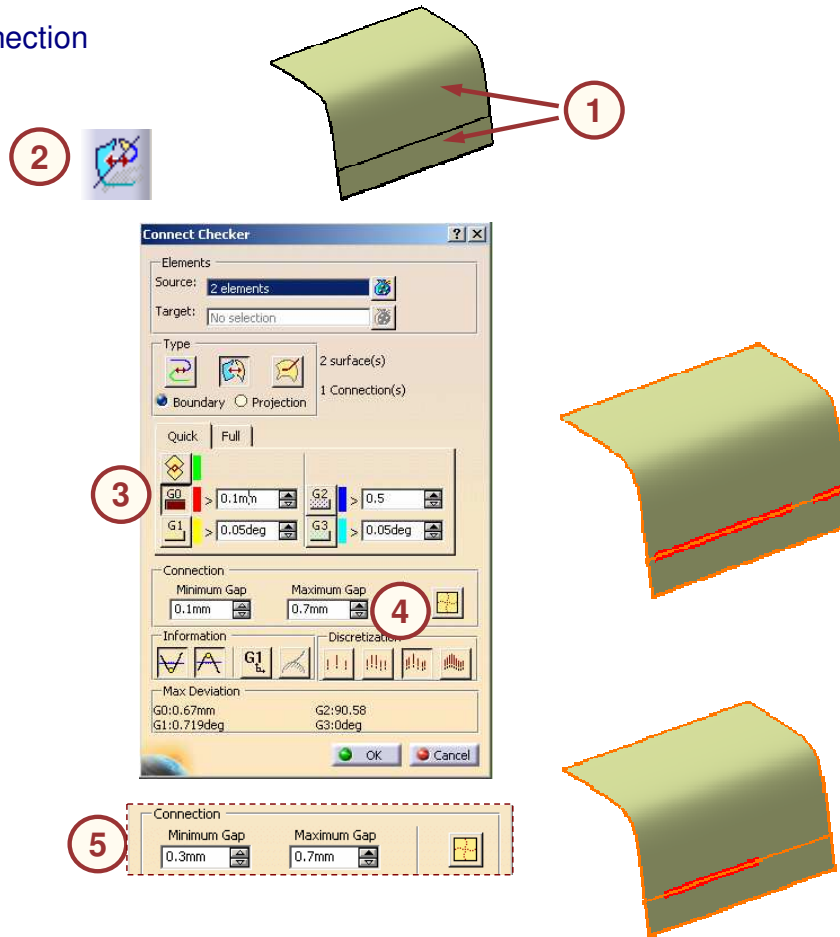
Analyzing Surface Connections in Boundary Mode (1/3)

Use the following steps to perform Quick connection analysis

1. Multi-Select the two surfaces between which you would like to check the connection.
2. Select the connect checker icon.
3. Choose the analysis type: You will perform distance analysis(G0).
4. Set the maximum gap to 0.7 mm. This gap represents the maximum permissible gap between the surfaces.

The Quick Analysis displays the maximum gap of 0.67mm between the surfaces.

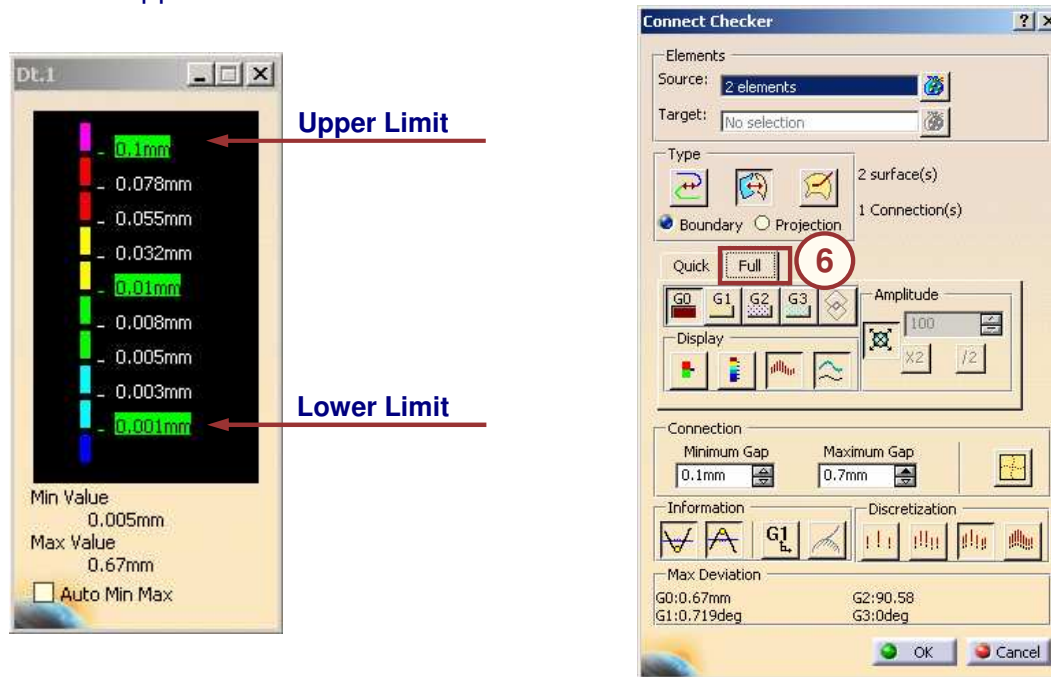
5. Define the tolerance range between 0.3mm - 0.7 mm. Observe that only areas which have values between this range are highlighted in RED.



Analyzing Surface Connections in Boundary Mode (2/3)

Use the following steps to perform Detailed connection analysis (continued...):

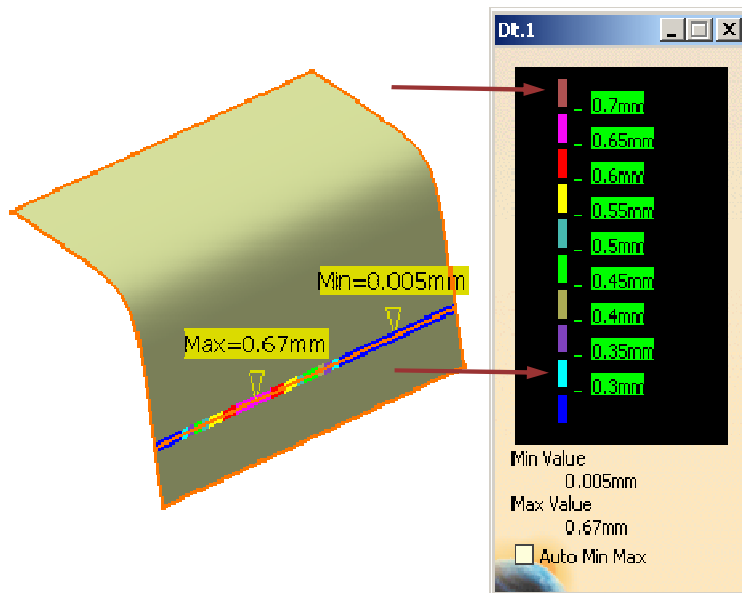
- Switch to Full Analysis mode. The analysis shows the default color ranges and default tolerance range. Observe that the lower limit is 0.001 mm and upper limit is 0.1 mm.



Analyzing Surface Connections in Boundary Mode (3/3)

Use the following steps to perform Detailed connection analysis (Continued).

7. Double-click on the values to define new ranges to customize the tolerance range to suit your requirement. That is from 0.3 mm to 0.7mm (and not from 0.001 mm to 0.1 mm).
8. Similarly, re-define all the values for the analysis.
9. Modify the color of the Analysis, by right-clicking on that particular color



8



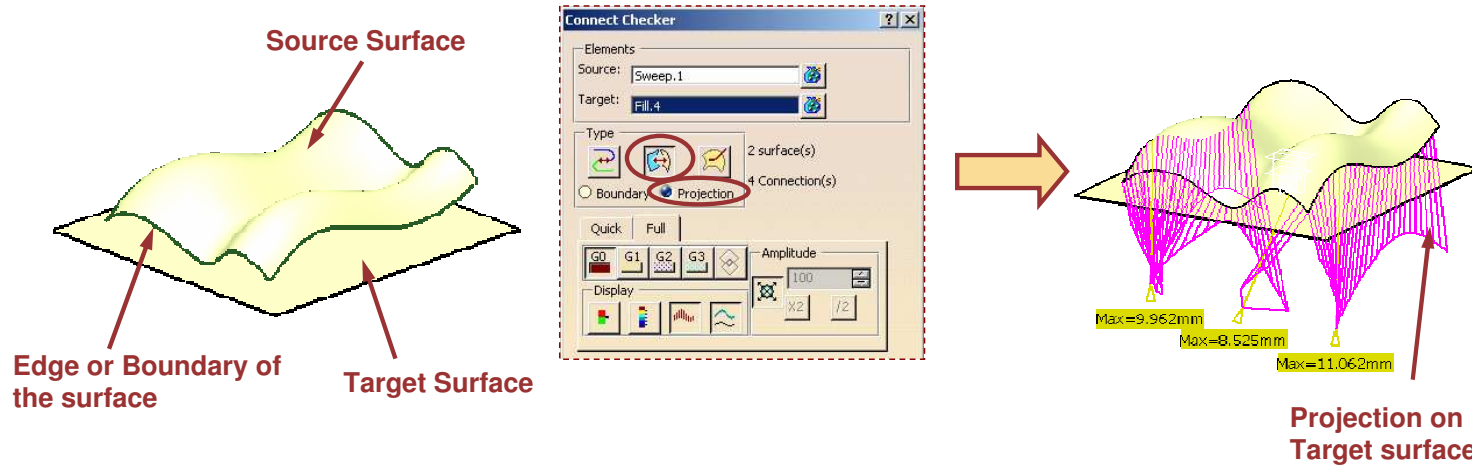
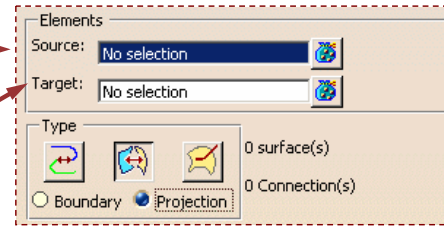
Connection Analysis in Projection Mode (1/2)

Surface-Surface Connection Analysis:

The Projection mode for Surface-Surface analysis allows you to directly project the boundary or edge of the first selected surface, onto the second surface. The analysis is then performed between this source border and its projection on the second surface.

The surface selected first is the 'Source' surface. The edge or boundaries of this surface will be projected on the other surface.

Similarly, the surface selected second is the 'Target' Surface.



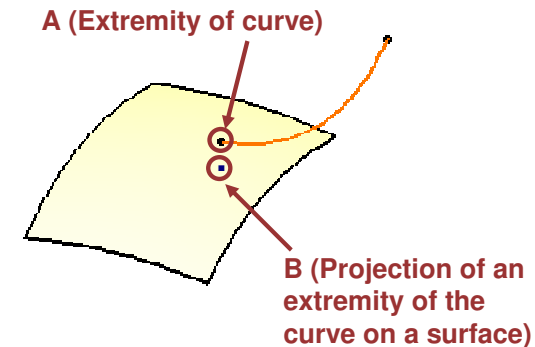
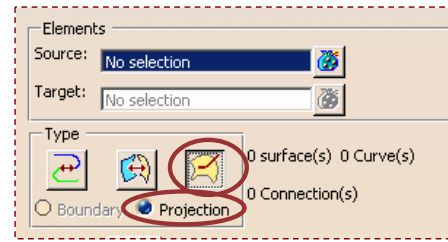
Connection Analysis in Projection Mode (2/2)

Surface-Curve Connection Analysis:

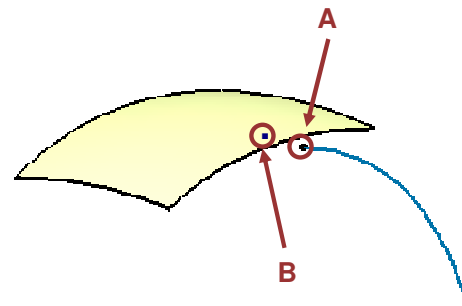
The Surface-Curve connection analysis is performed only in the Projection mode. Here, the connection analysis is done between extremity of the curve and projection of that extremity on a surface.

Let us understand this with the help of an example:

In this case, A is the extremity of the curve, and B is the orthogonal projection of A on a surface. The connection analysis will show the discontinuity values between them.



Projection of an extremity of the curve vertically

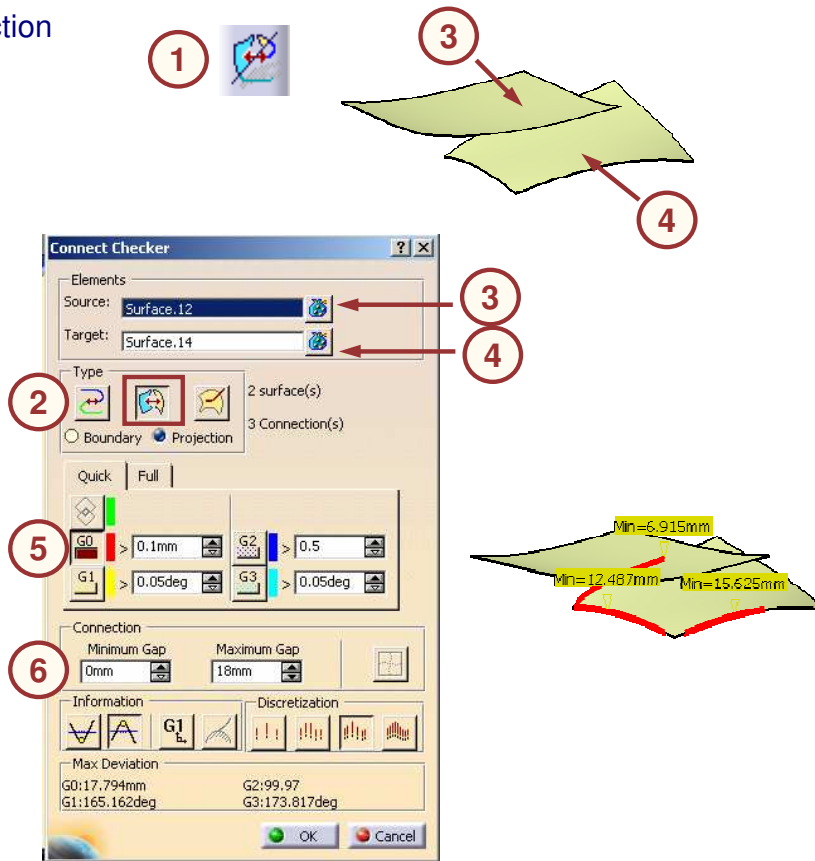


Projection of an extremity of the curve horizontally

Analyzing Surface Connections in Projection Mode

Use the following steps to perform Quick connection analysis in Projection mode:

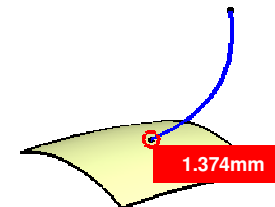
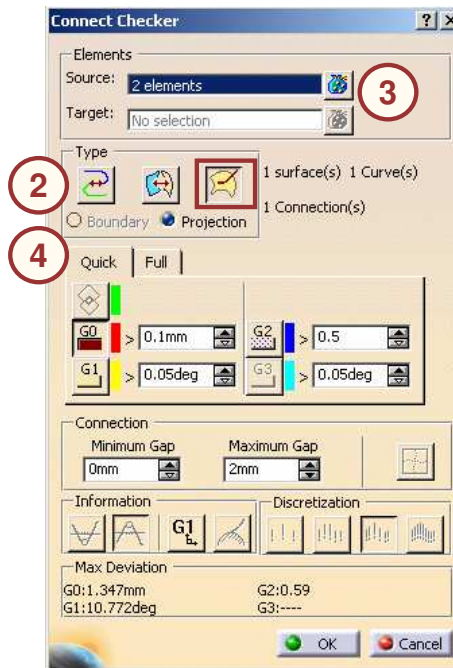
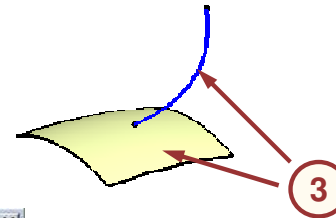
1. Select the **Connect Checker** tool.
2. Select the Surface-Surface connection analysis type and the Projection mode.
3. Select the Source text box and the source surface respectively.
4. Select the Target text box and the target surface.
5. Click the Quick button and select the analysis type: You will perform Distance analysis (G0).
6. Set the maximum gap to 18 mm. This gap represents the maximum permissible gap between the surfaces.
The Quick Analysis displays the maximum gap of 17.4mm between the surfaces.
7. Click **OK** to retain the results of the analysis.



Analyzing Surface-Curve Connections

Use the following steps to perform Quick connection analysis in Projection mode:

1. Select the **Connect Checker** tool.
2. Select the Surface-Curve connection analysis type. (Projection mode will be automatically selected).
3. Select the Source surface and the curve.
4. Click the Quick button and select the analysis type: You will perform Distance analysis (G0).
5. Set the maximum gap to 2mm. This gap represents the maximum permissible gap between the surface and the curve.
The Quick Analysis displays the Max. actual gap of 1.347mm.
6. Click **OK** to retain the results of the analysis.



Performing Porcupine Analysis on Surfaces

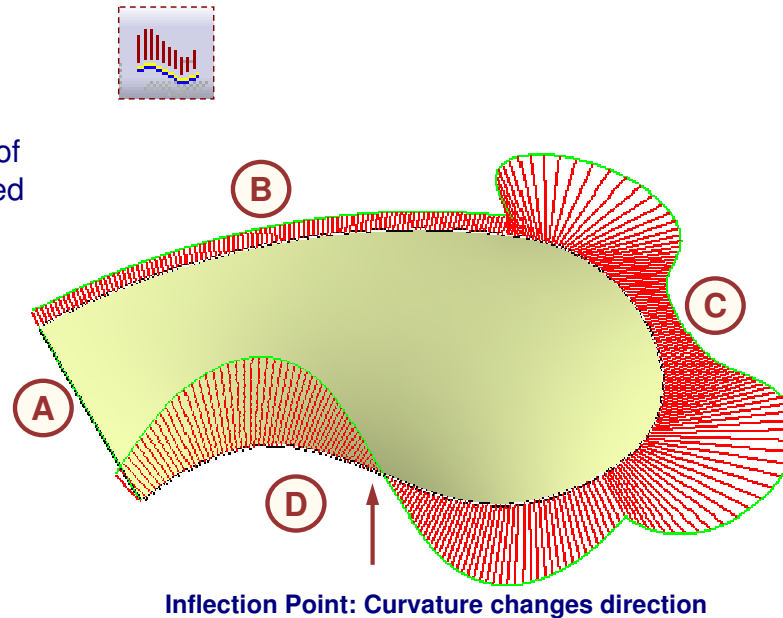
Porcupine Analysis tool helps to identify imperfections on surface boundaries. The analysis displays spikes normal to the boundaries.

The magnitude of the spikes is based on the value of the curvature at each point and the direction is based on the curvature direction at that point.

An inflection point occurs every time the curvature changes its direction (a bump in the curve).

Interpretation at different edges:

- A. Boundary at this edge is a straight line hence no spikes are displayed.
- B. Boundary at this edge is curvature continuous, with the curvature remaining constant throughout.
- C. Boundary in this area is continuous in curvature with smooth variation in the curvature's magnitude.
- D. Boundary here changes direction of the curvature, hence you can see a inflection point.

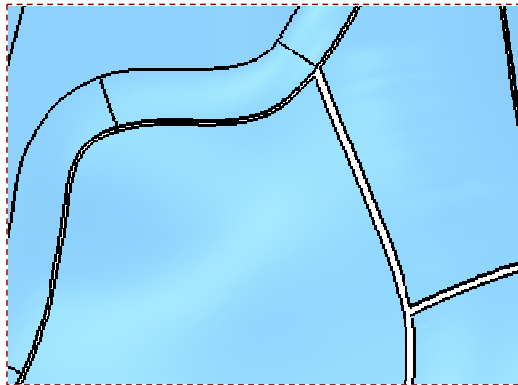


Student Notes:

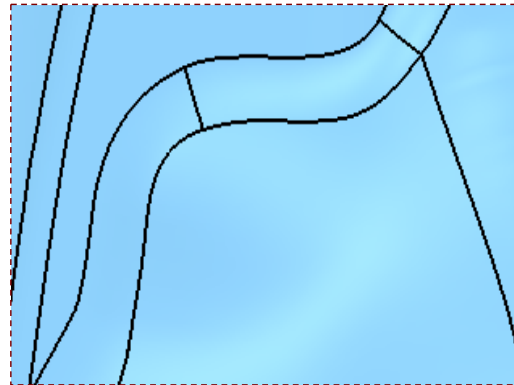
Correcting Defects in Surfaces with Healing

The Heal tool is used to correct the defects (gaps, continuity problems) found by performing an analysis between the surfaces. Heal deforms the surface to fill up the gaps and reduces the tangency and the curvature discontinuities.

Healing is a process by which one surface is deformed at a boundary to form a smooth transition into another surface. It will mathematically deform the shape of the surfaces at boundary areas so that they smoothly blend into one another.



Before Healing



After Healing



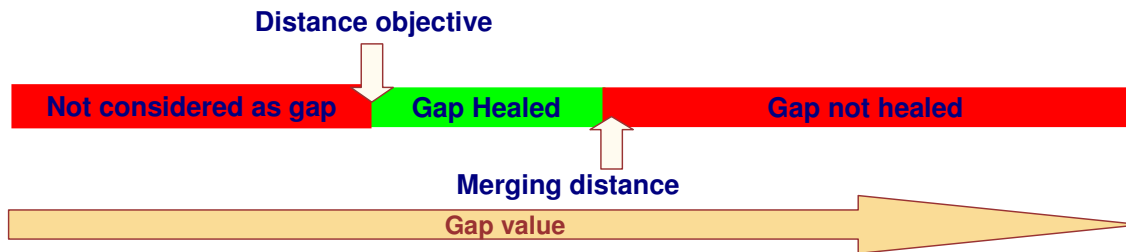
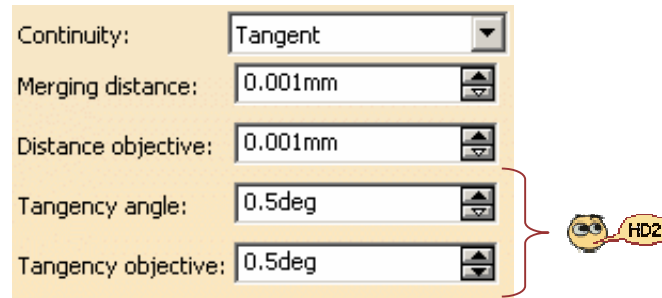
Let us see the healing tool
(L5.CATPart/HEAL)

Healing Parameters

To heal the surfaces, you need to enter healing parameters. These parameters are threshold values and should be deduced from the results of the analysis.

Parameters allow you to:

- A. Define the discontinuities which are important and must be healed. To heal these discontinuities, **merging distance** and **tangency angle** parameter values must be greater than the maximum value you get from the connect checker analysis.
- B. Define the discontinuities which are not important and must not be healed. The magnitude of **distance objective** or **tangency objective** parameters must be set less than the discontinuity that you desire to heal. In other words, discontinuities less than these values are not considered as gap.



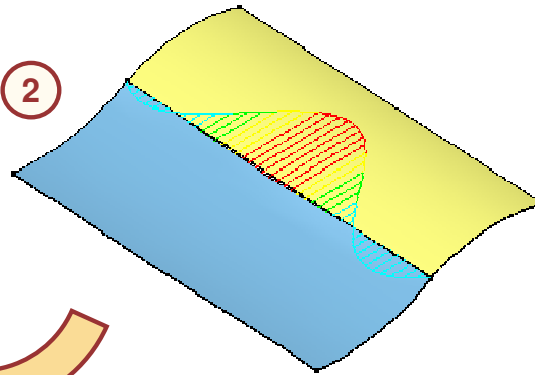
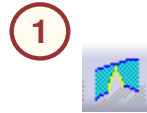
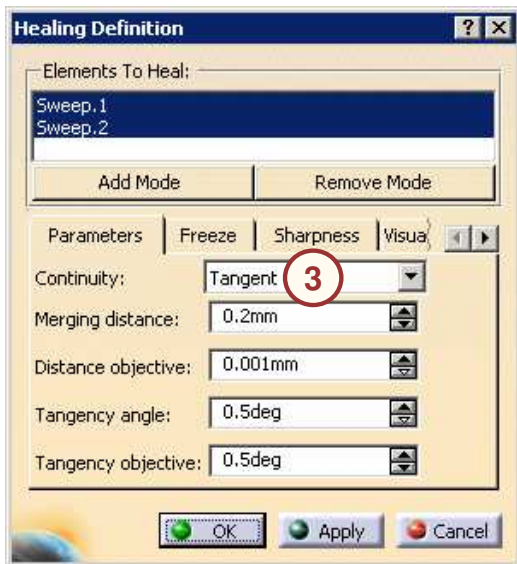
Hence, the tool will heal the gaps in the band mentioned between Distance objective and Merging distance.

Healing Surfaces (1/2)

Healing is done to correct deformities pointed out by connect checker tool between surfaces.

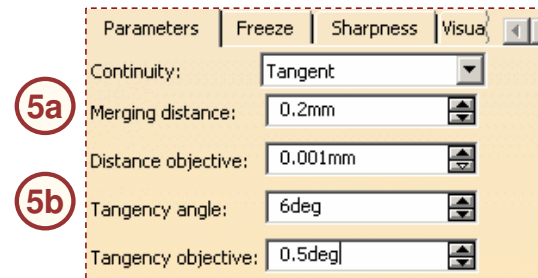
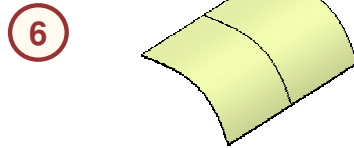
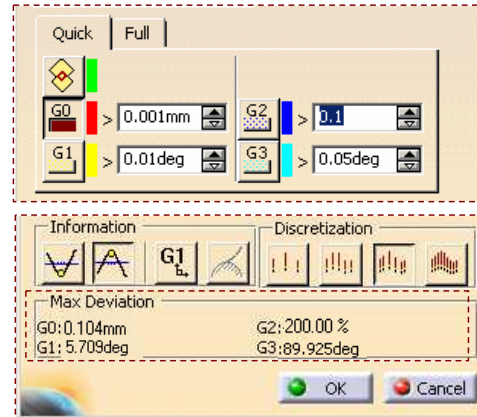
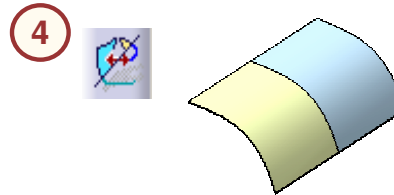
Use the following steps to Heal surfaces

1. Select the Healing icon
2. Select the surfaces to heal
3. Choose the type of discontinuity you want to heal. Here Tangency discontinuity is selected.



Healing Surfaces (2/2)

4. To fill in the parameters for healing, edit the connect checker analysis. The results of the connect checker analysis will help you to choose the parameter values.
5. Set:
 - a. Merging distance: 0.2mm
 - b. Tangency angle: 6 deg in field
6. Click **OK** to confirm the healing operation. Now re-perform connect checker analysis. It gives the following results:



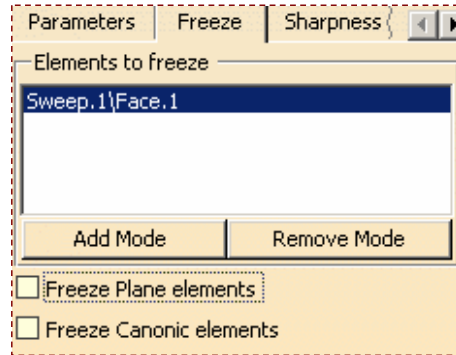
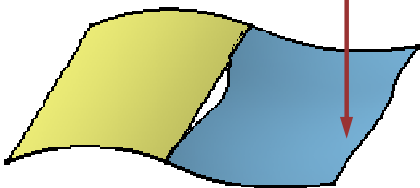
Student Notes:

Impact of Healing Operation on Surface

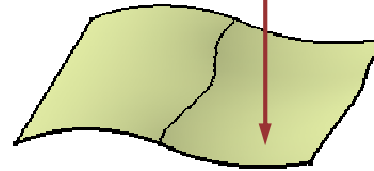
When you heal surfaces, these surfaces get physically deformed so that they perfectly blend into each other respecting the continuity constraints.

You have the option to protect surfaces from deformation by freezing them. These frozen surfaces do not deform, but other surfaces involved in the process are deformed and adjust themselves so that they flow smoothly into the frozen surfaces respecting the constraints.

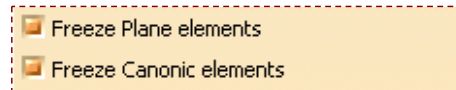
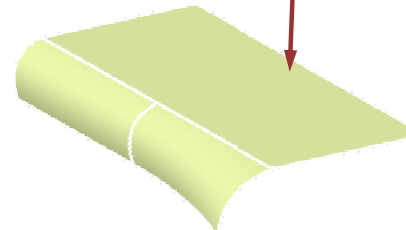
You can choose to freeze any face you want



This face have been left unchanged.



This plane face have been left unchanged.



Exercise 5A-Start

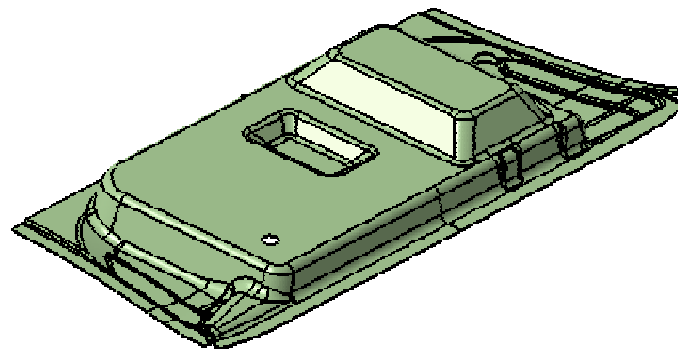
Recap Exercise



In this exercise, you will practice the tools to check surface connections in Generative Shape Design workbench. Detailed instructions are provided to perform this exercise.

By the end of this exercise you will be able to :

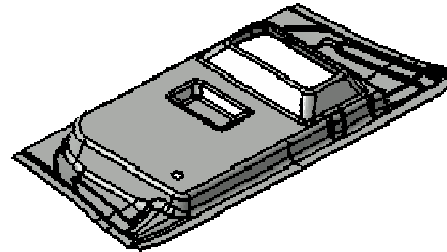
- Check the surfaces for gaps using the Distance option in surface connection checker.
- Check the tangency and curvature continuities between the two surfaces
- Heal the surfaces



Exercise 5A-Start (1/4)

1. Open the part file.

- Open an existing part file. The file consists of V4 surfaces of a sheet metal part.
 - a. Browse and open part:
Exercise_5A_Start.CATPart



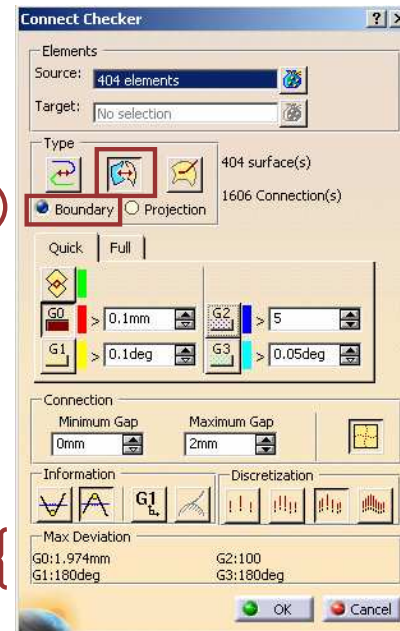
2. Perform the surface gap analysis on a given set of surface.

- a. Select the **Connector Checker** icon.
- b. Select the **Surface-Surface Connection** type and check the Boundary check box.
- c. Select the surfaces to analyze the continuities. (You can select the Geometrical set containing all V4 surfaces).

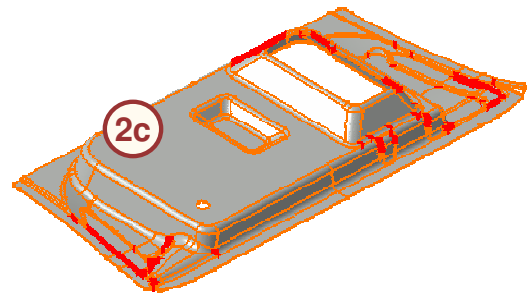
2a



2b

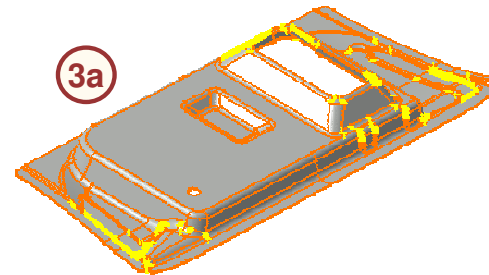


Maximum Discontinuity values



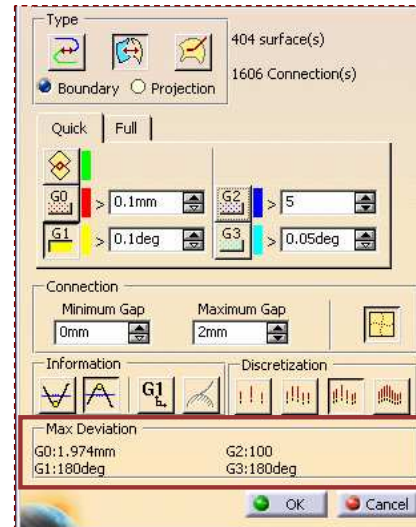
Exercise 5A-Start (2/4)

- d. Select the Quick button in Connect Checker Dialog box.
- e. Select the G0 option. Specify the value as 0.1mm. The gaps bigger than the specified values are highlighted in red.
- f. Note the maximum gap on a part.



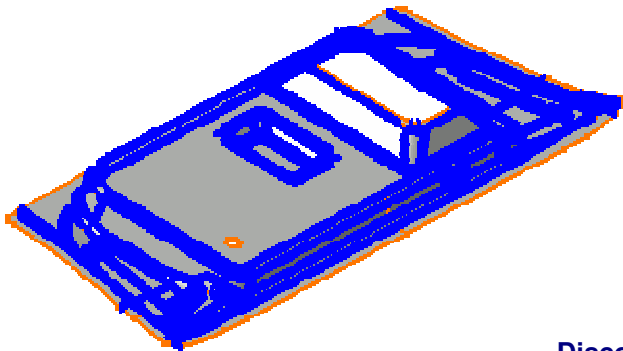
3. Check the Tangency discontinuity between the surfaces of the given part.

- a. Select the 'G1' option. Specify the values 0.1deg. The areas where tangency discontinuity is more than 0.1deg are highlighted in yellow color.
- b. Note the maximum degree of tangency discontinuity on a part.
- c. Click **OK**

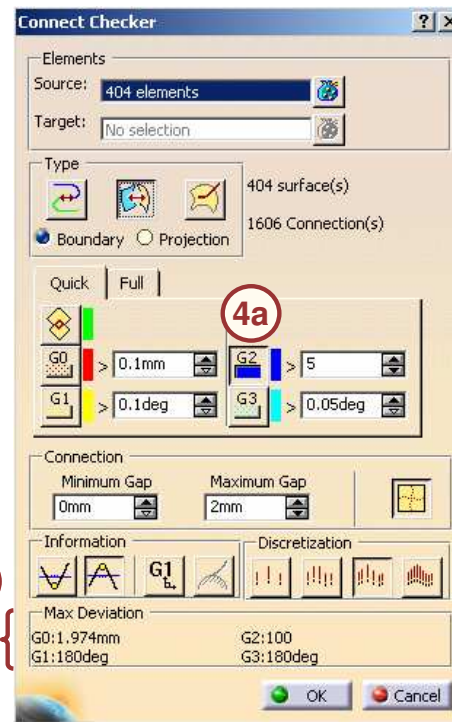


Exercise 5A-Start (3/4)

4. Check the curvature discontinuity between the surfaces of the given part.
 - a. Select the G2 option. Specify the curvature value as 5%. The areas where curvature discontinuity is more than 5 % are highlighted in blue.
 - b. Note the maximum percentage of curvature discontinuity on a part.
 - c. Click **OK**.



4b
Maximum Discontinuity values



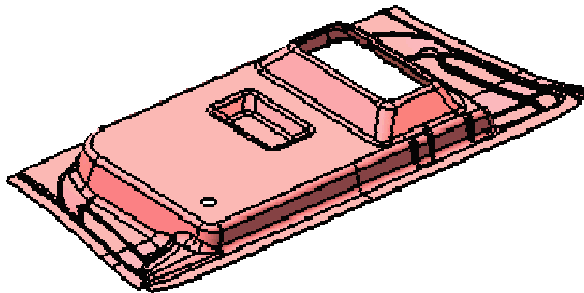
Exercise 5A-Start (4/4)

5. Heal the discontinuities between the surfaces.

- a. Select the **Healing** icon.
- b. Select the surfaces to heal.
- c. Specify the parameters as shown.
- d. Click **OK** to heal the surface.

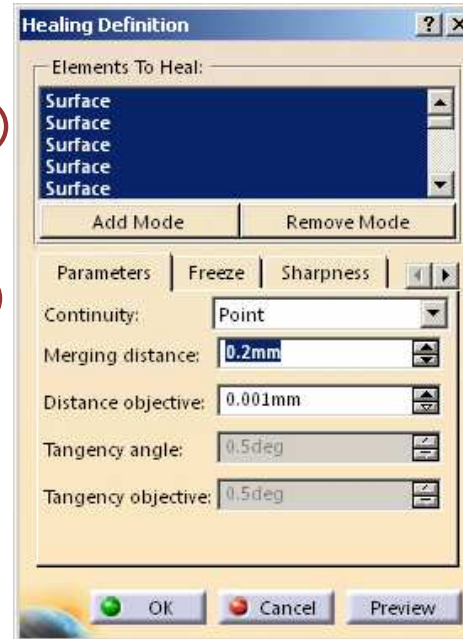


- With these values, you will heal the gaps which are more than 0.001mm and less than 0.2mm distance.
- In case the gap between two surfaces is more than the Distance Merging value, a warning indicating the remaining gap is displayed as follows



2b

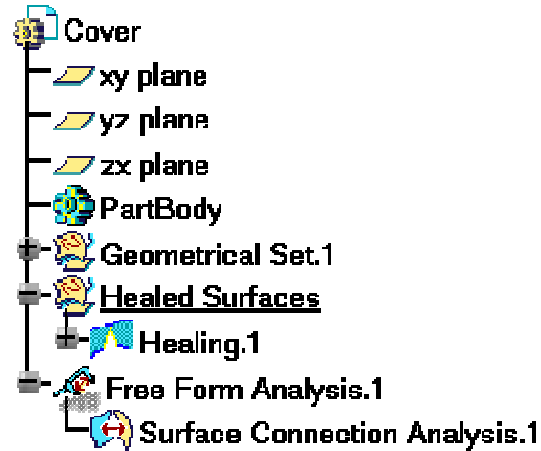
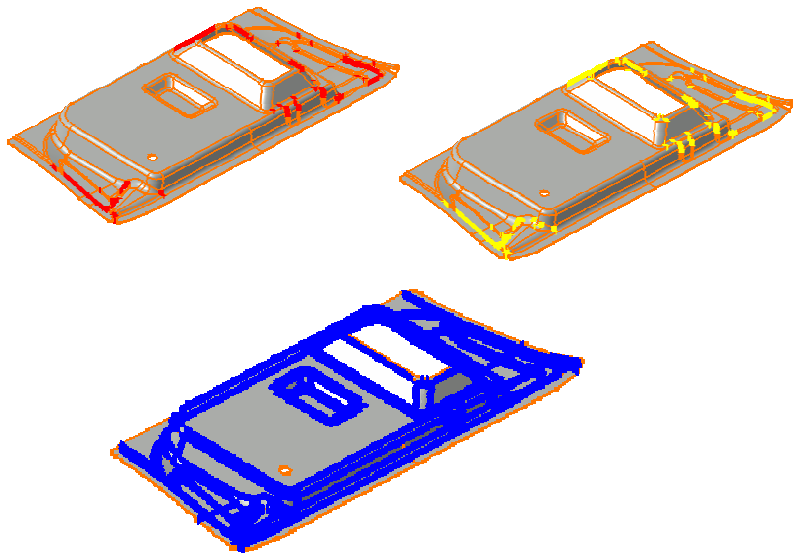
2c



Student Notes:

Exercise 5A-Start: Recap

- ✓ Check the surfaces for gaps using Distance option in surface connection checker.
- ✓ Check the tangency and curvature continuities between the two surfaces.
- ✓ Heal the surfaces

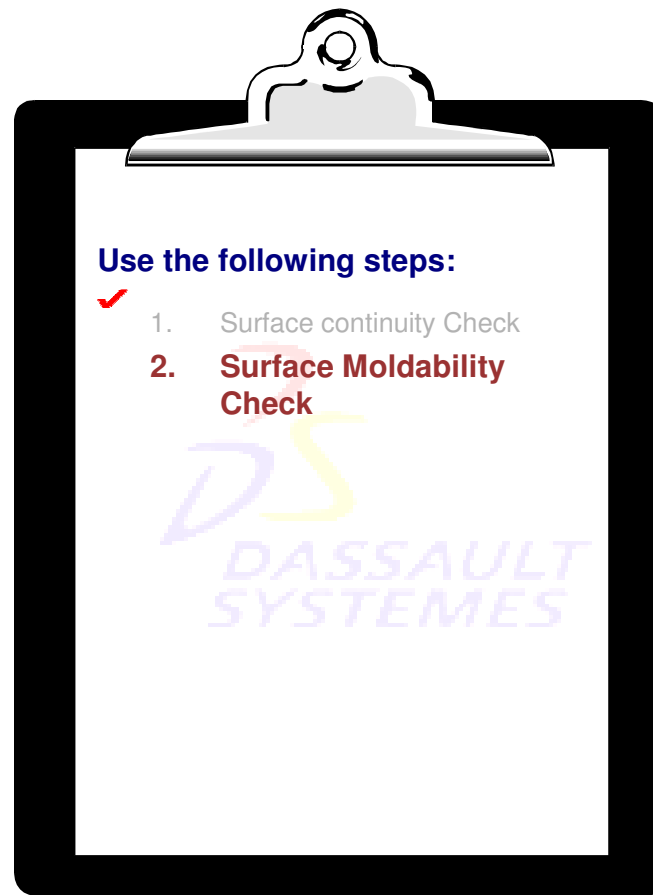


Step 2: Surface Moldability Check

In this section, you will learn about the particularities of a molded surface and how to achieve them using the Generative Shape Design Tools.



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Characteristics of a Molded Part

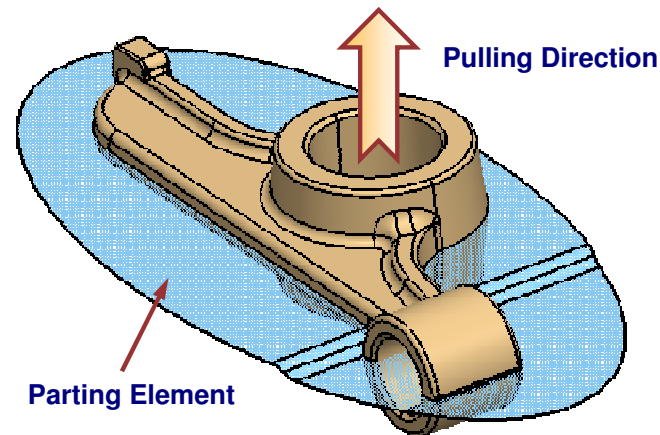
Cast, forged, plastic components and press parts require dies and molds for manufacturing. While designing the parts, care should be taken so that the part is feasible for manufacturing.

Whenever you design a part, it is necessary to understand a few particularities of manufacturing in order to achieve the best results.

Generative Shape Design workbench provides the tools to analyze the parts for its moldability before manufacturing. Using these tools you can perform the molding feasibility checks on a part.

Let us understand the particularities of molding a surface.

- A. The plane tangent to the surface to be molded should have an angle superior to a certain value with respect to a Pulling direction. This angle is called as a **Draft angle**.
- B. A **Parting element** : It is a line which divides the mold into two halves.
- C. A **Pulling direction** : The direction corresponds to the reference from which the draft faces are defined. It represents the direction in which the part is pulled from the mold.

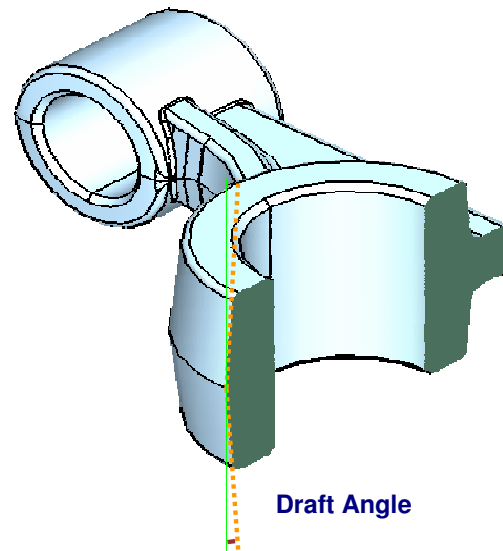
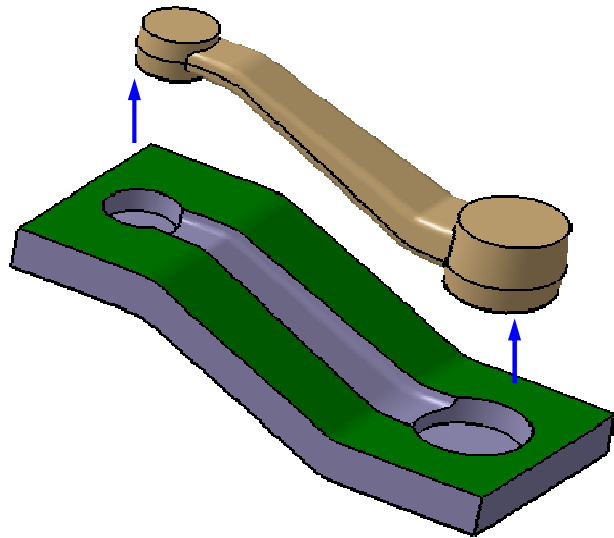
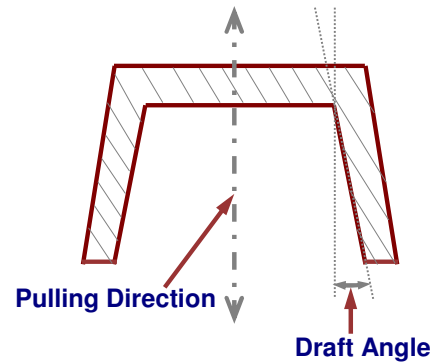


Student Notes:

Draft Analysis

A certain value of draft angle is provided on the walls of a part to be molded. This is done for easy extraction of the part from the mold.

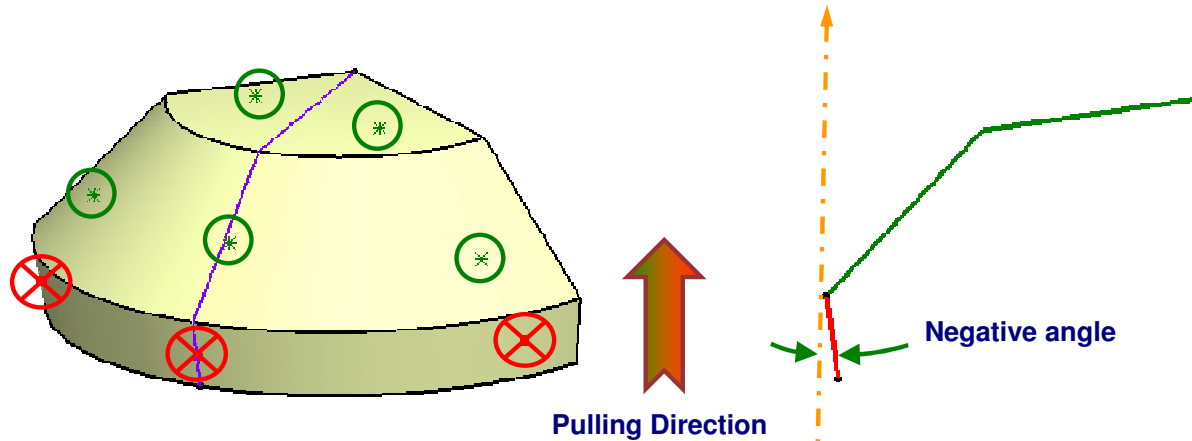
Generative Shape Design workbench provides the draft analysis tool. Using this draft analysis tool, you can check whether the part is extractible from the mold at the given draft angle.



Student Notes:

How a Draft Analysis is Computed

- At these points, the angle between the planes tangent to the surface and the mold direction is higher than the specified angle threshold.
→ These areas will not be a problem during mold extraction



- ⊗ At these points, the angle between the planes tangent to the surface and the mold direction is under the specified angle threshold.
→ These areas may be a problem during extraction from the mold

➔ The objective of the draft analysis is to detect these areas.

Using the Draft Analysis Tool

Draft Analysis tool identifies the zones (using color codes) and highlights the areas which deviate from the specified values along a defined draft direction.

Use the following steps to perform Draft Analysis:

1. Set the customized render style.
2. Select the part you want to analyze.
3. Select the Draft Analysis tool.
4. Set the analysis to Quick analysis mode
5. Adjust the Draft direction to Z using the compass.

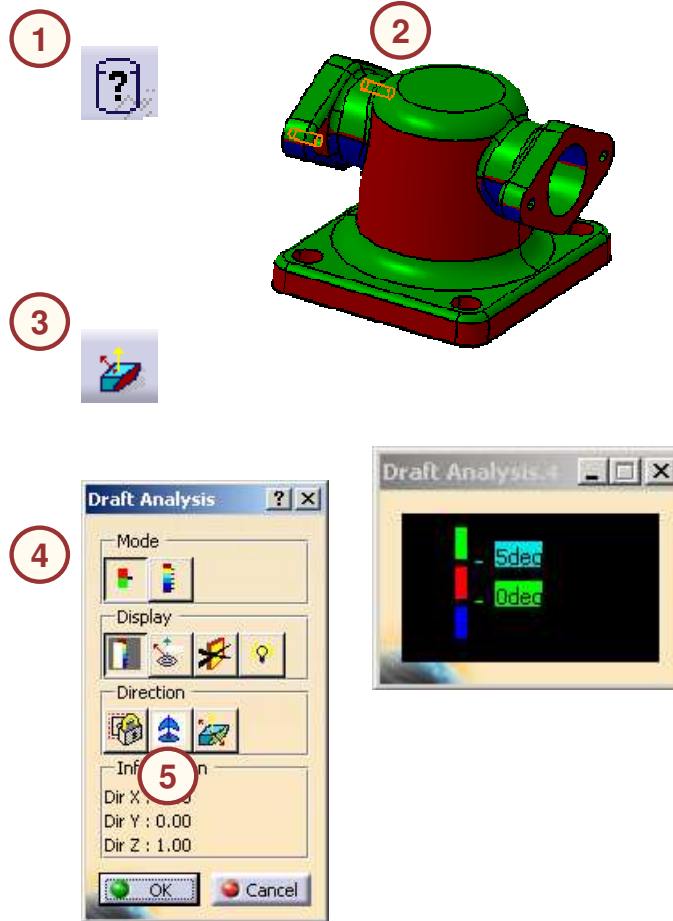
Observe the color ranges:

Green: Draft value above 5deg

Blue: Below 0deg

Red: 0 – 5deg

In an ideal part, the analysis results in two color zones (Red and Blue) which meet at the parting line signifying two halves of a mold.

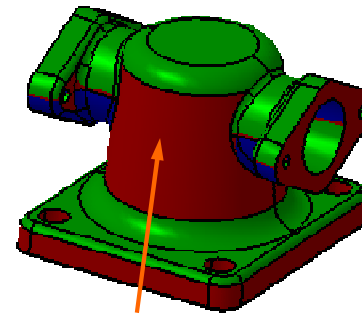


Methods to Make the Part Extractable

You have learnt how to identify the problem areas which cannot be extracted from the mold by performing Draft Analysis.

Now, in order to extract the part from the mold, you will have to eliminate the problem areas. There are two possible ways to do it:

- A. By modifying the inputs of existing surface .
- B. By removing the erroneous area of the part and building a replacing drafted surface.



Apply a draft greater than 5deg here

Assemble.1

- Body.2
 - Pad.1
 - Sketch.1
 - Draft.1
 - EdgeFillet.1
 - EdgeFillet.2
- Assemble.2
 - Body.3
 - Pad.2
 - Sketch.2
 - Draft.2
 - EdgeFillet.3
 - EdgeFillet.4

Draft Analysis is updated and shows green color – now this portion will be extracted from the mold

 Let us see the draft analysis (L5.CATPart/DRAFT/DRAFT ANALYSIS)

Student Notes:

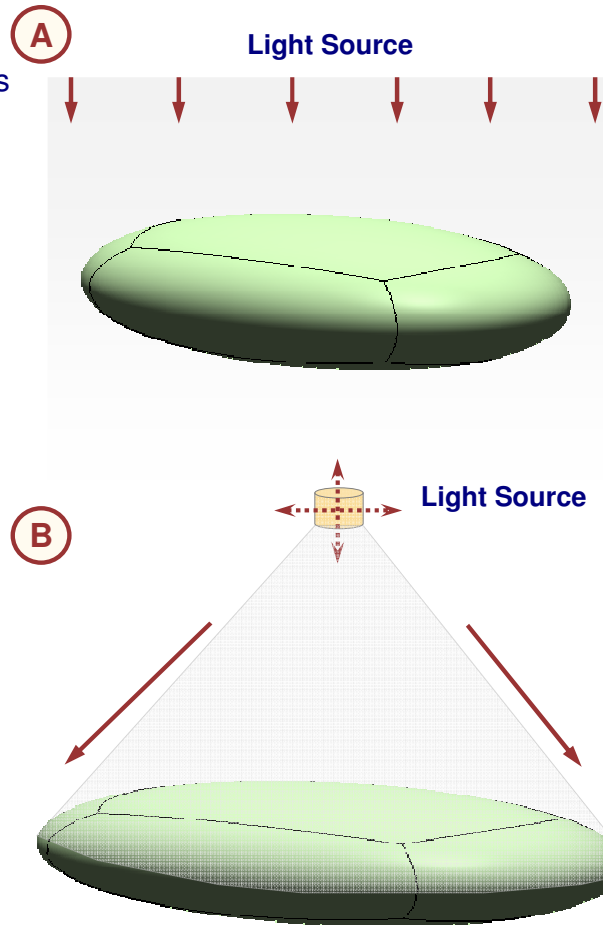
What is a Reflect Line? (1/2)

Consider an object which is held below a light source. The light source is at an infinite distance. All the light rays will be parallel in direction. If the object has canonic surfaces, some part of the object that is facing the light source will be bright and the opposing end will be dark.

The lighted and the dark areas will be divided by a line, which is called as the reflect line. The curve represents the extremum curve in a specified direction.

There are two ways of calculating the Reflect Line.

- A. Cylindrical
- B. Conical



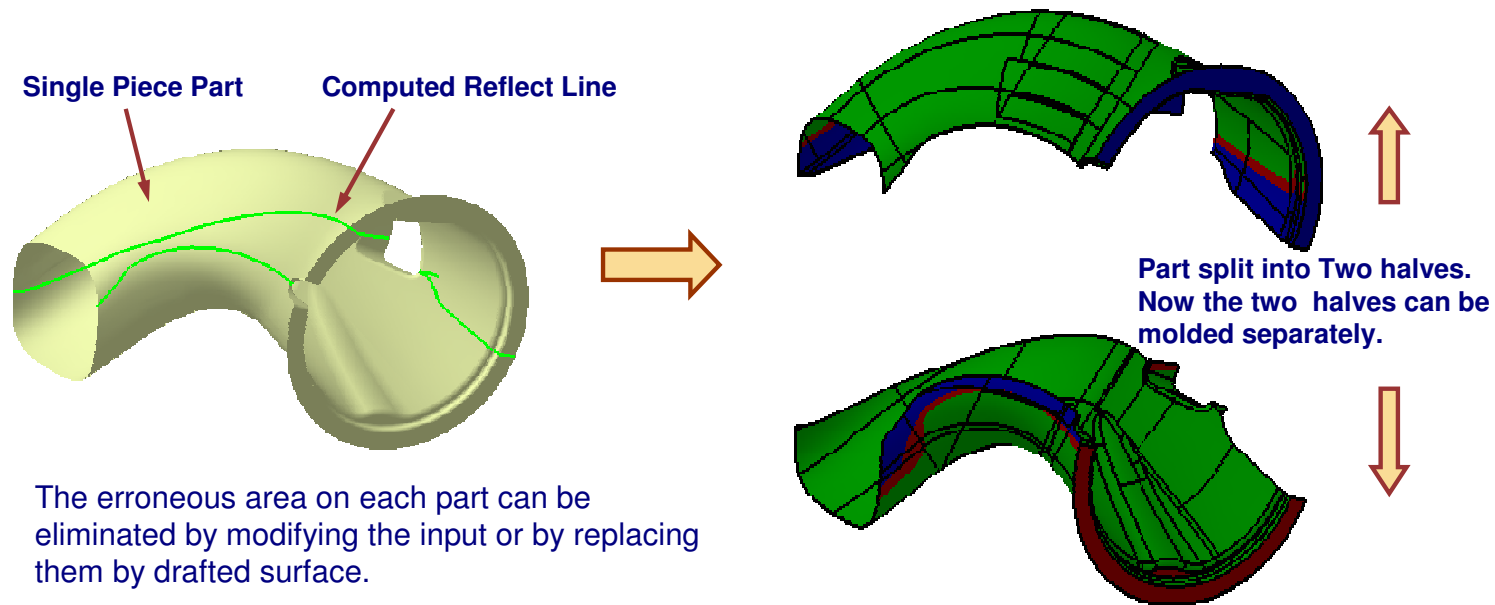
Let us see the draft analysis
(L5.CATPart/DERAFT/REFLECT LINE)

Student Notes:

What is a Reflect Line? (2/2)

Reflect line is used for various purposes in an industrial design. One of the applications of reflect line is to determine the retractability of a part. In case of huge parts it helps you to divide a part into two or more smaller parts which can be easily retractable.

At the same time, it helps you to determine the parting line of a part provided with the pulling direction. Reflect line tool is used to find this parting line along which the entire surface can be cut or split.

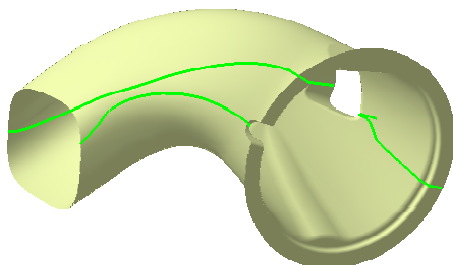
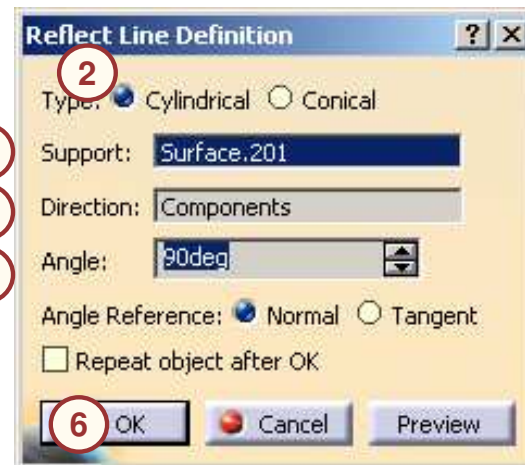


How to Find a Reflect Line?

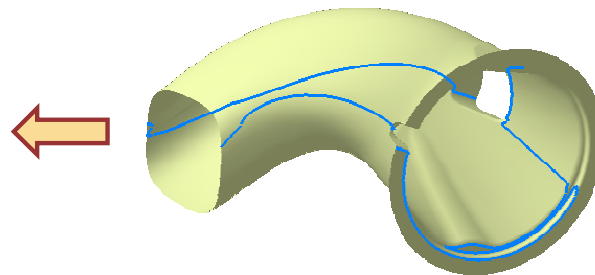
Reflect lines are curves for which the normal to the surface in each point present the same angle with a specified direction. Reflect line tool is used to find a parting line.

1. Select the Reflect line tool
2. Select the type of Reflect line type: Cylindrical
3. Select the Support Surface
4. Select the direction.
5. Specify the angle
6. Click **OK** to create the reflect line

Observation: You may sometimes get Non-Connex result. In such cases you will have to edit the curve by creating a few splines, extracts etc.



Edited Reflect line



Use of Draft Sweep to make the Part Extractable

One of the ways of eliminating the erroneous area on the surface is replacing it by drafted swept surface. This also makes the surface extractable.

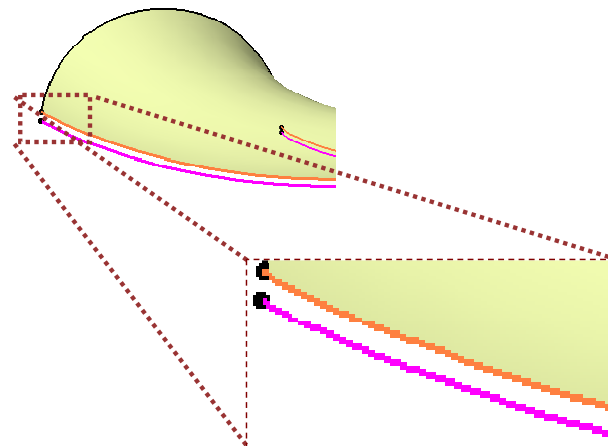
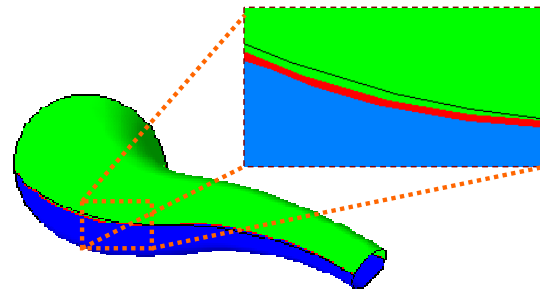
For Example,

In the part shown, Red zone is the area having zero draft (detected by draft analysis). You will replace the Red zone by a drafted surface using the draft sweep tool.

To define the boundary of the red zone we will create a reflect line with an angle corresponding to the limit of what can be extracted from the mold (5 degrees for instance)

The Yellow line is this parallel curve and the Pink line is parting curve and the red zone lies between these curves. The surface can now be split using the reflect curve. The *replacing surfaces* can be modelled using Line sweep – with draft direction option.

Let us see how to create a draft using Line sweep - draft option.



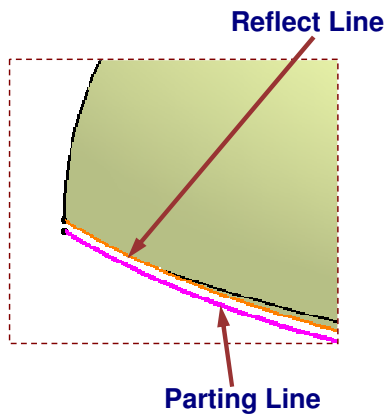
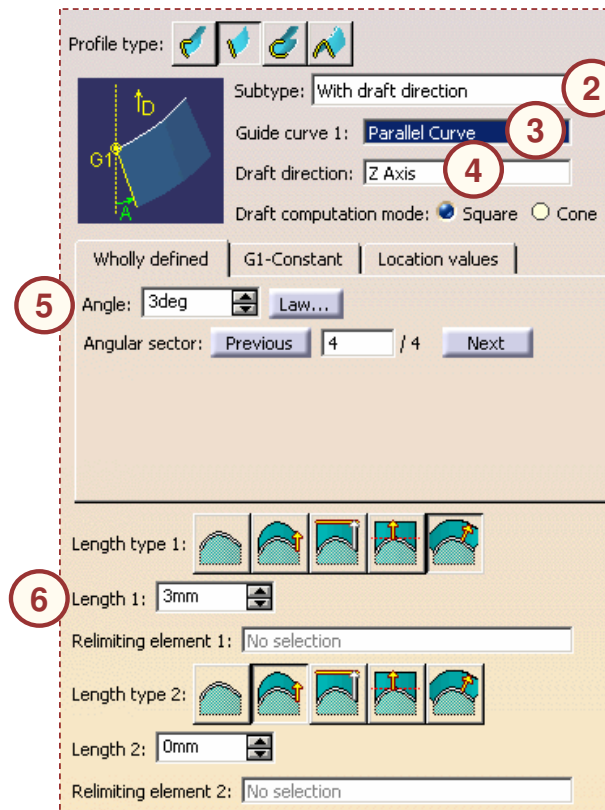
The Surface is split by the parallel curve to remove the bad area

Creating Line Sweep - with Draft Direction (1/2)

In this type of sweep you have to specify the draft direction and draft angle



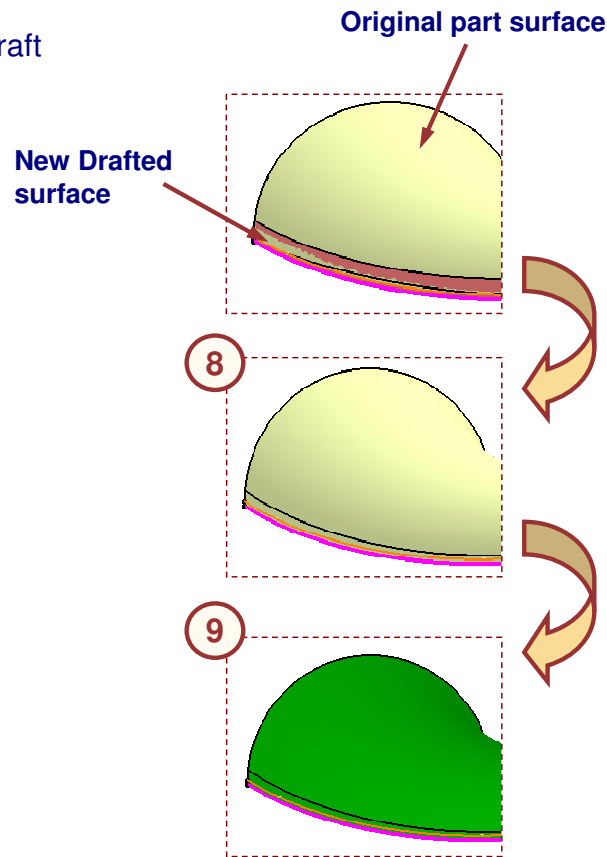
1. Select the Sweep Icon
2. Select line sweep – with draft direction
3. Select the Guide curve
4. Specify the draft direction
5. Set the whole angle. The angle input corresponds directly to a mold draft angle.
6. Specify the length of the draft.
7. Click **OK** to generate the drafted surface.



Creating Line Sweep - with Draft Direction (2/2)

In this type of sweep you have to specify the draft direction and draft angle (continued...).

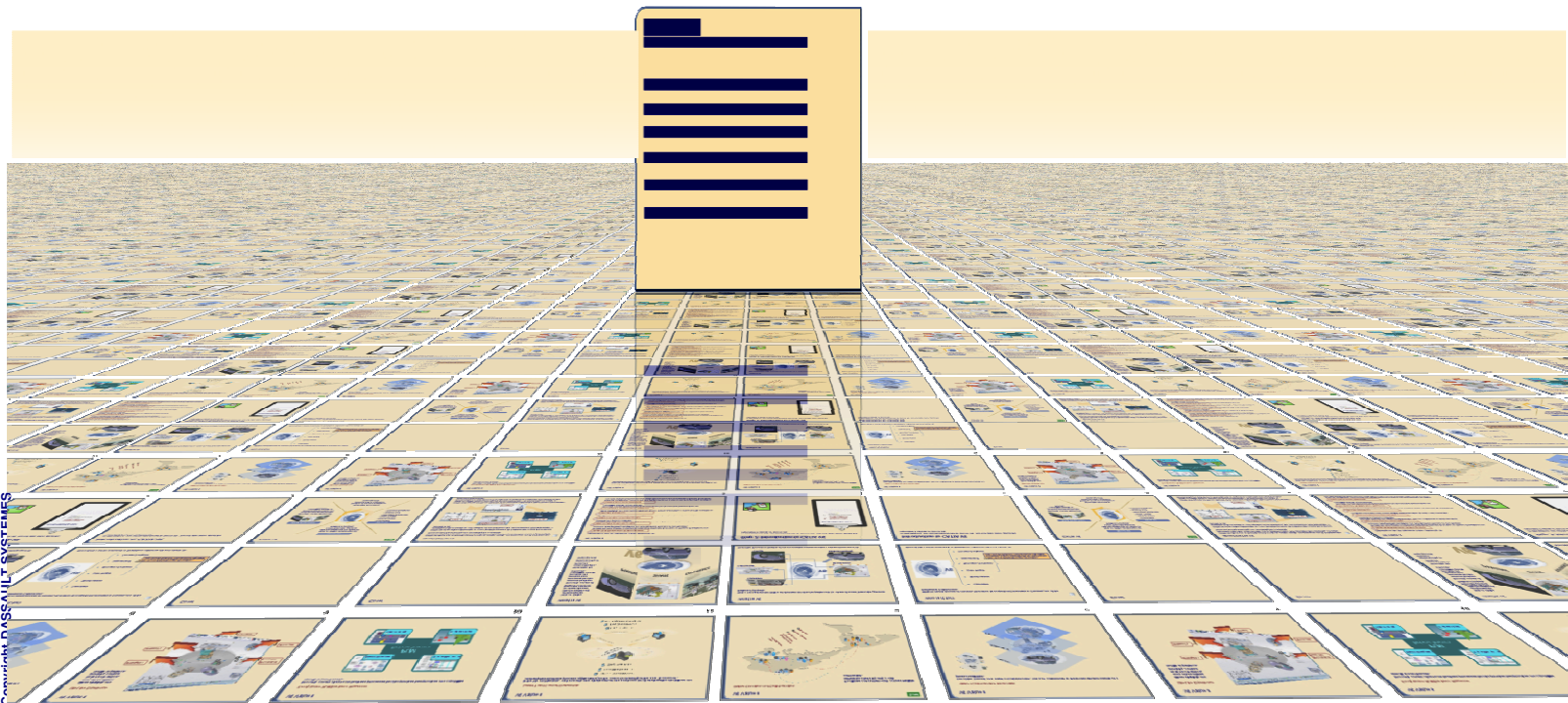
8. Trim the new drafted surface with the original surface of the part.
9. Perform the draft analysis on the resulting trimmed surface. You will observe that the surface is clear from the negative or zero drafts. The part is extractable.



To Sum Up

In the following slides you will find a summary of the topics covered in this lesson.

Student Notes:



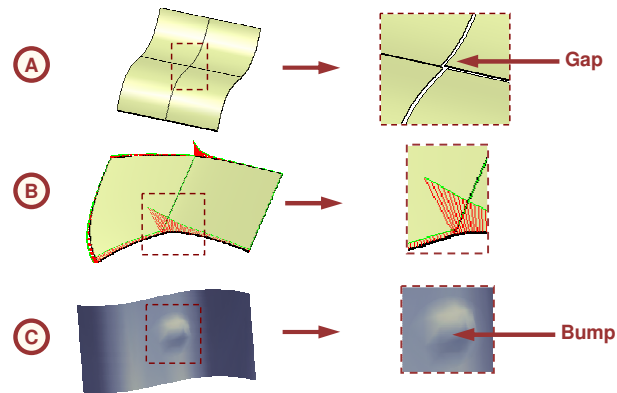
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Surface Continuity Check

We need to perform surface connection analysis when surfaces from CATIA V4 or other CAD packages are imported into CATIA V5. This ensures that good quality surface is provided for further processing.

Following are the flaws that can be detected between surfaces:

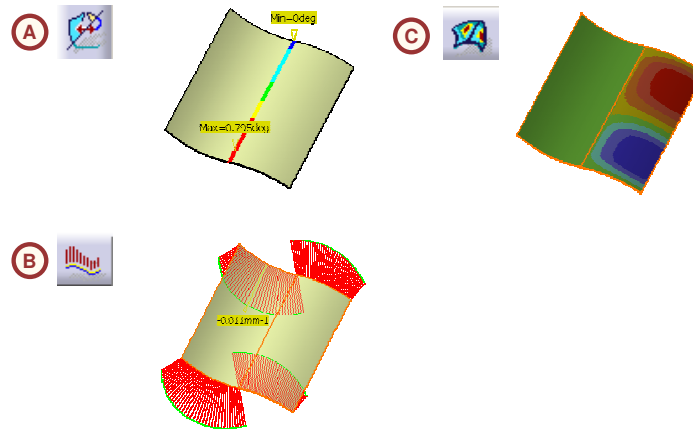
- A. Surface continuity faults like gaps, overlapping surfaces and tangency and curvature discontinuities.
- B. Irregular surface boundaries.
- C. Surface Inflections.



Tools to Detect Geometric Connection

Following are the tools to detect geometrical connection faults:

- A. Connect Checker:** It is used to check connections between two or more surfaces. The tool gives a measure of Distance (mm), Tangency (degrees), and Curvature (percentage) between the edges of the surfaces.
- B. Porcupine Analysis:** It is used to detect the imperfections in the boundaries of a surface which cannot be seen with the naked eye. The result is shown in the form of spikes.
- C. Surface Curvature Analysis:** It is used to detect curvature changes on a surface or group of surfaces.

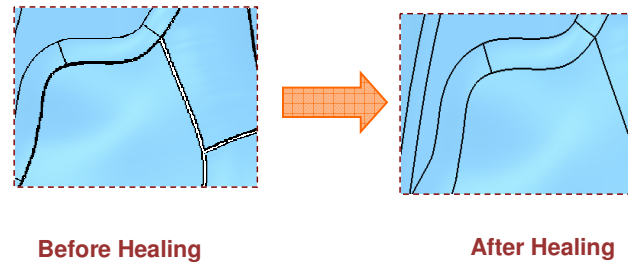


Correcting Defects in Surfaces

The Heal tool is used to correct the defects (gaps, continuity problems) found by performing an analysis between the surfaces. Heal deforms the surface to fill up the gaps and reduces the tangency and the curvature discontinuities.

To heal the surfaces, you need to enter healing parameters. These parameters are threshold values and must be deduced from the results of the analysis. Parameters allow you to:

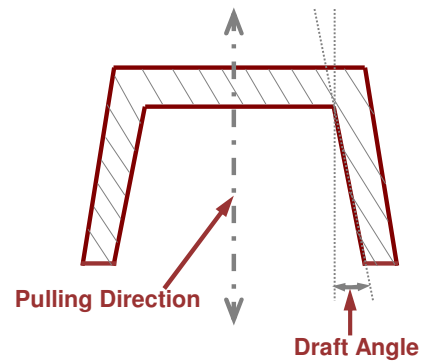
- A. Define the discontinuities which are important and must be healed: Merging distance and Tangency angle parameter values must be greater than the maximum value you get from the connect checker analysis.
- B. Define the discontinuities which are not important and must not be healed: The magnitude of distance objective or tangency objective parameters must be set less than the discontinuity that you desire to heal. In other words, discontinuities less than these values are not considered as gap.



Surface Moldability Check

A certain value of draft angle is provided on the walls of a part to be molded. This is done for easy extraction of the part from the mold. Using the Draft Analysis tool, you can check whether the part is extractible from the mold at the given draft angle.

In case of huge parts reflect line helps you to divide a part into two or more smaller parts which can be easily retractable. It helps in determining the parting line of a part.



Student Notes:

Main Tools

Analysis Toolbar

- 1 **Connect Checker Analysis:** Checks connections between two or more surfaces.
- 2 **Feature Draft Analysis:** Analyzes the draft direction on selected surfaces.
- 3 **Surfacic Curvature Analysis:** Analyzes the Gaussian curvature on shape.
- 4 **Porcupine Curvature Analysis:** Detects the imperfections in boundaries of the curve.



1 2 3 4

Wireframe Toolbar

- 5 **ReflectLine:** Creates a reflect line.



5

Operations Toolbar

- 6 **Healing:** Heals the surface.



6

Exercise 5A-End

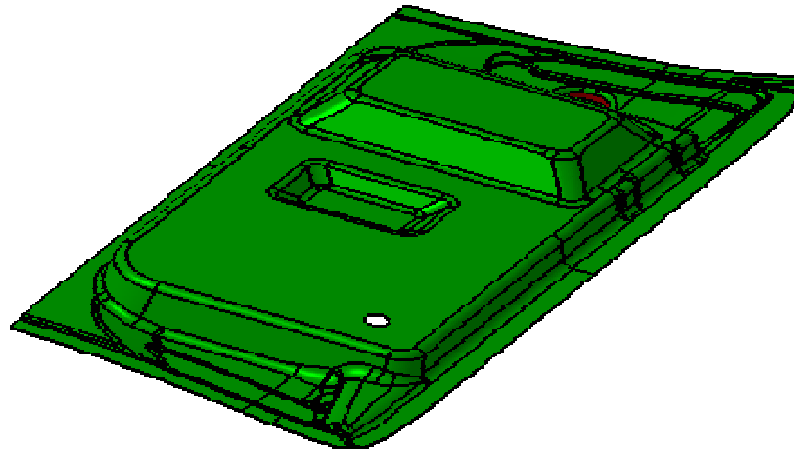
Recap Exercise



In this exercise you will practice the draft analysis. Detailed instructions are provided to perform this exercise.

By the end of this exercise you will be able to :

- Check the draft on the part.

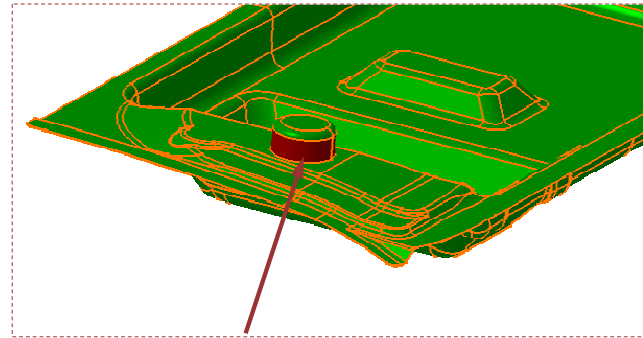


Student Notes:

Exercise 5A-End (1/2)

1. **Open an existing part file.**
 - a. Browse and open part:
Exercise_5A_End_Initial.CATPart

2. **Perform the draft analysis on the surface.**
 - a. Change the view to material mode.
 - b. Select the **Draft Analysis** icon.
 - c. Select the color shade
 - d. Edit the angle values in the panel to 3 degrees so that the draft angles between 0 to 3 degrees are shown in red. Draft angles below zero degree (Negative draft) are shown in blue.
 - e. Adjust the compass and set Z axis as pulling direction.
 - f. Select the given surface.
 - g. Visualize the draft results. Check for the red and blue zones which needs to be repaired.
 - h. Click **OK** to retain the results.



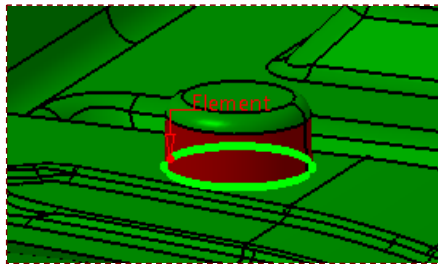
Face having draft less than 3 degrees and more than 0 deg



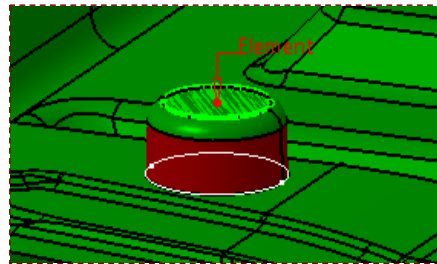
Student Notes:

Exercise 5A-End (2/2) 

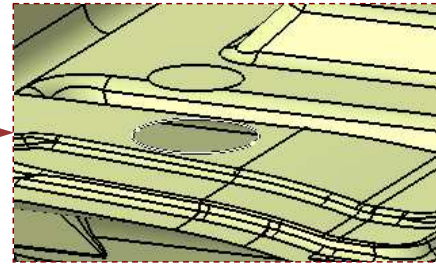
3. Replace the defective area with a draft surface.



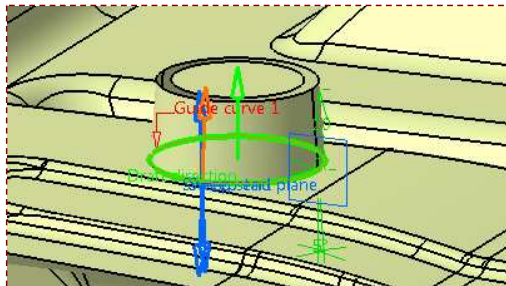
Extract the lower edge



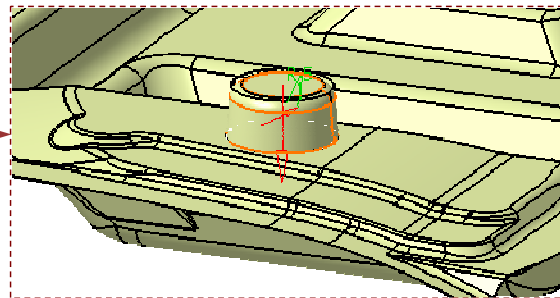
Extract the upper face



Split the defective surface

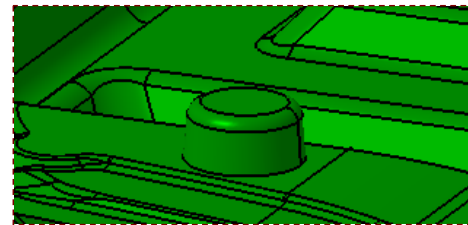


Create a draft sweep using the extracted curve as a guide curve, Z axis as a draft direction, and 5 degrees as a draft angle.



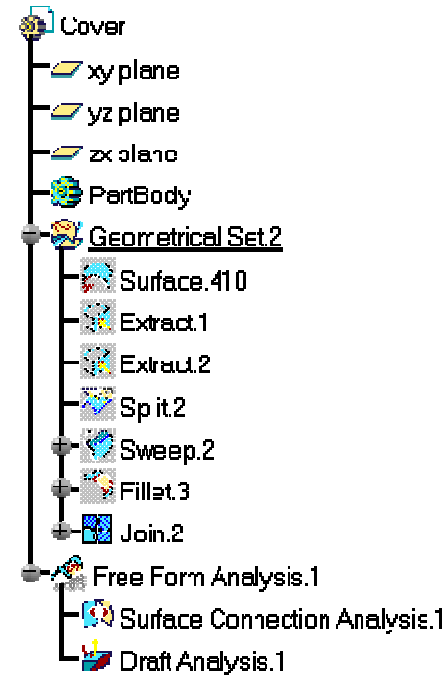
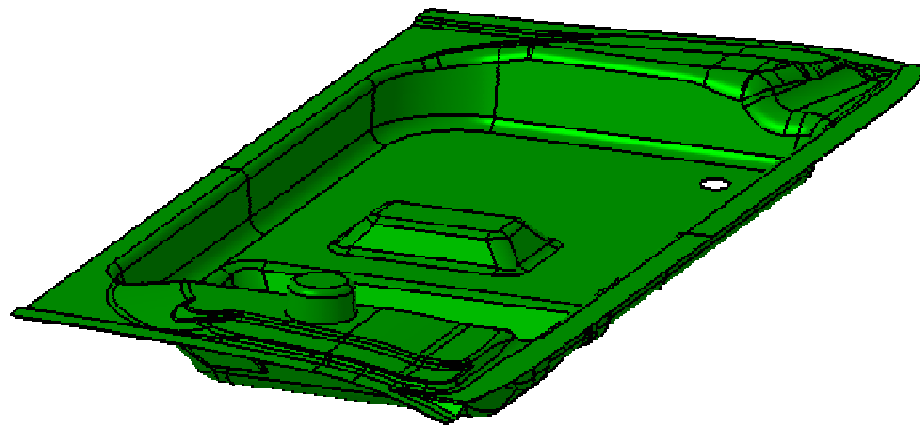
Create a Shape Fillet of 5mm radius between swept surface and top surface.

Join the two surfaces and perform a draft analysis.



Exercise 5A-End: Recap

✓ Check the draft on the part.



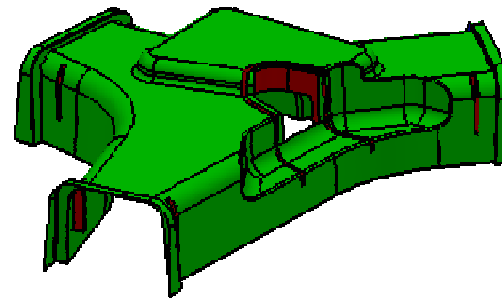
Exercise 5B

Recap Exercise



In this exercise, you will practice how to analyze the draft angle of molded parts using draft analysis tool in Generative Shape Design workbench. High-level instructions are provided to perform this exercise.

By the end of this exercise you will be able to perform draft analysis on a part using the Draft Analysis tool.



Exercise 5B (1/2)

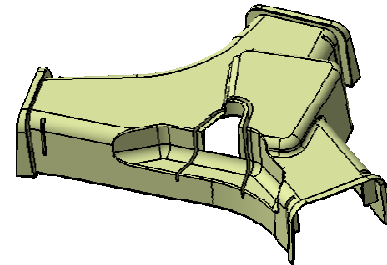
1. Open the part.

- Open an existing part file. The file consists of V4 surfaces of a molded part.
 - Browse and open part:
Exercise_5B_Start.CATPart

2. Check the surface for their extractability using the Draft Analysis tool.

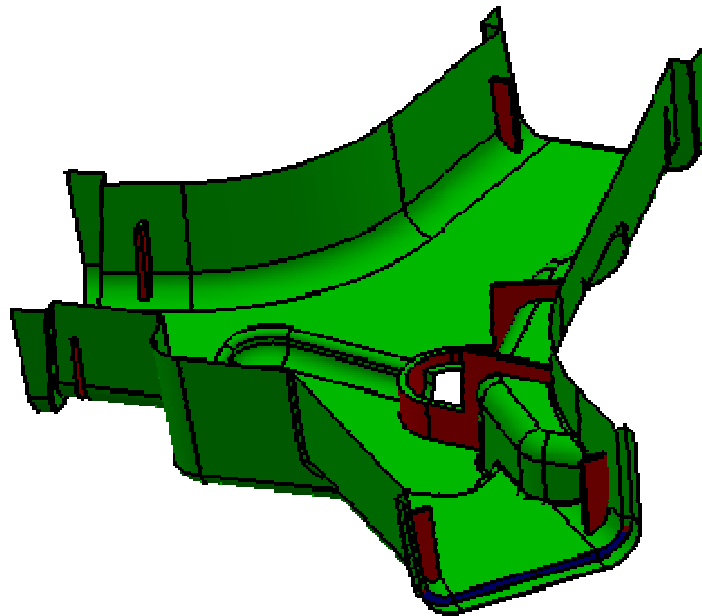
- Perform a draft analysis on the joined surface (Join.2 in start part).

3. Check for surfaces having draft less than 1deg.



Exercise 5B (2/2)

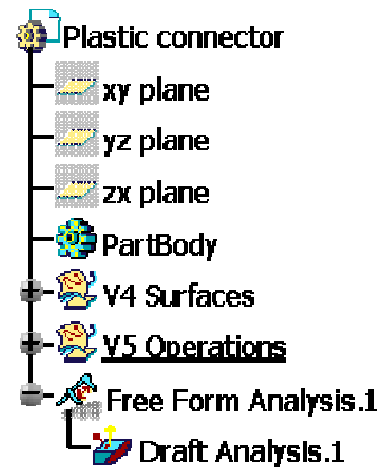
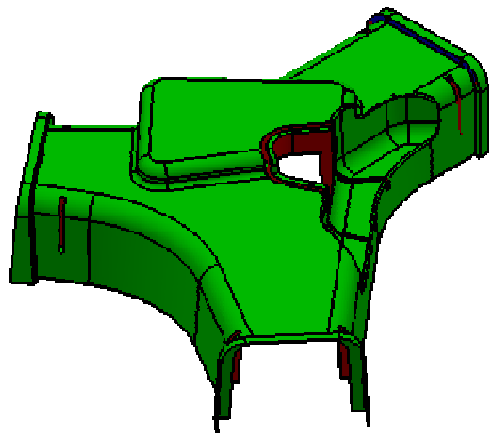
4. Study the results of the draft analysis.
 - a. The red color signifies that these surfaces have the draft less than 1 deg and greater than 0deg.
 - b. The blue surface has draft less than 0deg (negative draft).
 - c. The green surface has draft greater than 1deg.



Student Notes:

Exercise 5B: Recap

✓ Analyze the draft on the part using the Draft Analysis tool.



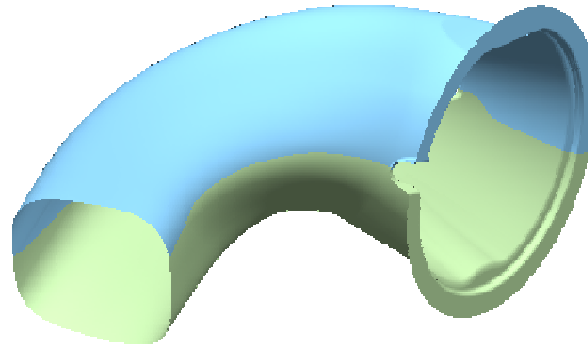
Exercise 5C

Recap Exercise



In this exercise, you will determine the parting line for a given surface using the Reflect Line tool. With the given set of surfaces, you will be able to divide the surface into separate parts which have to be molded independently. High-level instructions are provided to perform this exercise.

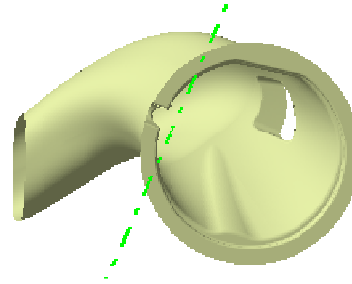
By the end of this exercise you will be able to determine the parting line of a given surface.



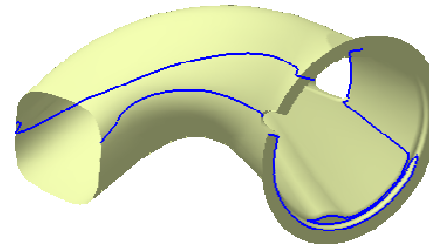
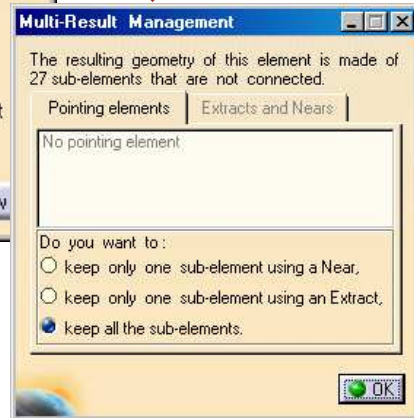
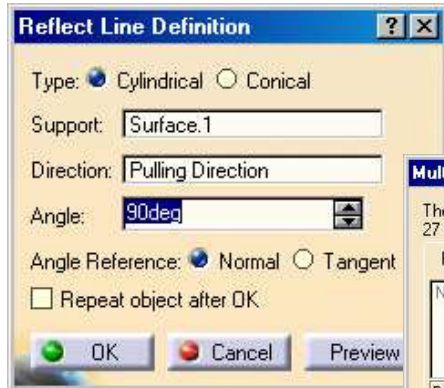
Student Notes:

Exercise 5C (1/3)

1. **Open the part.**
 - Open an existing part file. The file consists of V4 surfaces of a molded part.
 - a. Browse and open part:
Exercise_5C_Start.CATPart



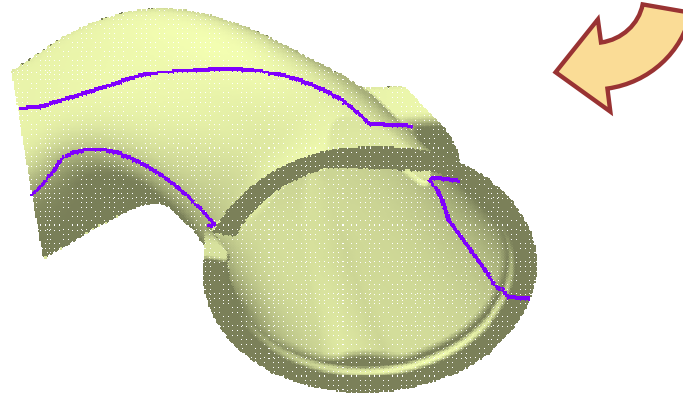
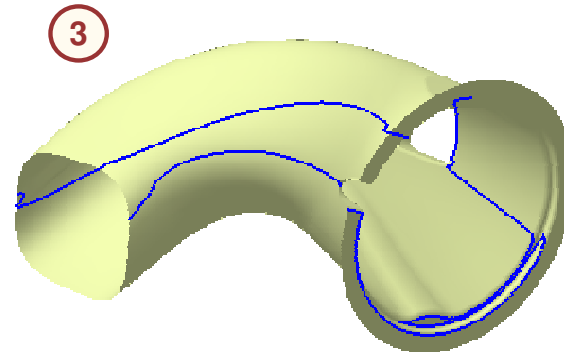
2. **Compute the reflect line on the surface using the given pulling direction.**



Exercise 5C (2/3)

3. Edit the reflect line to get a smooth parting line.

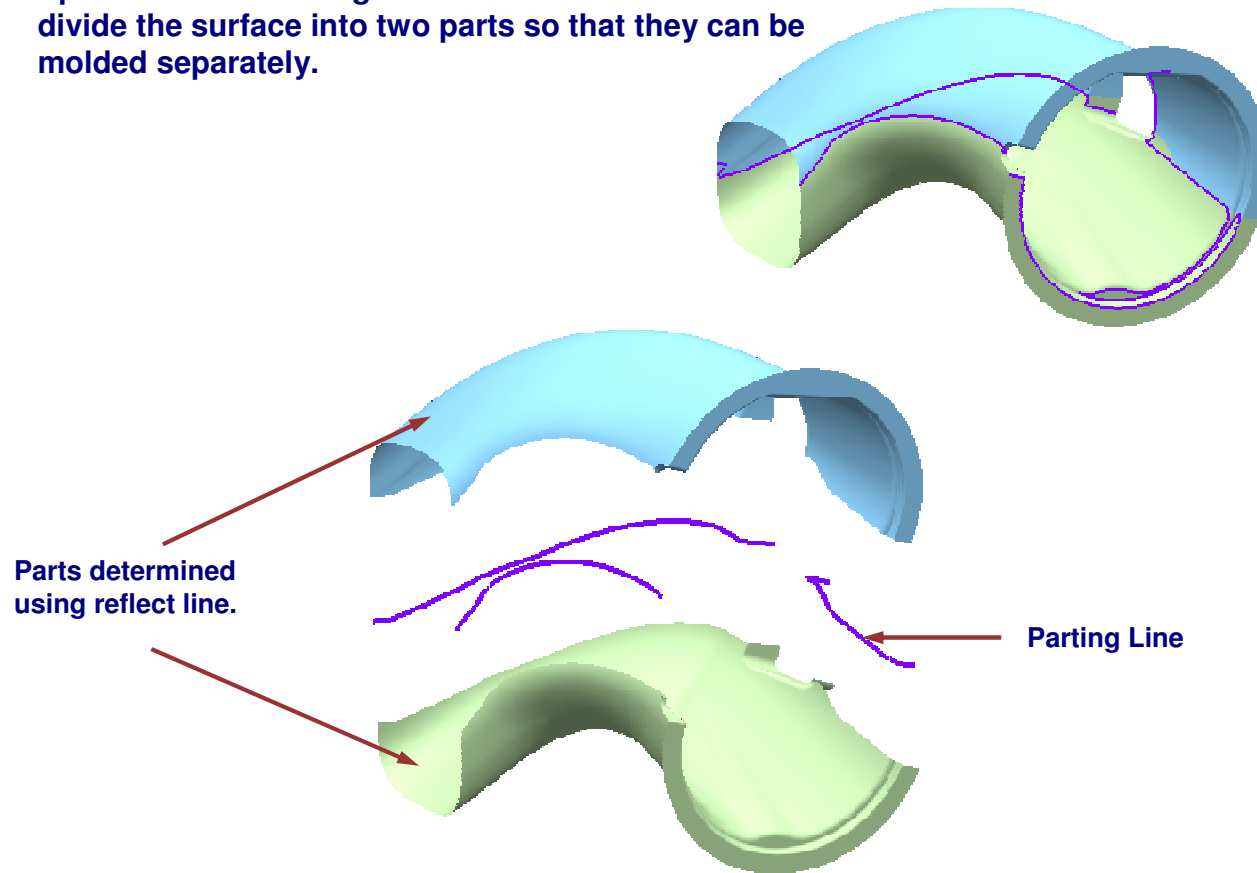
- Extract the curves from the resultant reflect line and edit them. You will edit the reflect line when it has more than one sub-element. The editing consists of splitting the erroneous area of the curve and filling the gap between the curves.
- As shown below, create three curves. These curves are later used to split the surface into two parts.
- Join the three curves.



Student Notes:

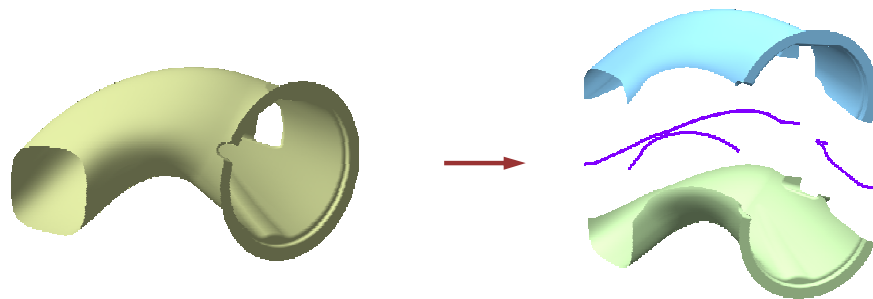
Exercise 5C (3/3)

4. Split the surface using the edited reflect line. You will divide the surface into two parts so that they can be molded separately.



Exercise 5C: Recap

✓ Determine the parting line using Reflect line.



- Reflect Line
 - xy plane
 - y7 plane
 - zx plane
- PartBody
- Geometrical Set.1
 - Surface.1
- PartingLine Definition
 - PartingLine Original
 - Reflect line.1
 - PartingLine Edited
- Point.4
- Pulling Direction
- ConstructionGeometry
- Split Parts
 - Split.1
 - Split.2

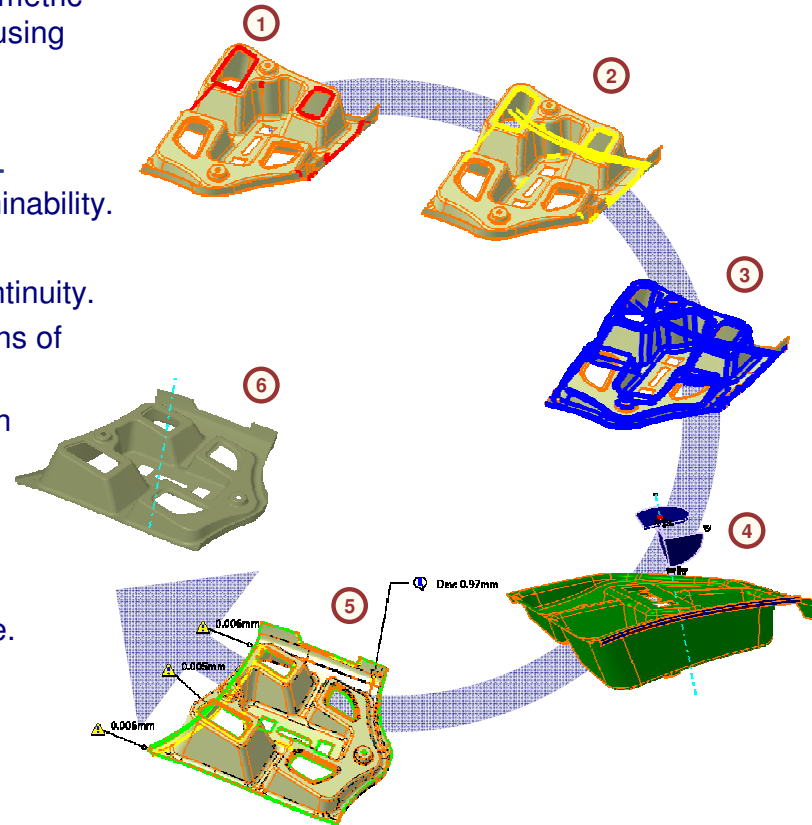
Student Notes:

Case Study

The case study for this lesson is to analyze the geometric connections between the surfaces of a plastic part using different surface analysis tools.

Design Intent

- A. Check the surfaces for gaps to ensure easy machinability.
 - Use Connect Checker.
- B. Check the surface for tangency and curvature continuity.
 - Use the Tangent and Curvature analysis options of Connect Checker.
- C. Check the draft on the surface for better extraction of the part from the mold.
 - Use Draft Analysis tool to measure the draft angle on the part features.
- D. Heal the discontinuities between the surfaces.
- E. Replace the undercut faces by positive draft angle.



Student Notes:

Stages in the Process

1. Check the surface for surface gaps.
2. Check the surface for tangency discontinuities.
3. Check the surface for curvature discontinuities.
4. Perform the draft analysis.
5. Heal the surface from discontinuity problems.
6. Replace the undercut defective surface by a drafted surface.