Curve from Sketcher - III

This tutorial includes an other mode to design the charateristic curves of an economy car from three blueprint images. Now we'll use the curves by control points, a different approach to describe planar or space curves but not intepolated in the internal points.

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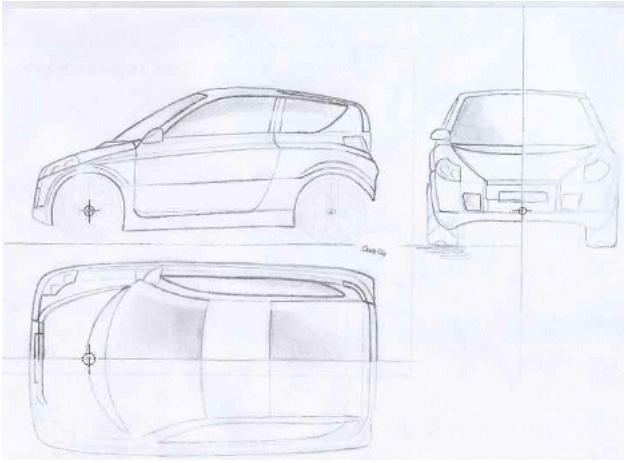
1. Step 1 - Raster Image

Typically, to create 3D geometry we need a series of raster images to be introduced in thinkdesign. Here we've to split the 2D sketch into three images, keeping the same proportions for all three.



A designer thinks about a real car, with necessary background and lighting, that can be developed using proper sketching and rendering tools. In this picture we have used render tools to obtain a real representation with a sea as background.

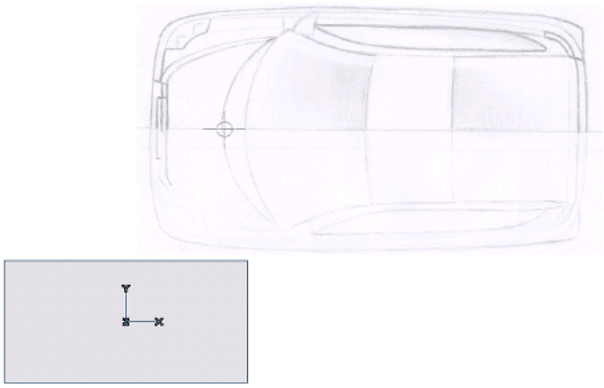
Here's one other quick render image using some other parameters.

Enhancement - Insert Multiple Images

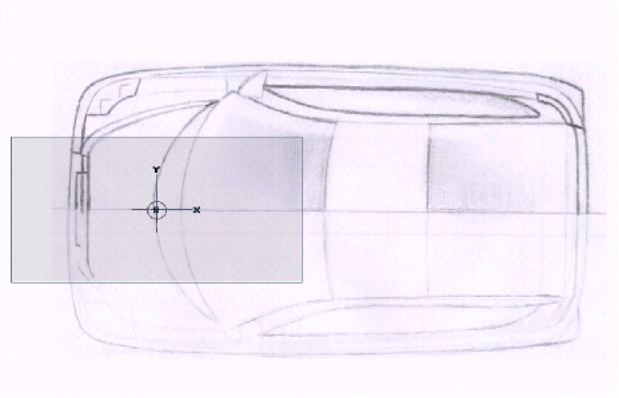
Let's insert few images into the thinkdesign environment and try to work with them.

Choose the **Insert Image** command and open top-view.jpg.

- Select an arbitrary point in the graphic area to place the image.
- Start the **Scale Image** command and select the image.
- Set Dots per inch as 96 and Scale as 1 in the Image Scaling window.



- Start the **Edit Image** command and select the inserted image.
- Select the red axes and move the image in such a way that the reference point on the sketch coincides with the Work plane axis as shown in the image below.
- Press Esc to exit the command.

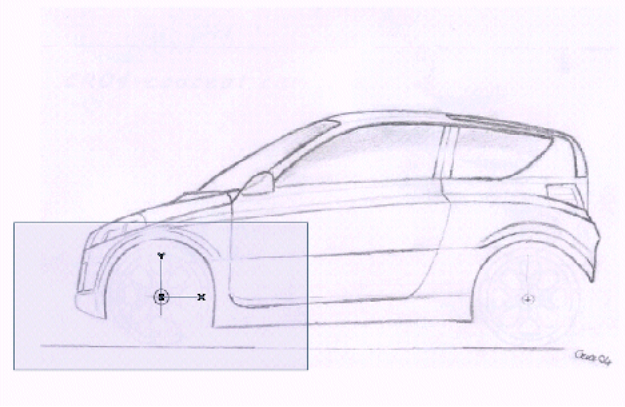


Now let's rotate the Work Plane axis appropriately and insert the front and side view images.

- First click on **Front View**.
- Right click on the Work Plane and choose **Set Work Plane on View**.

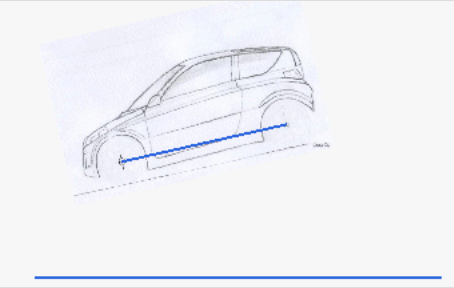
Only the Orientation of the Work Plane will change.

- Start the **Insert Image** command and open side-view.jpg.
- Select an arbitrary point in the graphic area to place the image.
- Start **Edit Image** and select the image. Move the image so that the reference point on the front wheel of the car coincides with the Work Plane axis as shown below.

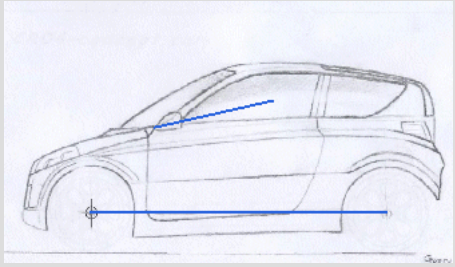


Place images by points

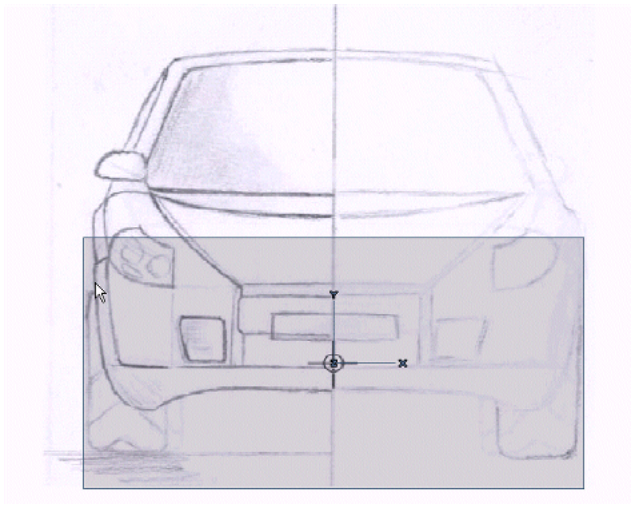
Other fast mode to move and to place an image could be using the command Reposition on 2 Points can be found under Modify - Image.



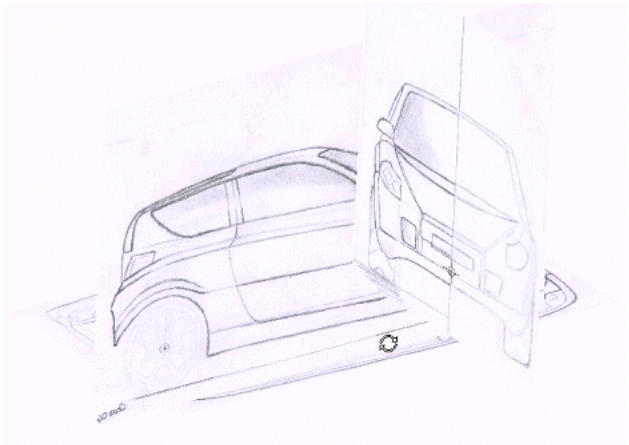
Select the image, two limits points on its line and then the same on the new



- Click on **Left View**.
- Right click on the Work Plane and choose **Set Work Plane on View**.
- Start **Insert Image** and open front-view.jpg.
- Select an arbitrary point in the graphic area to place the image.
- Start **Edit Image** and select the image. Move the image so that the reference point on the car coincides with the Work Plane axis as shown in the image below.

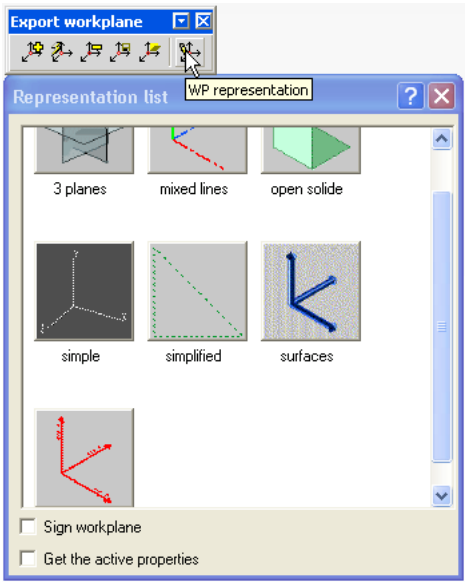


Now we have the preliminary image that can be used to trace the outline of our car.



Right click on the graphic area and select **Options/Properties**. Click on the Image category under System Op-

tions tab. Change the Display option to either Behind or Transparent in the Show drop-down list.



Click on the WP representation button (fourth) on the Workplane manager toolbar to get the Representation list. (If you're not able to locate this toolbar, go to **Tools**⇨**Customize**and select it under the Toolbars tab.) Double click on the mixed lines option to insert the reference lines.

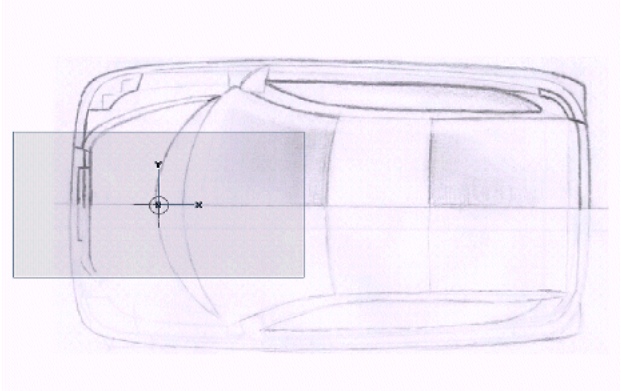
Utilities

The Workplane manager can be found under the download section of the thinkcare web site http://care.think3.com, that can be accessed only after entering a valid Username and Password in the login page. Here you will find a series of tools that can be used in both 2D or 3D environment. Read the Tools.chm file for more information.

2. Step 2 - Trace planar curve (top view)

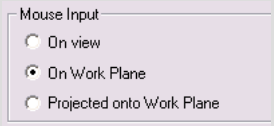
The second step describes how to trace the reference planar curves on the inserted images. Make sure you have defined the right Work Plane orientation.

- Click on **Top View**.
- Set the **Color** as Blue and the **Line Width** as 3.
- Right click on the Work Plane and choose Set on View.



Where to draw the main curves.

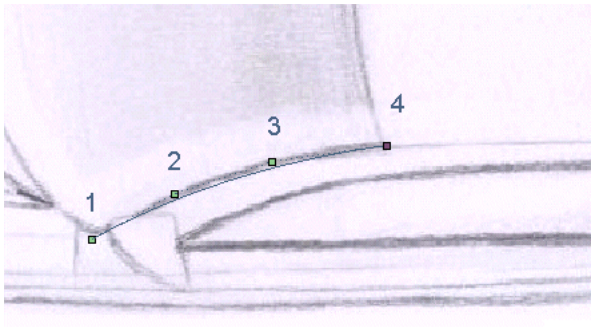
It's very important to know which plane has to be taken as reference to draw the new entities (curves, lines, points). These entities will be used to define the shape of the surfaces.



Go to **Tools**➪**Options/Properties**and click on the Input category under System Options tab. Select the On Work Plane option in the Mouse Input section. It is important to draw entities always on the Work Plane and not on any other plane On view.

Zoom-in to the windshield area to draw the basic curve.

- Start the **Insert Curve through Control Points** command.
- Pick the four points as shown below.

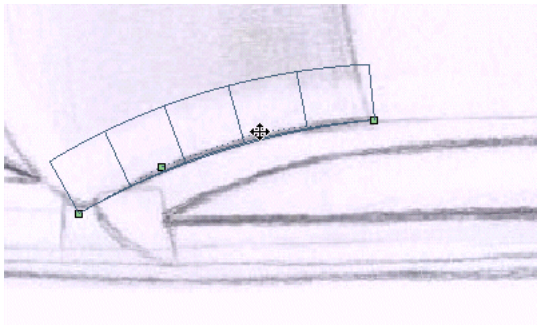


- By Right Mouse Button (RMB), select Info - Curvature. If this command isn't present, follow the Note steps.

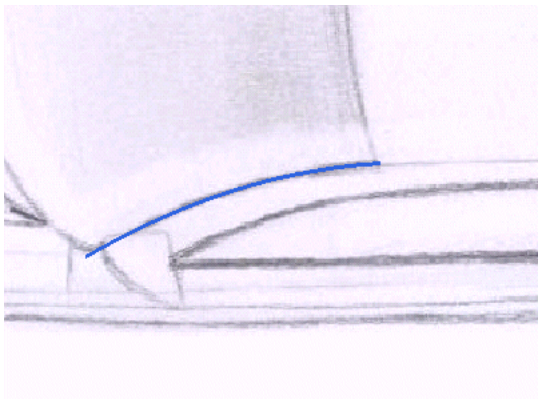
Note: customize context menu

By RMB select Customize and under Commands - Tools, drag the Curve Curvature icon in the current context menu. Every time you'll active the **Insert Curve through Control Points**, in the RMB there will be Curve Curvature command.

Select one or two control points and move the curve to match the curvature of the windshield and also to give it a better internal continuity.



- Hit OK.



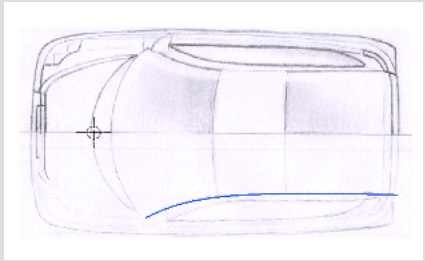
Note: Why are we creating the curves with Control Points mode and not with Interpolation Points mode?

We want to have curves that can trace our object. These curves can be obtained by using any of the line, arc, ellipse, spline, or NURBS curve commands. For NURBS curves we can use either Interpolation Points or Control Points mode. But the former mode always creates a cubic curve, which doesn't help us in tracing the raster image.

What it means... To define a complex shape, the NURBS algorithm -- having degree 3 as constant -- has to increase the number of arcs and control points to keep the internal continuity on curvature. But the Control Points mode creates a NURBS curve with one arc, and the degree is always the number of indicated control points minus 1, with a maximum of 5. In this case, thinkdesign increases the number of internal arcs.

--> Indicating 3 control points you obtain a curve with 1 arc, continuity 1 and degree 2.

--> Indicating 7 control points you obtain a curve with 2 arcs, continuity 4 and degree 5.

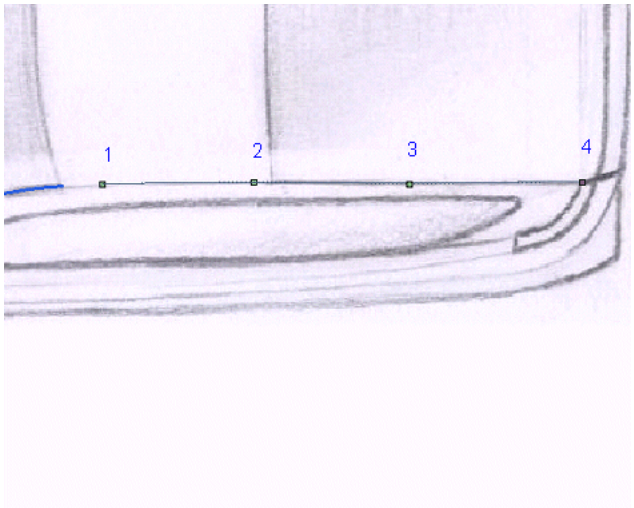


Try to draw a curve as shown in the image above using both modes. Specify the number of points as 5 for both Interpolation Points and Control Points mode. Activate the Curve Curvature. The Control Points mode helps you change the curves of a complex shape and at the same time have a good internal continuity and behavior. Ana-

lyze the curve using **Single Entity Info**.

Repeat the steps we followed to create the first curve. Zoom-in to the hood area.

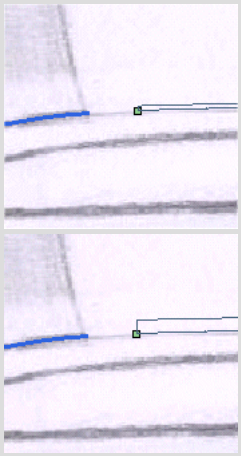
- Start the **Insert Curve through Control Points** command.
- Pick the four points as shown below.



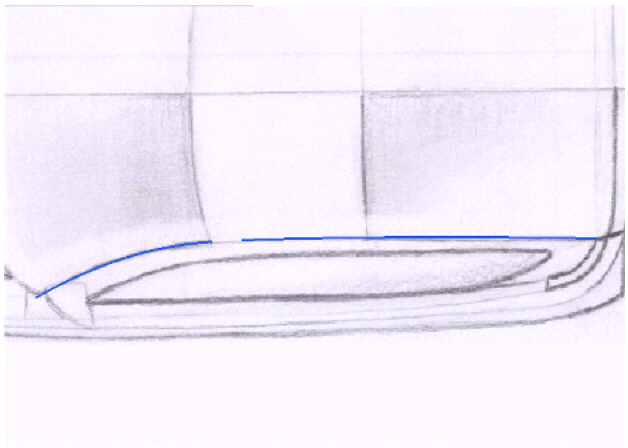
- Check Curve Curvature.

Note:

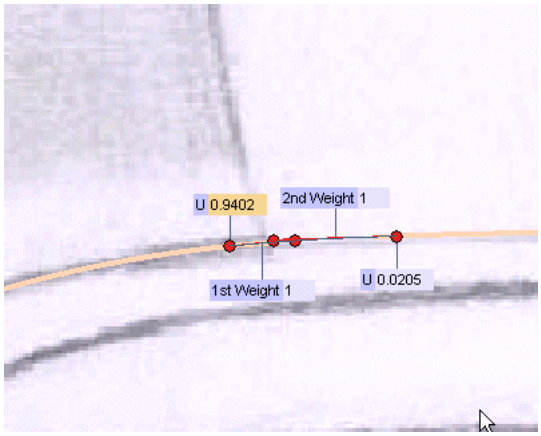
If the curve is flatter than desired, change the Scale value under Curve Curvature to obtain a better representation.



Click on OK to confirm the command. Now let's connect the two curves keeping the tangency at the end points.

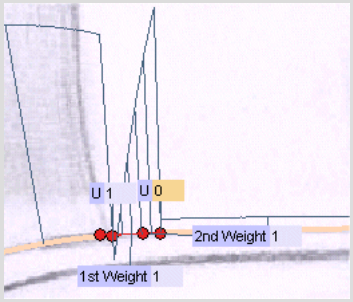


- Start the **Connect Curve** command.
- Select the two curves to be connected as shown below.

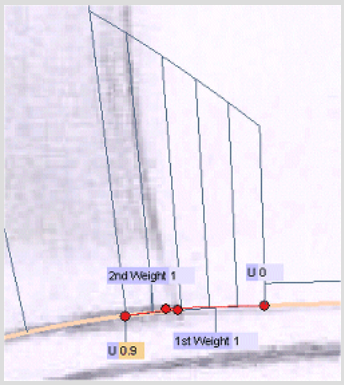


Note:

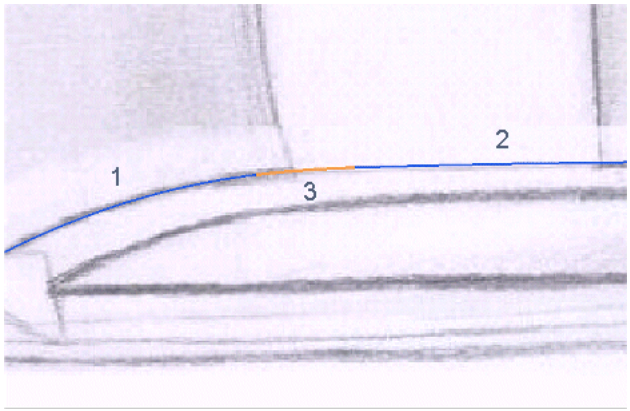
By RBM active Curve Curvature option to show the curve representation. It's important to check and validate the new entity. Usually, as in the above image, we give U1 and U0 respectively as 1st and 2nd parametric positions. Without the curvature line we don't know if there will be some strange behavior due to inflexion points on the curves.



Try to change the U values or the Weight values by dragging the pointers or inserting numbers in the Mini-Dialogs.



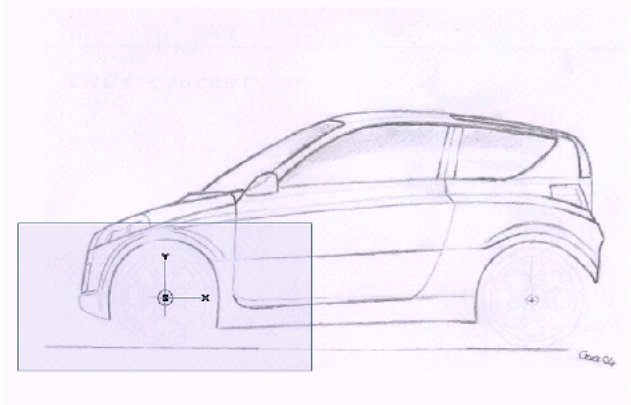
- Hit OK.



3. Step 3 - Trace planar curve (side view)

In this step we'll first create the silhouette curve on side part and then use the same method to create the car's mounting.

- Again click on **Front View**.
- Right click on the Work Plane and choose Set on View.



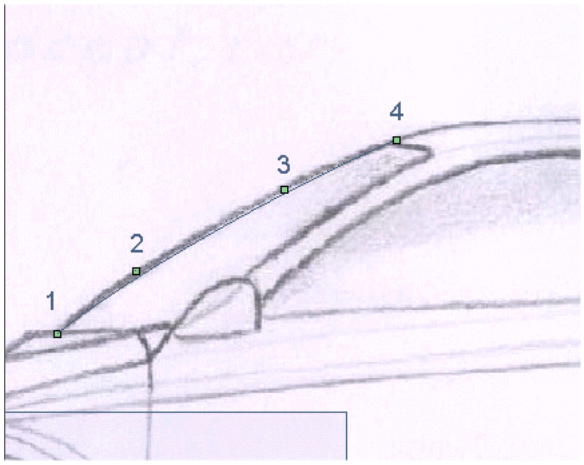
Note: Why Top and Front views for the hood?

To create 3D curves from 2D raster images it is always advisable to use two different views of the same shape.

For the hood, we will choose Top and Front Views. You do not always need to trace precise curves in the sketch limits, but sometimes it's better to imagine a hypothetical stretch of them.

Zoom-in to the windshield area to trace the basic curve.

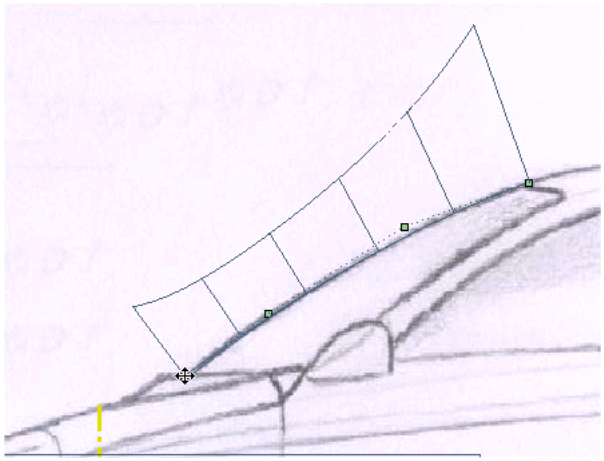
- Start the **Insert Curve through Control Points** command.
- Pick the four points as shown below. The points are used to indicate the shape of the curve first. You can adjust the shape using these points to get a better result.



Note: Why use curve through Control Points and not another method?

It is a better mode to control the shape and behavior of the track, especially for cusped or inflexion points. If you take the image above as reference, points 1 and 4 are limits of the planar NURBS curve; points 1-2 and 3-4 give the tangent's vector at the entry and exit; points 1-2-3 and 2-3-4 give the curvature.

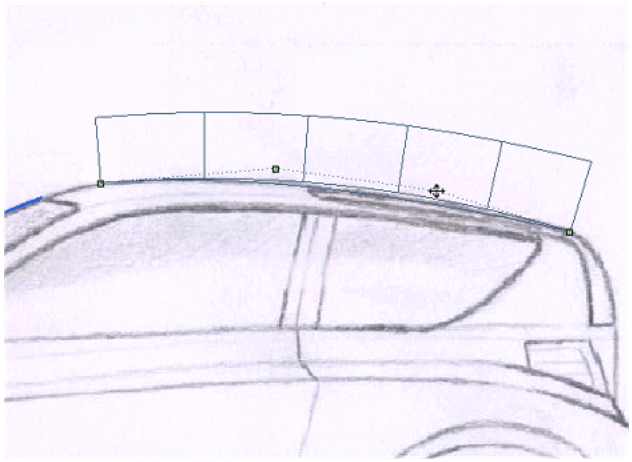
- Check Curve Curvature.



- Hit OK.

Continue following the same guide. Our goal is not to create all the entities with Control Points command -- sometimes it is advisable to generate the primary curves and link them through the **Connect Curve** command.

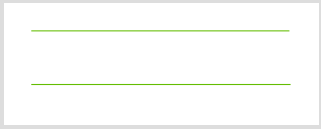
- Start the **Insert Curve through Control Points** command.
- Pick the four points as shown below



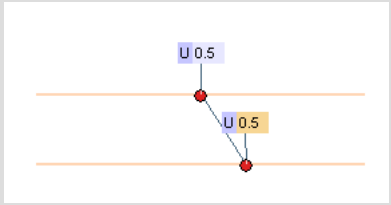
Note: How to place the four control points at intervals?

You can move, delete or add the control points at any point in time. The distance for each is given from the curve that you have to make and is compared from its curvature (max distance for a line - less distance for an arc with a little radius).

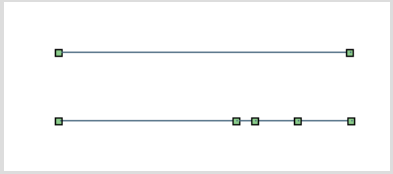
Other mathematical concepts could be given for the Uniform or Not Uniform curves, especially in the internal parameterization.



We could think of two simple lines.



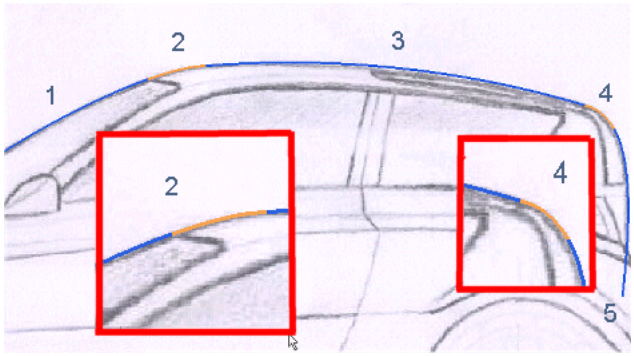
But using a connect curve between their 0.5 parametric middle points, we obtain a strange result.



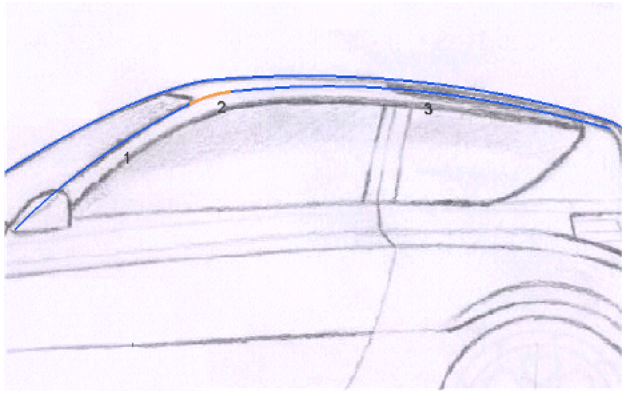
We would suggest for you to use the **Fit Curve** command on the second line.

- Check Curve Curvature.
- Hit OK.

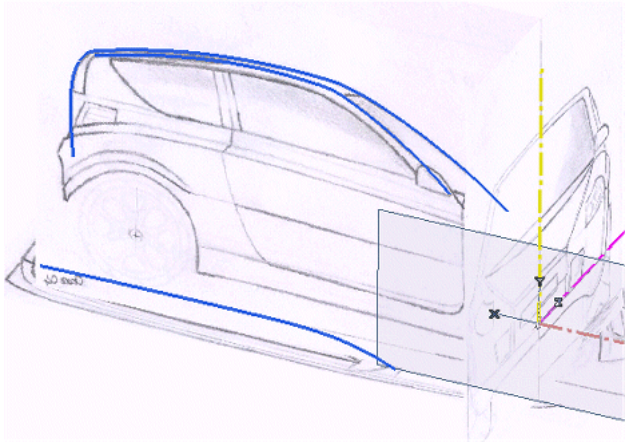
- Use **Connect Curve** twice to join the three curves as shown in the image below.



You've just created the silhouette curve on the side part. Use the same method to create the car's mounting as shown in the image below.



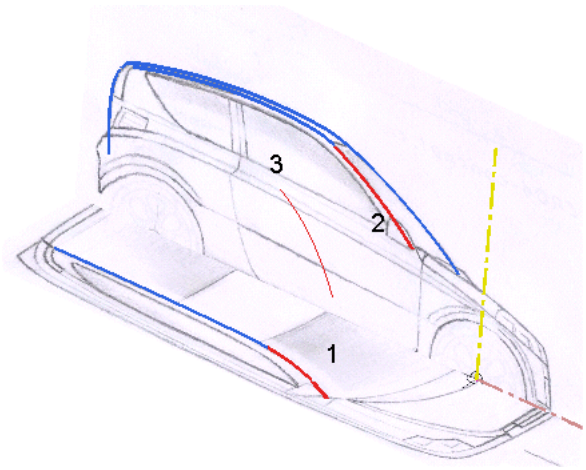
Rotate the model to see the basic planar curves.



4. Step 4 - Move curve on 3D space

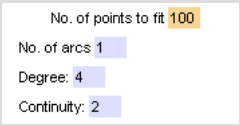
Now with the planar curves we are ready to give the 3D depth using the **Two D to Three D Curve** command.

- Set the **Color** as Red and the **Line Width** as 3.
- For better visualization, hide the front view using **Hide Image**. You can unhide it later using the **Unhide Image** command.
- Start the **Two D to Three D Curve** command.
- Select curves marked as 1 and 2 and hit OK to obtain curve 3 as shown in the image below.

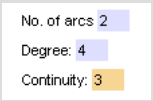


Fitting mode.

Non-uniform 3D curves may have different shapes, behaviors and parameterizations. Using the **Single Entity Info** command, you can find these parameters (Control Points 9 - Arcs 6 - Degree 3 - Continuity 2). The Control points option under the **Fit Curve** command enables you to assign better parameters and still retain the same shape of the curve.

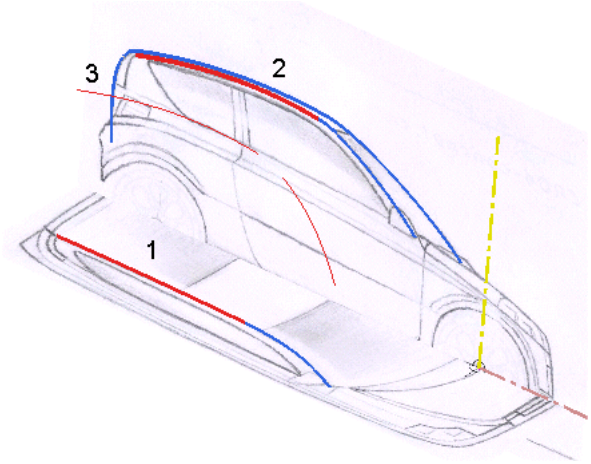


In this command you have the possibility to impose one internal span (1 Arc -Bezier) and if necessary increase the No. of arcs (Continuity has to increase to max geometrical law value). Look how the control points are disposed.

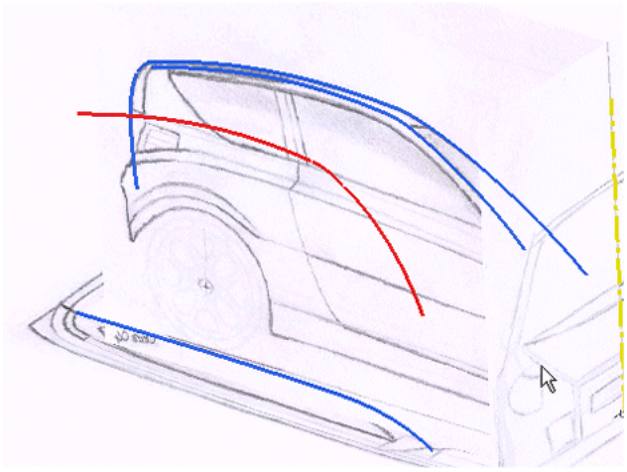


Now is important to check the distance factor between the old and the new curve under Quality Checks. It has to be about 0.001 mm in this case, or could be 0.1 mm if you work with a real scale model.

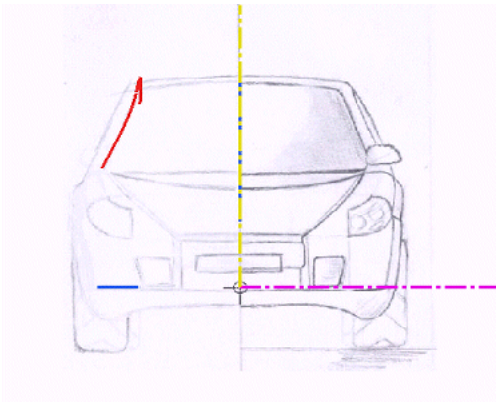
Repeat the 3d curve creation with the rear curves (see image below).



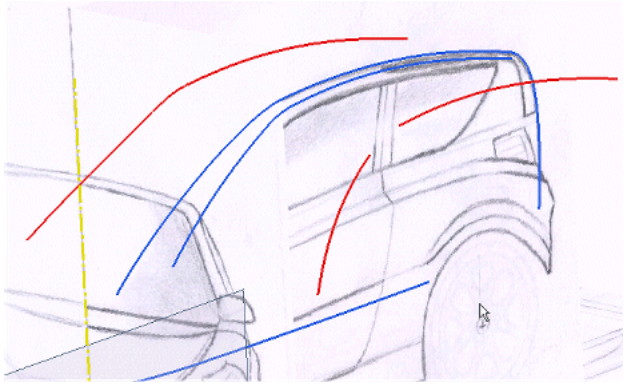
The two new curves can be joined using the **Connect Curve** command or by using the **Two D to Three D Curve** command and selecting the connect curves of the front and rear curves.



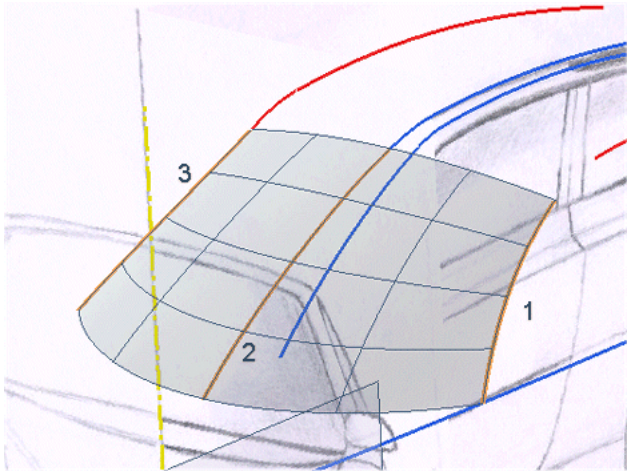
- Click on **Left View** to observe the 3D curve's behavior.



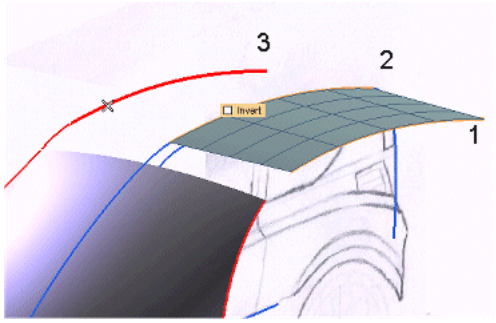
- Click on **Front View**.
- Right click on the Work Plane and choose Set on View.
- Set the Color as Grey and the Line Width as 1.
- Rotate the view with right mouse button.
- Start the **Mirror Entities** command.
- Select the 3D curves as Entities and choose Perpendicular to axis & through point as the Symmetry plane. Then select Parallel to Z and through point for the Axis.
- Select the Copy option and click on OK.



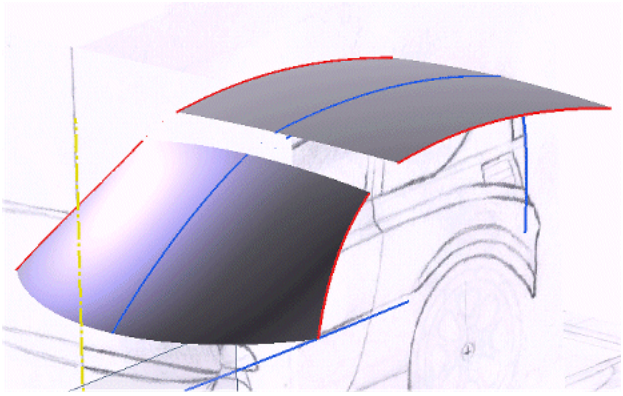
- Start the **Lofted Surface** command.
- Select marked curves as Boundary Set A.
- Hit OK.



- Start the **Lofted Surface** command.
- Select marked curves as Boundary Set A.
- Hit OK.



Applying the **Lofted Surface** command we got the geometry that shows the windscreen and the roof as shown in the image below.

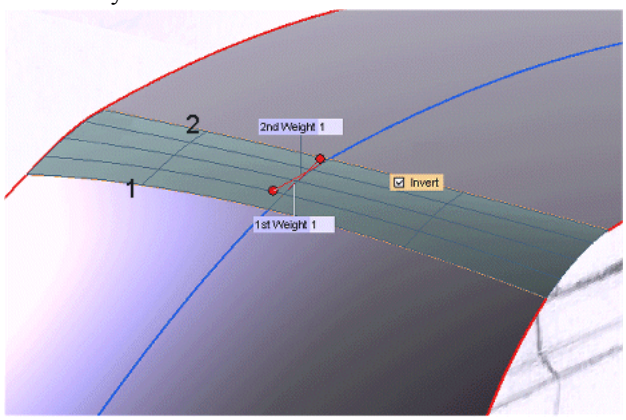


5. Step 5 - Surfaces

In this step we'll show you different ways of connecting the two surfaces we created in the previous step. Let's try **Connect Lofted Surface**, **Blending Shapes**, **Grid Lofted Surface** and **Capping** commands and decide on

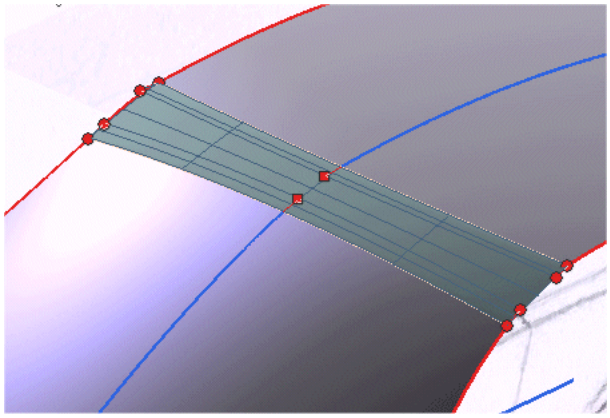
one that suits our needs the best.

- Start the **Connect Lofted Surface** command.
- Select the marked surface boundaries (1 & 2) as Boundary Set A as shown in the image.
- Modify the value to obtain a better surface. Hit OK to complete.



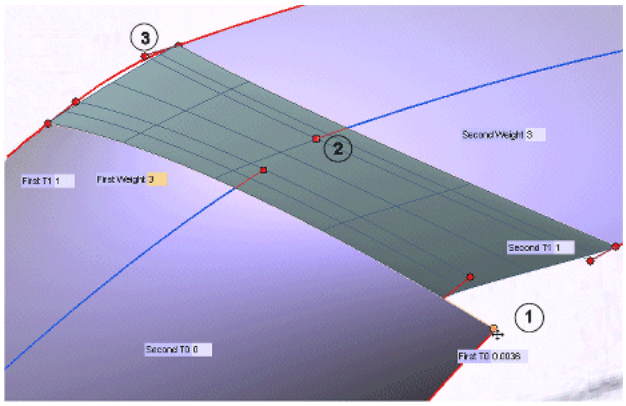
The next command works similar to the first one but shows how to blend the groups of surfaces with one.

- Start the **Blending Shapes** command.
- Select the upper surface boundary as First Curves.
- Select the other boundary as Second Curves.
- Hit Preview.



Some information: In the Selection List you will find a lot of possibilities to impose better continuity and shape condition. Certainly to obtain a good result we have to search for a good basic surface, and take into account these factors:

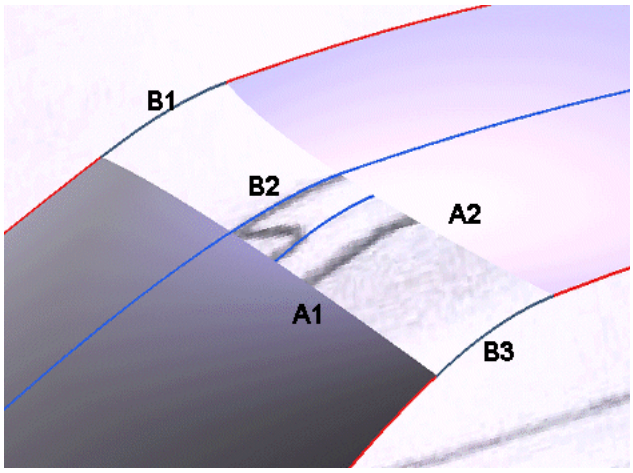
1. Possibility to reduce the parametric start or end points of both new boundaries.
2. Dragging the middle reference you can choose the global Weight referred to the current continuity.
3. Dragging the external references you can choose the local Weight referred to the current continuity.



- Hit OK.

You have used two similar commands to create a connecting surface. Now we want to propose work arounds using a grid of curves and boundaries. As shown in the image below you have to create the curves B1 and B3. You can use the previously generated curve using **Two D to Three D Curve** or create new entities using **Connect Curve**.

- Start the **Grid Lofted Surface** command.
- Select the boundaries marked A1 and A2 as Boundary Set A.
- Similarly select B1, B2 and B3 as Boundary Set B.



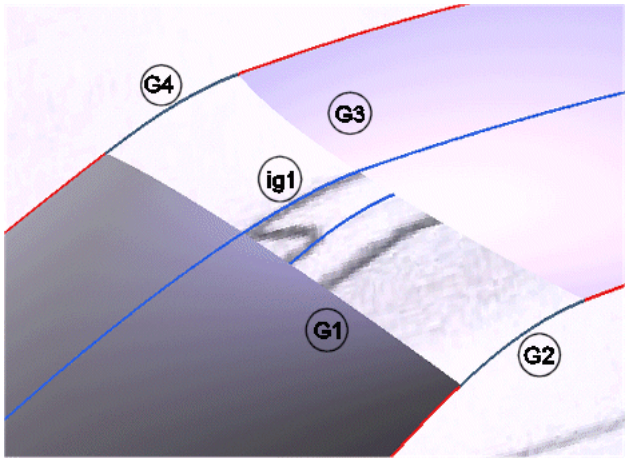
- Set ContinuityTangent in both minidialogs.
- Hit OK to complete.

Blending Shapes and Side Curve.

Starting again the **Blending Shapes** command, you can obtain a simila result using Side Curves. You have also the possibility to assign the two side curves to close the domain and force the result to pass through.

Now try the **Capping** command. It's easy to use this command but the only condition is that the curves selected become a closed loop.

- Start the **Capping** command.
- Open Constraint Boundary curves.
- Select the marked surface boundary G1 as Group 1 and impose ConstraintPosition + Tangent.
- Select the marked curve G2 as Group 2 and impose ConstraintPosition.
- Select the marked surface boundary G3 as Group 3 and impose ConstraintPosition + Tangent.
- Select marked curve G4 as Group 4 and impose ConstraintPosition. .



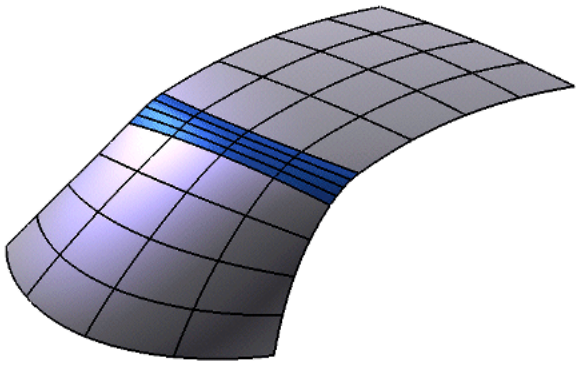
- Open Constraint internal curves option.
- Select the marked curve ig1as Group 1 and impose ConstraintPosition.
- Hit Preview.
- Open Precision window and change the No. loops to 6 and No. points to 30.
- Check Enable under Approximation.
- Hit OK to complete.

Note: Are the results same?

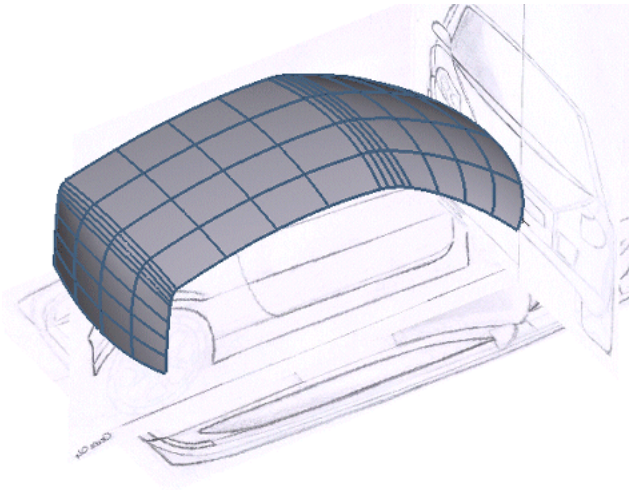
For each command look at the isoparametric curves of all surfaces with **Shaded View and Boundaries**. You'll find that only for the capping mode, the isoparametric curves of new surface are not aligned with others. In fact, the capping surface is created with the GSM engine on a basic temporary surface. Follow the next step that explains how you can give better internal parameters, perhaps to use in other circumstances.

- Delete the last surface.
- Start **Lofted Surface** and select G1 and G3 boundaries to make one ruled surface.
- Hit OK.
- Again start the **Capping** command.
- Open Constraint Boundary curves.

- Keep the same selections you made earlier or hit to recapture last selection.
- Open Generic Shape and choose Existing surface.
- Select the ruled surface as Surfaces and Normal as Projection type.
- Hit Preview and OK.

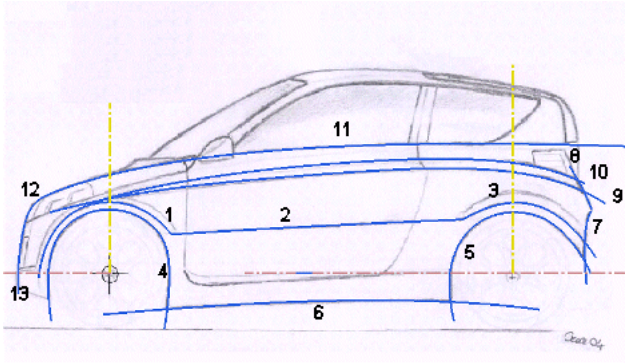


Now you have all the info to complete this task. Similarly, try to generate the surfaces for the rear window.



6. Step 6 - Other Planar Curves

As explained in the previous step, you have all info to make the marked curves below.



Note: When to use 3, 4, 5 or more control points?

Take as reference the curve number 2 in the above image. It's a regular curve with a possible constant curvature; so 3 control points are enough. Curve number 6 has smooth continuity but could have two different curvature values, hence 4 control points may be sufficent. In curve number 9, the continuity may differ as it is in the rear of the car where there is a rapid change of curvature. In this case 5 control points may be required to define the curve.

Note: How to control the movement of the control point?

Select the control point that you want modify and move the cursor. You obtain a free movement always on current work plane and its parallel plane or respect view planes..

Select a control point, press one of the following keys and move the cursor:

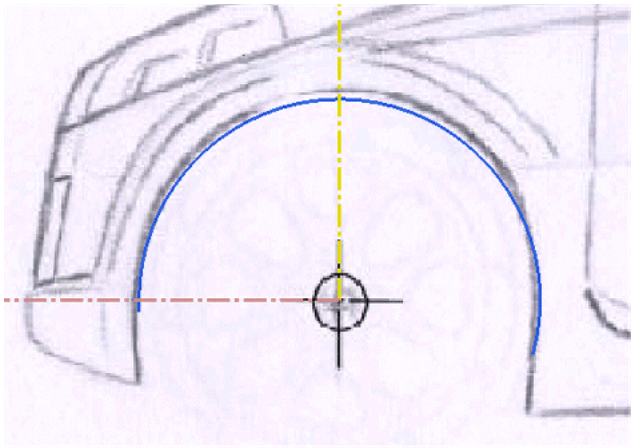
- H to move along the horizontal direction of the screen .
- V to move along the vertical direction of the screen.
- D to move along the depth direction (the one perpendicular to the plane of the screen).

- X to move along the X direction of the World Plane .
- Y to move along the Y direction of the World Plane .
- W to move along the Z direction of the World Plane.

Other mode is to press more time the same keyboard buttons, X for example, to move by intermediate steps in the indicated direction. Shift + X to move in opposite direction.

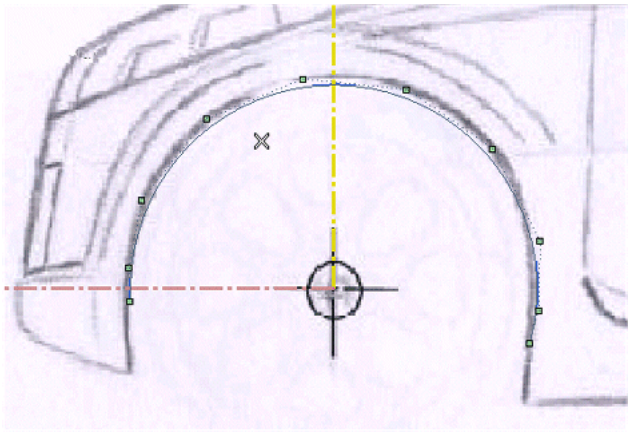
Let's now look at a possible method to create the fender curve over the wheel, starting from a specialized entity; an arc in our case.

- Create an arc, with its center on **Work Plane Origin** and radius 45 mm.

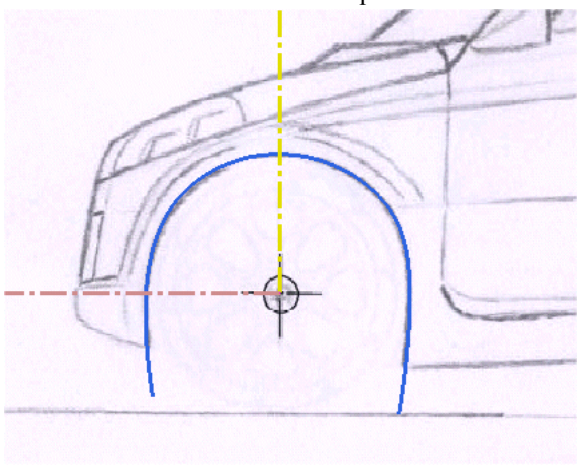


- Start **Convert to NURBS (Curves)** command and select the arc.

- Set Fix Tolerance and Max. control points 100 and Tolerance 0.001 mm.
- Uncheck Specialized.
- Hit OK.



- Start **Modify Curve Control Points** and select the curve. Drag and move the control points, change the curvature to obtain the better shape as shown below.

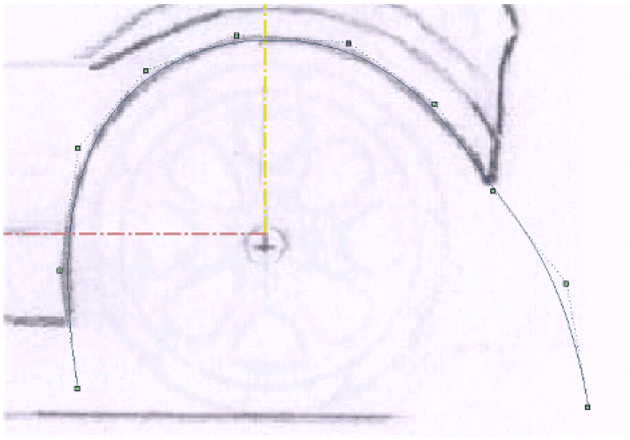


- Right Click the curve at the rear axle and click **Move Copy Entities**.
- Select Start point in the Selection List and pick the Work Plane origin.
- Select End point and click the center of the rear wheel as shown.
- Check Copies to 1.
- Hit OK to copy the curve to the new position.
- Right the second curve and click **Modify Curve Control Points**, drag and move the control points to change the curvature and obtain the better shape as shown below.
- Hit OK to complete the modification.

Curvature Map.

It is recommended to use the Curvature Map Analysis to determine the curvature of the curves that you are

sketching -- to make sure they do not have any sharp points or cusps in them. This check can be made using the Curvature option in the **Modify Curve Control Points** command.



- Use **Insert Curve through Control Points** command to sketch the remaining curves in this view.

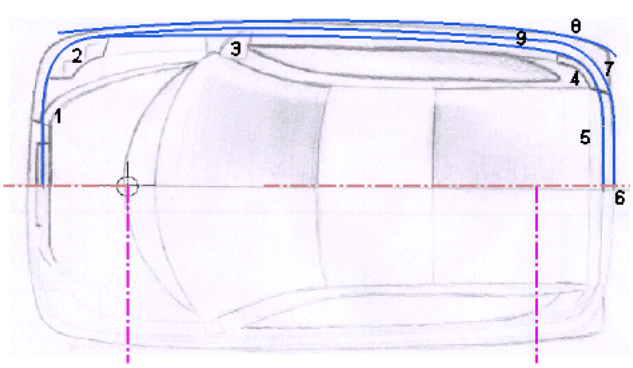
Lets now move to sketch curves in the top view. We will use the Top view image of the car for this purpose.

Utilities

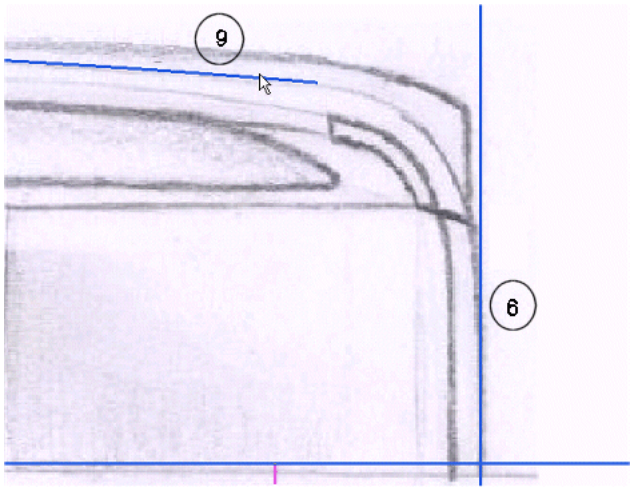
In the download area of the thinkcare web site http://care.think3.com (and after to have entered your Username and Password) you can find a series of tools to use in the 2d or 3d environment. Read the Tools.chm file to get more information. Use the Work Plane Manager commands try to obtain the same results. The commands are:

- Top + WP.
- Side + WP.
- Front + WP.

- Sketch the 9 curves as shown in the image below.



- Curves marked 1-5-6 could be lines.
- For curves, 3-8-9, use **Insert Curve through Interpolation Points**.
- Use **Connect Curve** to make curves 2-4-7.
- Use Edit Mode Control points if needed to get the proper curvature.



At end of your first step you have these curves, ready to project in 3D dimensions and try to define the main shape of car.

After to have been used the commands **Two D to Three D Curve**, **Curve Continuity**, **Join Curves**, **Connect Curve** and so on, you should fit these curves, especially with lots of control points.