GiD

The universal, adaptative and user friendly pre and postprocessing system for computer analysis in science and engineering

User Manual

Table of Contents

1 INTRODUCTION

This manual contains a collection of tutorials and practical information for learning the basics and advanced features of GiD, covering full flow of GiD user from preprocessing to postprocessing going trough meshing, analysis and introduction to customization.

1.1 Models used in this manual

In order to follow some of the tutorials included in this manual some files should be downloaded.

The models are located in GiD official webpage www.gidhome.com in Support->Manuals section.

The models are packed in a zip file and classified by chapters.

2 INITIATION TO GiD

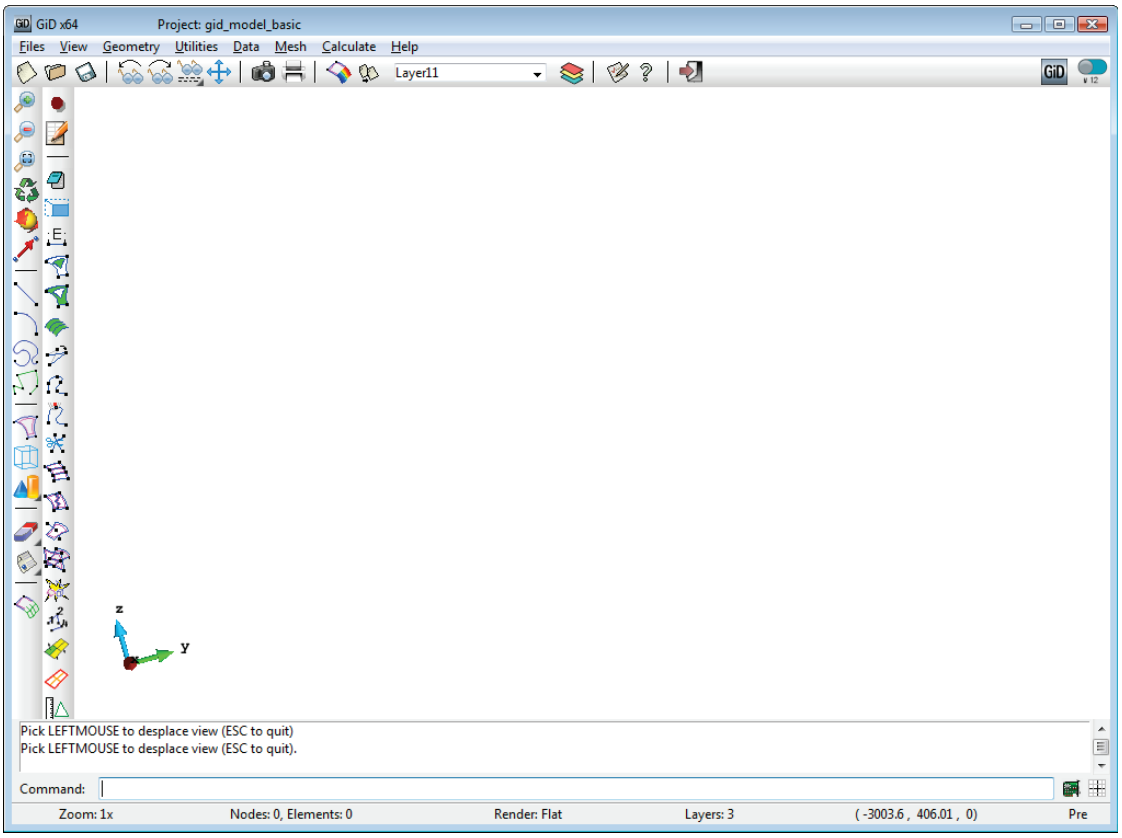
The philosophy of this tutorial is to get familiarized with GiD: how to change the views of the model, how to manage the Layers, and other basic features. Some of this features are both in the preprocessing and the postprocessing parts of GiD, although the examples shown are from the preprocessing one.

Many times the text will make reference to 'entities'. Almost all the options explained in this tutorial are valid both for geometrical and mesh entities, although the examples used are often geometrical ones.

The topics in this tutorial are further explained in the **Reference Manual**. We have selected some of the basic features to give to the user some basic tips to start working with GiD and make the rest of the tutorials.

2.1 User interface

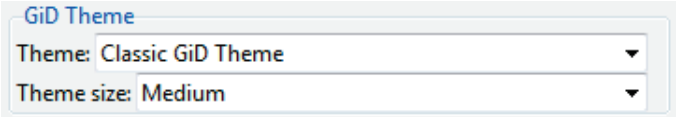
For further information about GiD user interface please consult the General aspects->User interface section in the **Reference manual**.



2.1.1 Change theme

User can choose between Classic and Dark themes, which change drastically the GUI appearance. User can also choose between some icon sizes in each theme.

These options can be changed in **GiD Theme** option inside **Utilities->Preferences->Graphical->Appearance** tab.



2.1.2 Warnline

In some of the operations made in GiD by the user, GiD gives information about what is expected to do by the user. This information is very useful the first times GiD is used as a guideline for the user.

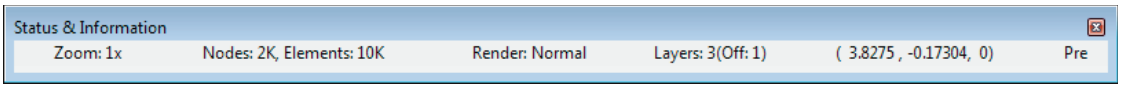
The place were GiD shows this kind of information is the lower part of its main window.

2.1.3 Command line

Using GiD, sometimes the user is asked to introduce data with the keyboard. The 'Command line' must be used for this purpose. It is placed in the lower part of GiD window.

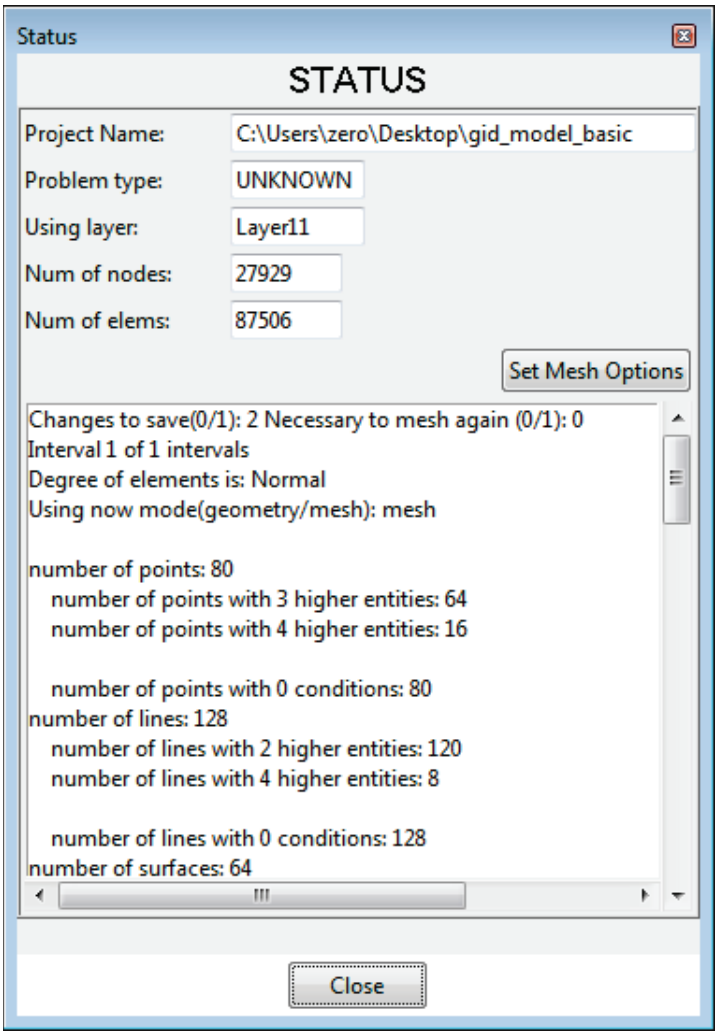
2.1.4 Status bar

The Status & Information bar located at lower part of GiD's Window, provides basic information at a quick glance.



From left to right you can find:

- Zoom factor
- Current number of nodes and elements (Click to acces to Status Window)

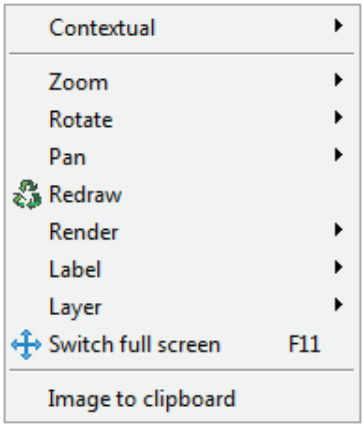


- Current renter mode (Click to change render)
- Number of layers in Pre, number of sets in Post
- Mouse coordinates (Click to open "Coordinate window" in Pre and "Change result units" in Post)
- Current Mode: Pre or Post

2.1.5 Contextual menu

Clicking the right-mouse button on GiD a popup menu will appear with options related to the clicked object.

When picking the main drawing space, on the top appear **Contextual** that is filled with different commands depending on the current GiD state, e.g. when asking for a point they appear options like "Point in line", to select a point over a line, or "Arc center" to select the coordinates of the center of an arc.



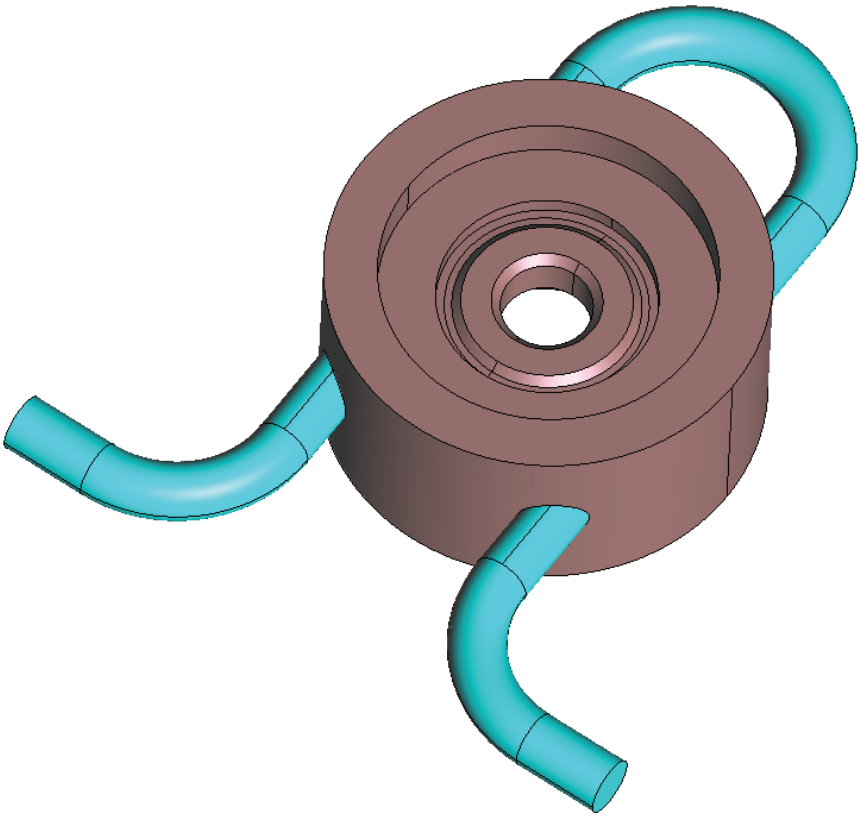
2.1.6 Escape function

An important thing a GiD user should know as a general philosophy of use of the program is the **Escape** key functionality: In almost all the actions performed by the user, to declare the action as done the user should press **Escape** key (or press the center mouse button).

2.2 Load a model

In the **Files** menu user can find the typical operations for managing the GiD projects like save a project, open an existing project, import and export files, print or quit the program. Most of this options are also accessible from the icons toolbar. The corresponding icon is shown in the menu, next to the option.

1 . Click on **Files->Open...** and select the GiD model **gid_model_basic.gid**. GiD also can load a model just with **drag & drop**.The following model should be loaded:

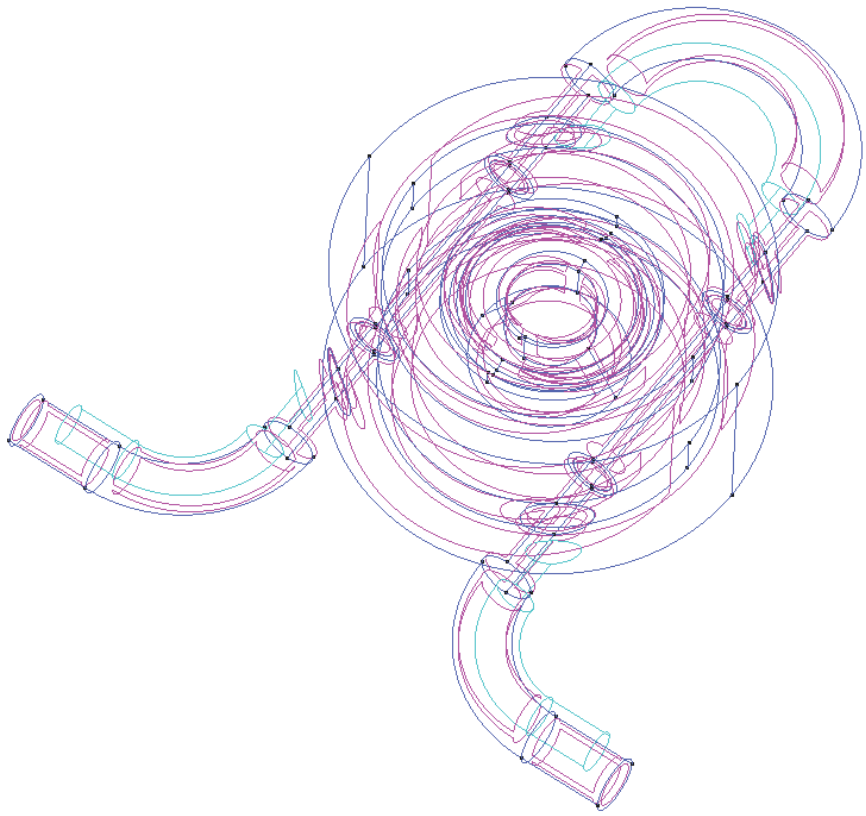


2.3 Render modes

In the **View** menu user can find the **Render** options. They are also accessible from the right mouse button and the status bar.

1 . Select **View->Render->Normal**

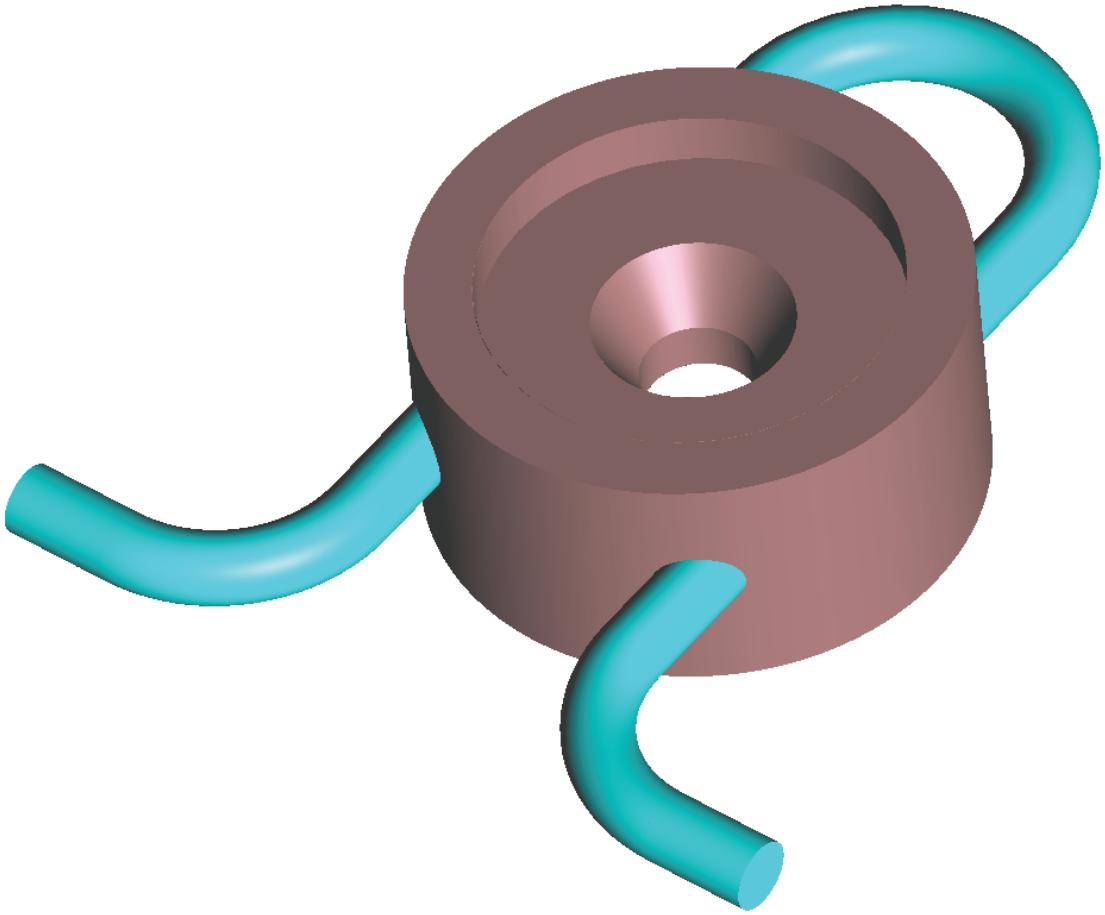
In **Normal** render mode, user can see the entities drawn in different colors, depending on the kind of entity: volumes in light blue, surfaces in pink, lines in blue, and points in black, as it can be seen in the following figure:



2 . Select **View->Render->Flat**

3 . Select **View->Render->Smooth**

Flat render mode draws each geometrical entity using the colour of the layer it belongs to, and **Smooth** mode uses also this criterion, but lines are not drawn to represent the geometry in a smoother way. The following figure shows the visualization of the model using 'Smooth' render mode:



2.4 Change views of the model

In the **View** menu user can find the options to change the point of view in which the model is shown. Many of these options are also accessible by the right mouse button menu, or the icons toolbar.

2.4.1 Zoom

To zoom in or out the model user can choose the corresponding options in the **Zoom** section of the **View** menu or the right mouse button menu.

A user friendly way of zooming the model is to use the wheel of the mouse, or clicking the center button of the mouse while the **Shift** key is pressed.

To get a view which includes the whole model the **Frame** option must be selected.

The icons corresponding the zoom operations are the following ones:

Zoom in: 

Zoom out: 

Zoom frame: 

2.4.2 Pan

To move the view of the model user must select the option **Pan**. This option is accessible from the **View** menu, the right mouse button menu, or moving the mouse while the

Shift key and the right mouse button are pressed.

The corresponding icon for the pan option is the following one:

2.4.3 Rotate

In the 'Rotate' part of the 'View' menu (also present in the right mouse button menu) there are the options to rotate the view of the model.

A user friendly way of rotating is to move the mouse while its left button and the 'Shift' key are pressed.

The corresponding icon for rotating the model is the following one:

2.4.3.1 Set center of rotation

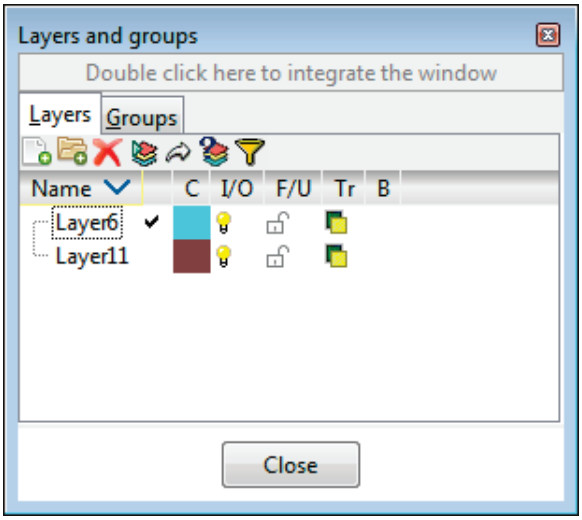
An interesting option for rotating the view of the model is to set the center of rotation. To change it:

1 . Select **View->Rotate->Center** from top menu or **Rotate->Center** from right button mouse menu. Then, the cursor changes into the selection mode.
2 . Select an existing point of the model.
3 . Now rotate the model and check that the center of the rotation is the one selected.

2.5 Layers and groups

A really useful way for organizing the different parts of the model is using 'Layers'.

1 . Open the Layers window by selecting the **Utilities->Layer and groups** option or clicking in the upper icons toolbar. The following window should raise up:

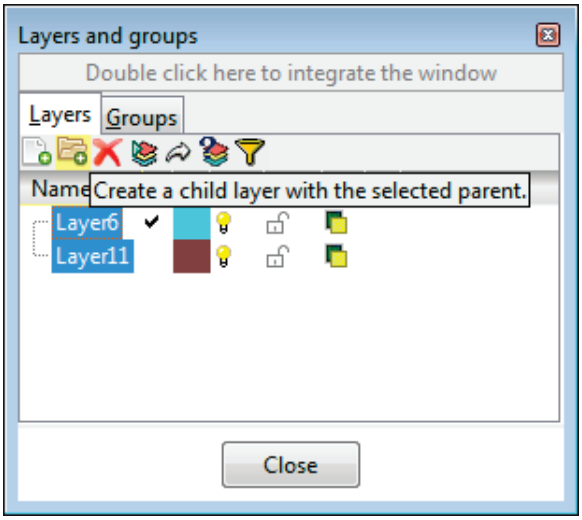


As it can be read in the upper part of the window, if user double click on that part, the Layers window is integrated in GiD window. User can choose to work with the Layers and groups window integrated or not.

All the actions related with layers and groups can be accessed by clicking the right mouse

button onto the Layers and groups window. Most of them can be also used by the corresponding icon in the upper part of the Layers window.

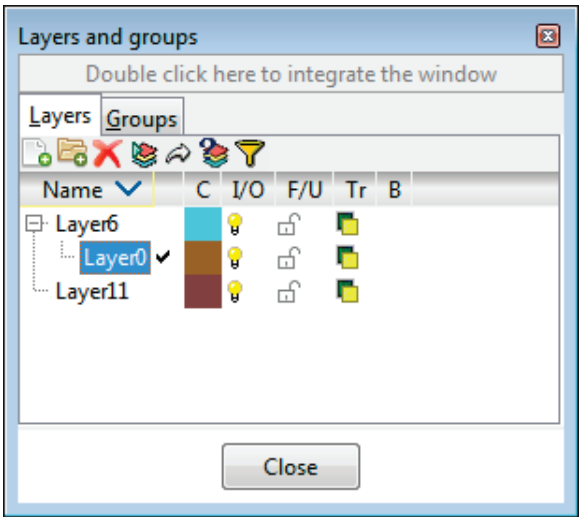
By moving the mouse over the icons of the upper part of the window and staying 2 seconds onto an icon, a help message is shown in order to give the user information about the action associated with the icon.



2.5.1 Create a layer

GiD allows to create a hierarchical structure of Layers, so as a Layer can contain sub-layers. Let's create a Layer into another one as an example:

1 . Select (using the left button of the mouse) the 'Layer6'.
2 . Select the **New child** option in the right mouse button menu, or click in the upper part of the Layers and groups window. Automatically, a layer named 'Layer0' should appear, as shown in the following figure:

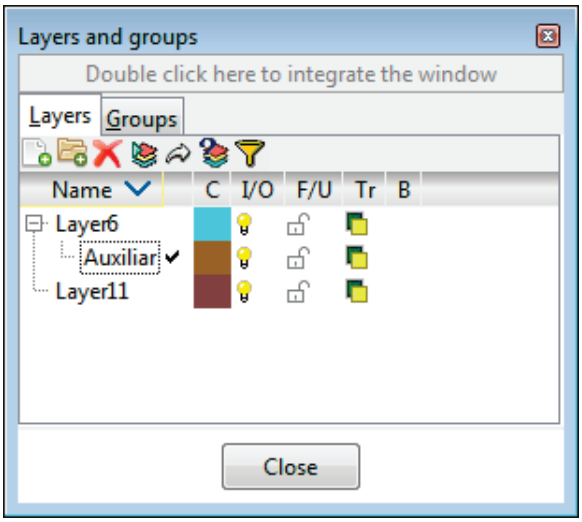


2.5.2 Rename a layer

To rename a Layer user should select the layer in the Layers and groups window and press **F2** key, or select the **Rename** option in the right mouse button menu.

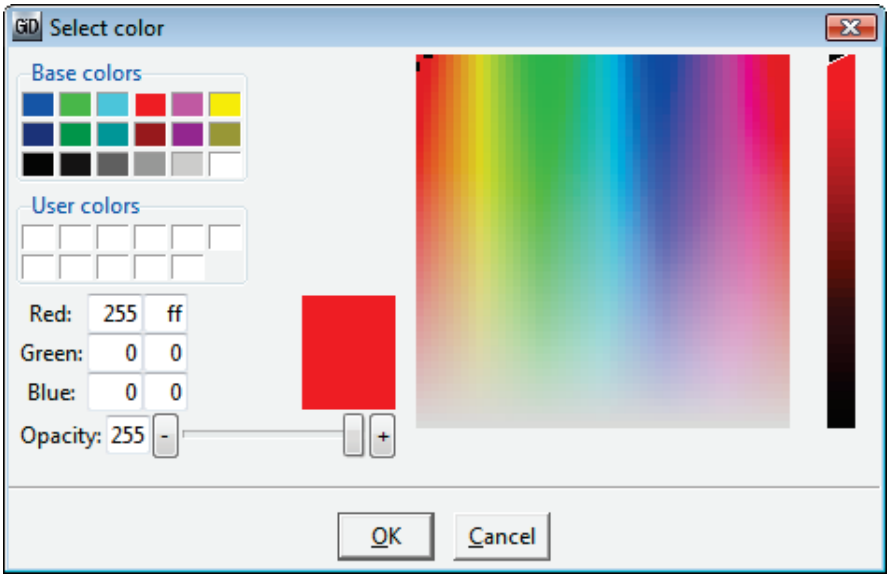
1 . Select the Layer0
2 . Rename it to 'Auxiliar'

Now the Layers window should look like the following picture:



2.5.3 Change the color of a layer

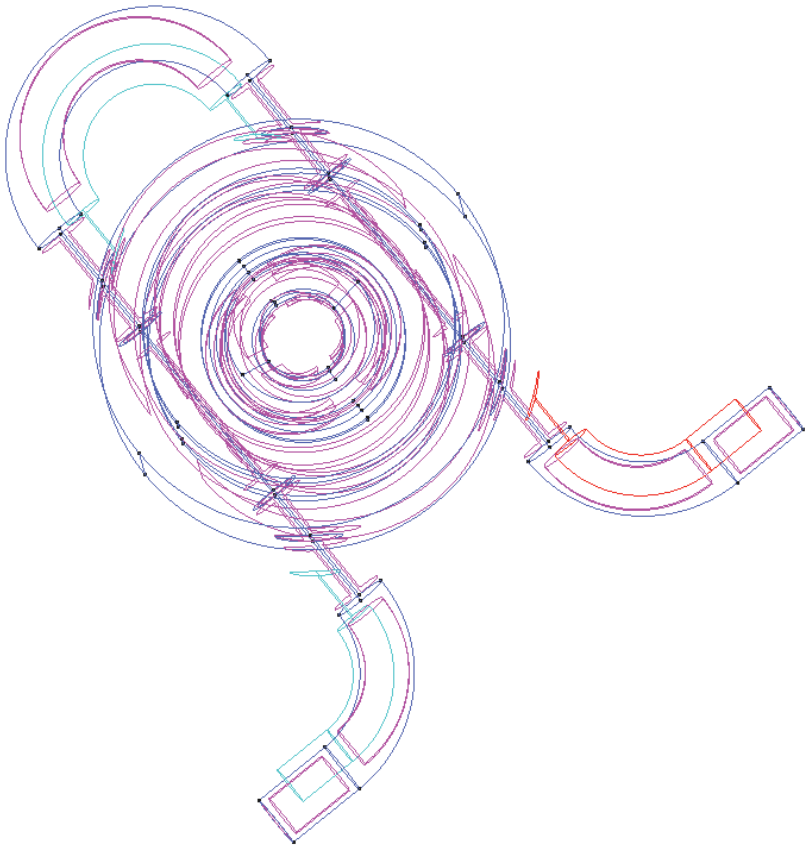
By clicking on the colored square next to each layer name, the following window pops-up, allowing the user to change the color of the layer:



2.5.4 Send entities to a layer

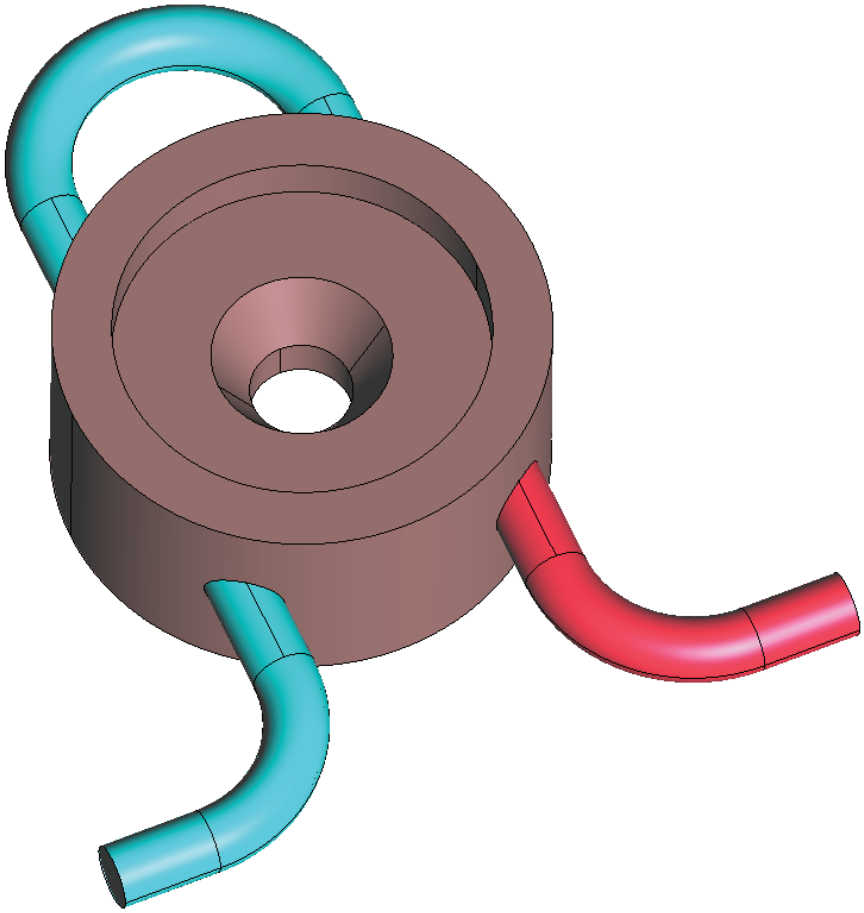
User can send entities to a specific layer. As an example we are going to send to the layer 'Auxiliar' a part of the model:

1 . Select the layer 'Auxiliar' in the Layers window
2 . Select the option **Send to** from the right mouse button (or click icon)
3 . Select **Volumes** and select the volume shown in red in the following figure:



4 . Then press **Escape** to exit the selection mode.

5 . Set the render mode to **Flat**. The color of selected volume has changed to the one of the layer 'Auxiliar', as shown in the following figure:



2.5.5 Switch On/Off

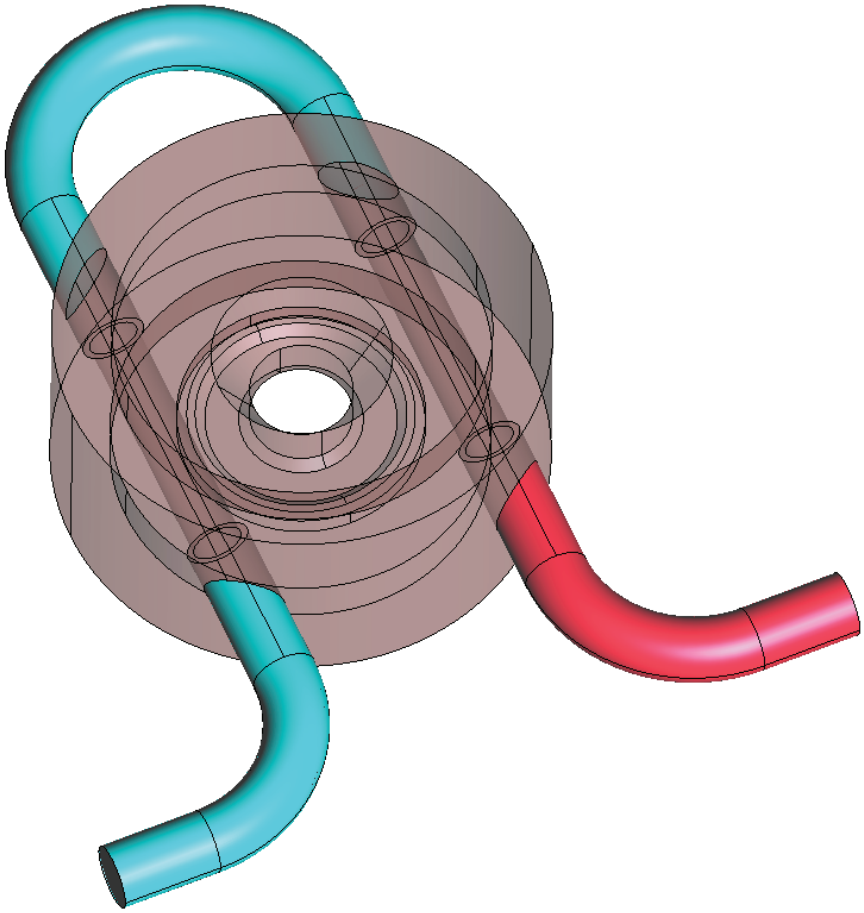
By clicking on the icon which is next to each Layer inside the Layers and groups window, user can switch on and off the corresponding layer. This is very useful in order to visualize just some specific parts of the model.

2.5.6 Freeze a layer

At the right side of the bulb, user can set an icon which is a lock. If the lock is closed, the layer is frozen. If a layer is frozen, GiD won't apply anything to the entities of that layer. For instance, if user select some entities to be deleted, if they are into a frozen layer they won't be erased.

2.5.7 Transparency

Next to the 'lock' icon of each layer is the transparency icon. By clicking there, the user can set a layer to be transparent or not. The following figure shows the model with the Layer11 set as transparent:

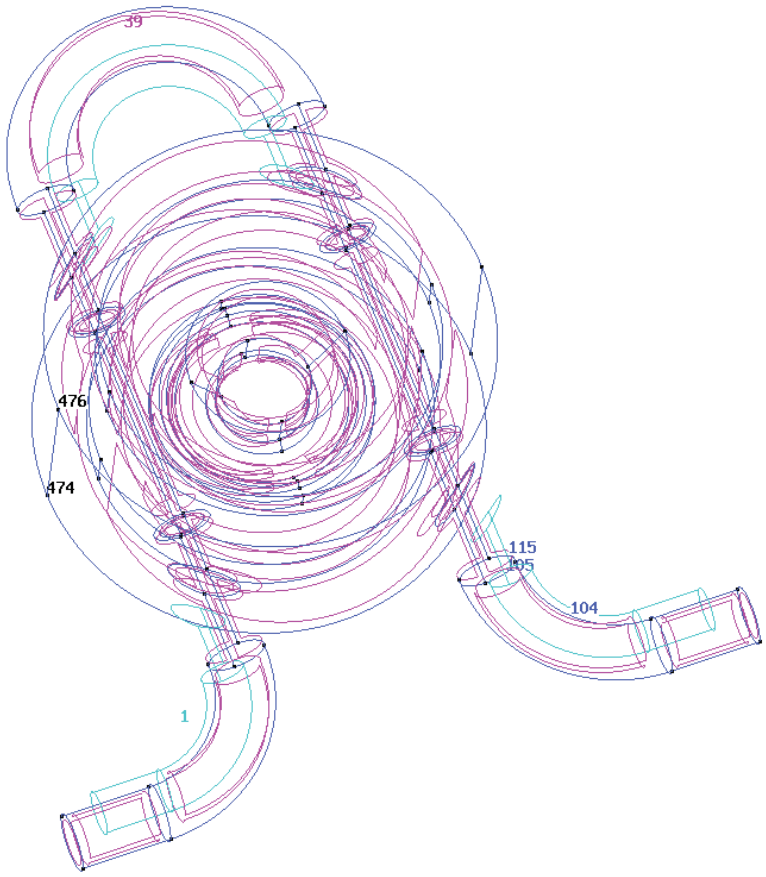


2.6 Entities information

2.6.1 Labels

Using the option **Labels** present in the **View** menu (and also in the right mouse button menu), user can see the number of the entities of the model. Either for points, lines, surfaces or volumes user can choose between viewing the numbers of all the entities, or just the selected ones.

In the following figure the model can be seen with the number of some entities:



As it can be seen, the colors of the numbers of the entities follows the philosophy of the colors of the entities in GiD (volume numbers are in light blue, surface numbers are in pink and so on).

In order to get a better visualization set the render mode to normal when showing labels.

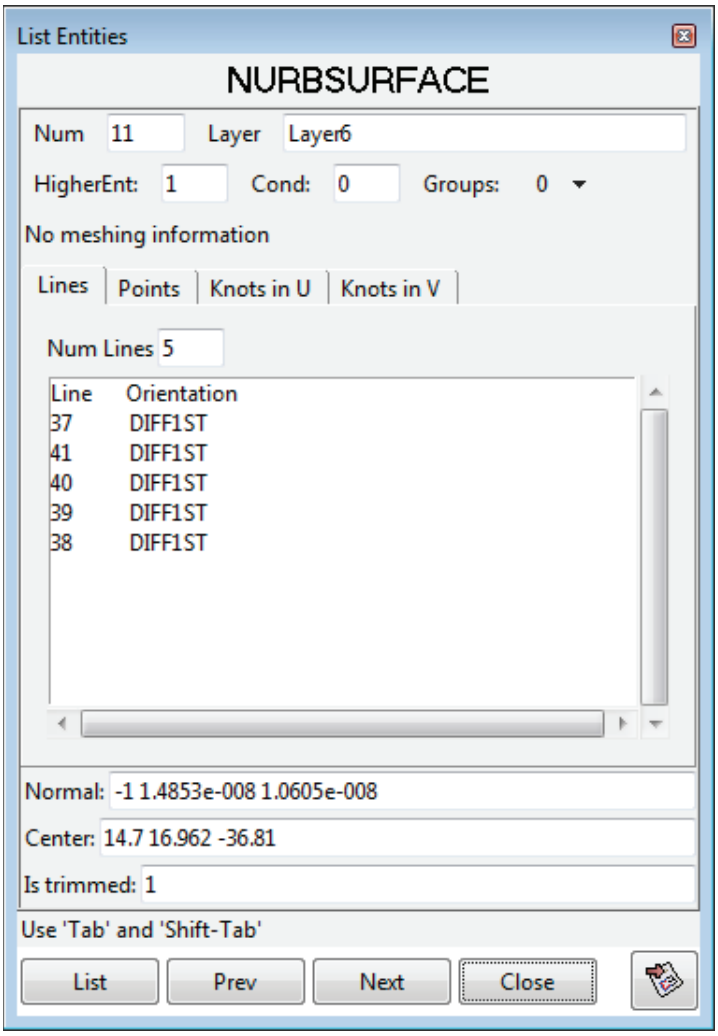
2.6.2 List entities

User have also the option of viewing all the characteristics of a specific entity by selecting **List** in the **Utilities** menu (or clicking in the icons toolbar).

For example:

1 . Select **Utilities->List->Surfaces** in the top menu
2 . Select some surfaces of the model
3 . Press **Escape**

An example of the information got using this option is the following figure:

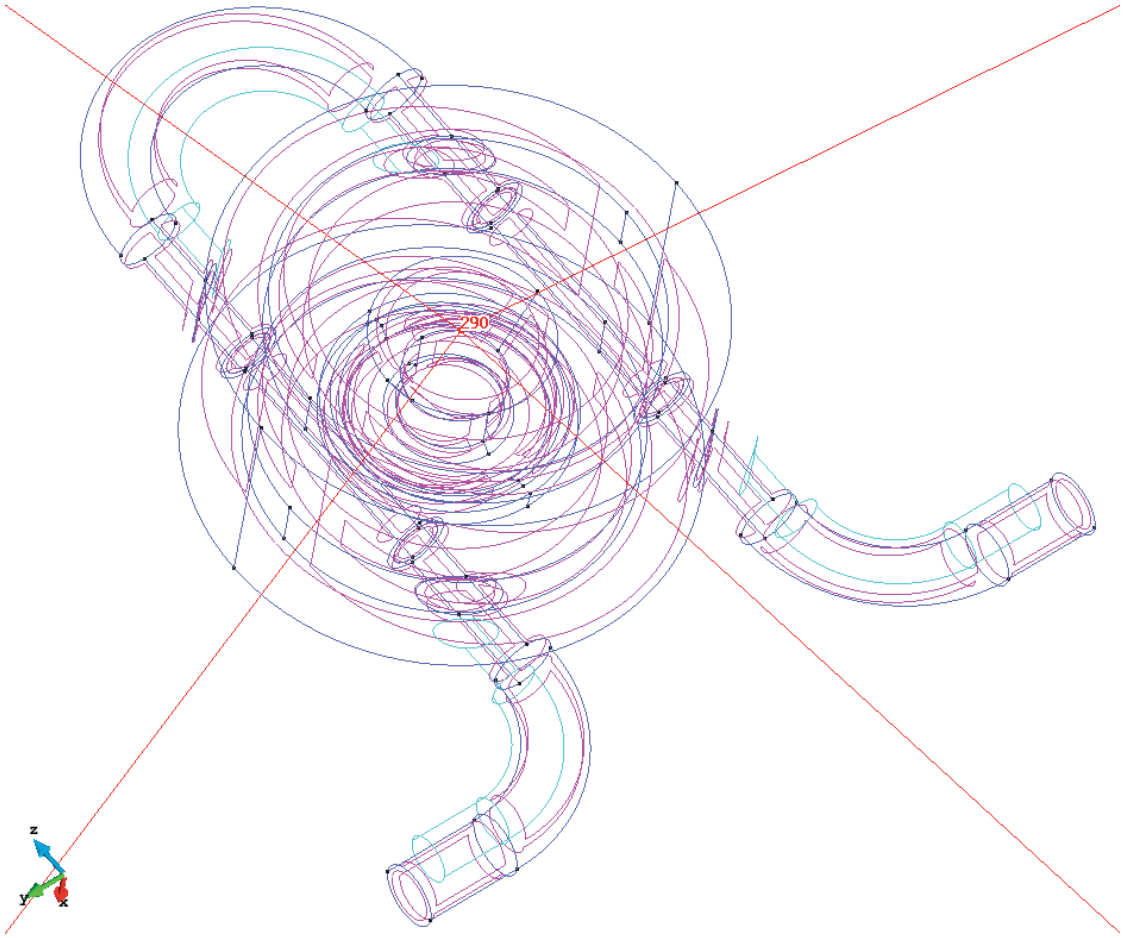


2.6.3 Signal

In complex geometrical models sometimes it is hard to localize an specific entity. Using the **Signal** option in the **Utilities** menu user can know graphically where the entity is, as GiD shows with a red lines cross its potition.

As an example we will signal the line number 290:

1 . Selec **Utilities->Signal->Lines**
2 . Write in the Command bar the number 290 and click ENTER. The result is shown in the next figure:

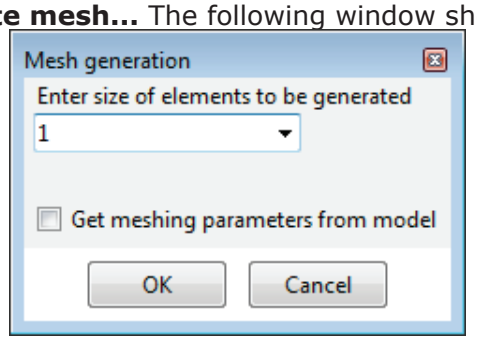


The red lines are centered always onto the specific entity independently on the rotations or view movements.

2.7 Geometry and Mesh modes

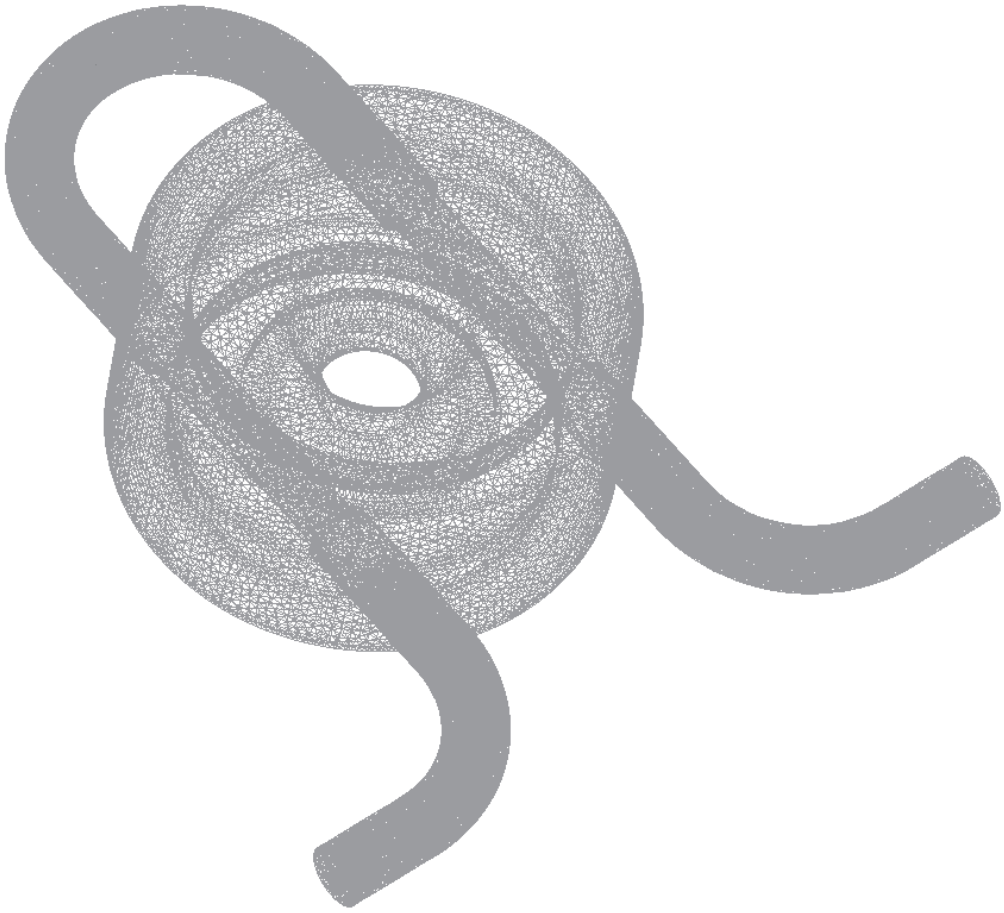
In the preprocessing part of GiD there are two basic modes the user can work with: geometry and mesh. Just in order to see how the mode can be changed we are going to generate a mesh with all the default parameters.

1 . Select **Mesh->Generate mesh...** The following window should appear.



2 . Click OK and wait for the mesh generation. Once the mesh is generated, a window pops up and show the user the result from the mesh generation.

3 . Click on 'View mesh' option, and the following visualization of the model should appear:



Now we are in 'mesh' mode. Changing the render mode user can see that the color of the mesh entities also follows the Layer colors.

Selecting **View->Mode->Geometry** user can change to the geometry mode again. The icon in the toolbar switch between both modes

2.8 Pre and Post

GiD basically works in two modes: preprocessing and postprocessing.

To change between both modes please select **Files->Postprocess** or **Files->Preprocess** (or clicking in the upper toolbar).

We will use a different model to work in postprocess mode.

1 . Open the **box3D.gid** project
2 . Select **Files->Postprocess**

2.9 Select and display style

Through the **Select & Display Style** window several options can be specified for volumes, surfaces and cuts. Among these options volumes, surfaces and cuts can be switched on and off, their colour properties can be changed, and their transparency too.

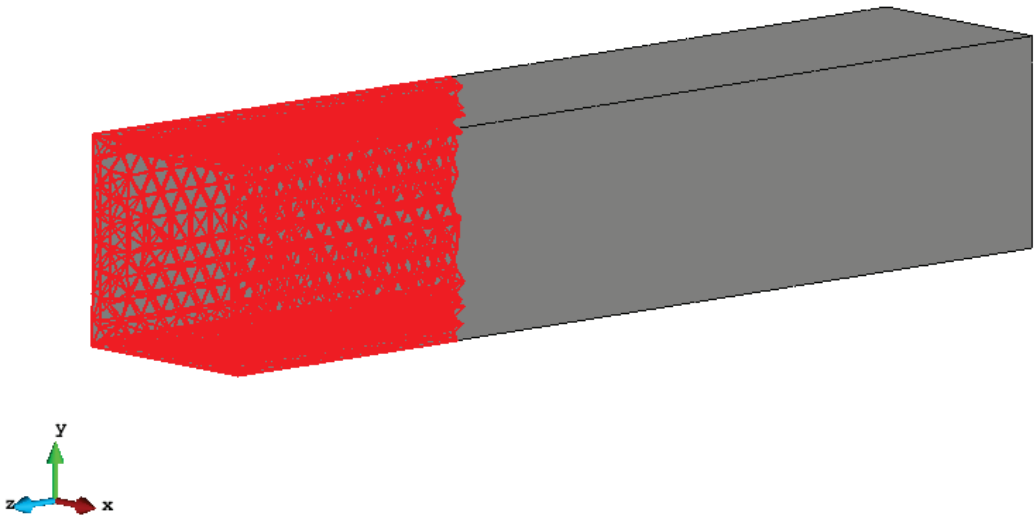
Other interesting options which can be changed are the style of the set and the width of the elements' edges.

From this window, volumes, surfaces or cuts can be deleted or their names can be

modified.

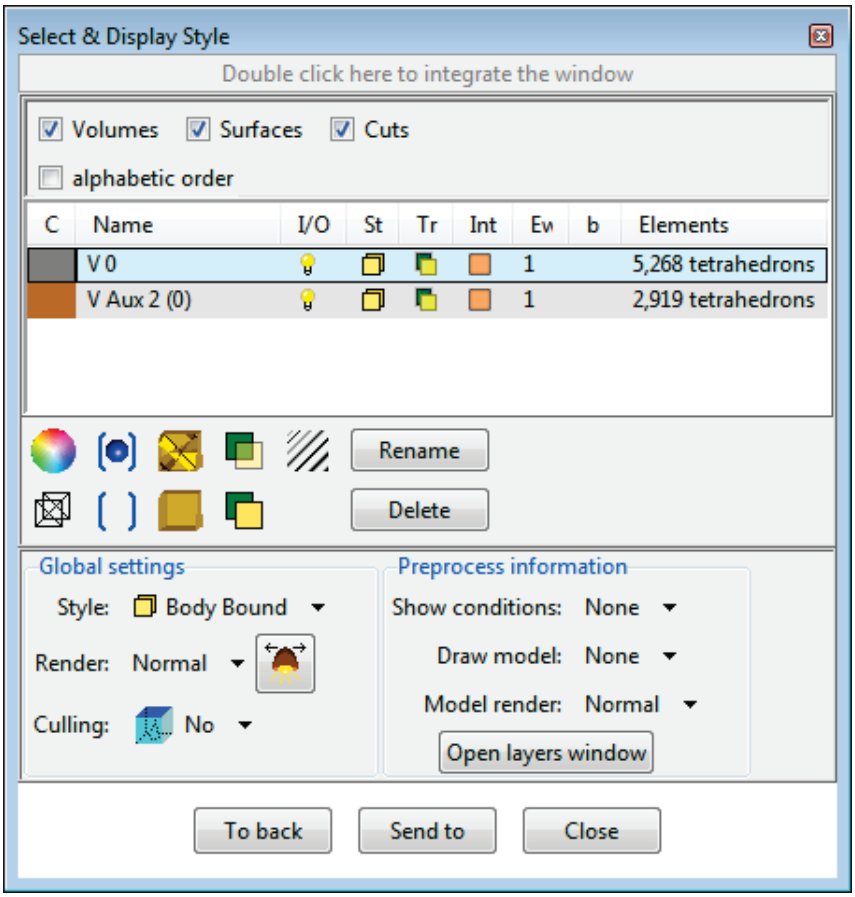
1 . Select **Window->View style...** using the menu bar or clicking on
Our model only has 1 layer. We will create a new layer with some elements.

2 . Press button **Send to->New set long name**.
3 . Select some elements.



4 . Press **Escape**.
5 . A window appears asking for a name. Enter 'Aux'.
6 . Press **Accept**.
A new layer is created with the selected elements. Now we will change the color of the new layer.

7 . Click on the colored square next to the layer name. A new window is opened. Select a new color.
8 . Press **Apply** and then **Close**.



Let's play with some visualization options

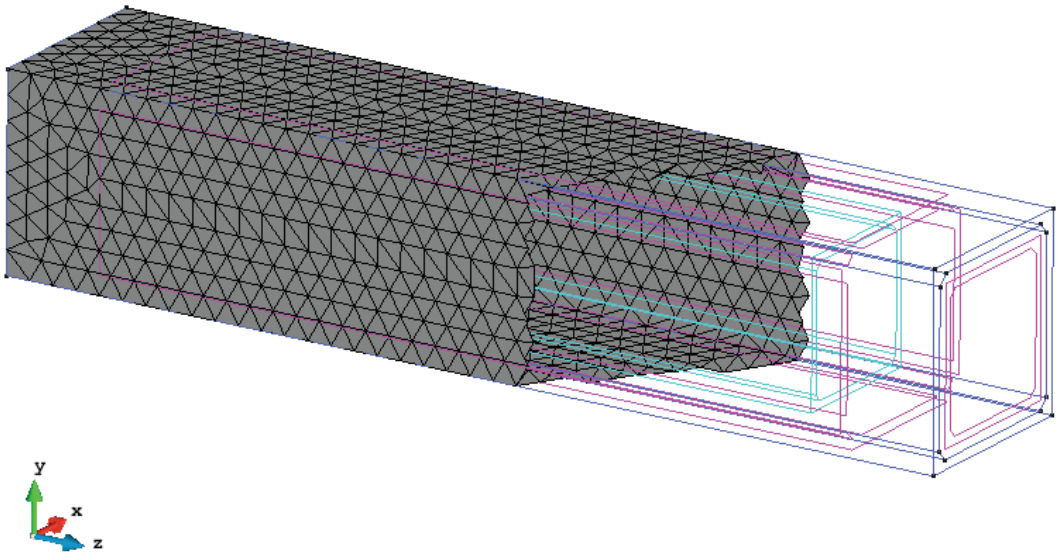
9 . Select **Body Lines** in the "Style" option, at the bottom of the window. You can also do it clicking on in the St column or the same icon in the main window.

10 . Click on the icon of 'Aux' layer in order to switch it off.

It's possible to draw preprocessing information, for example the geometry.

11 . In **Draw Model** option select **Geometry**

Now our model should look like this:

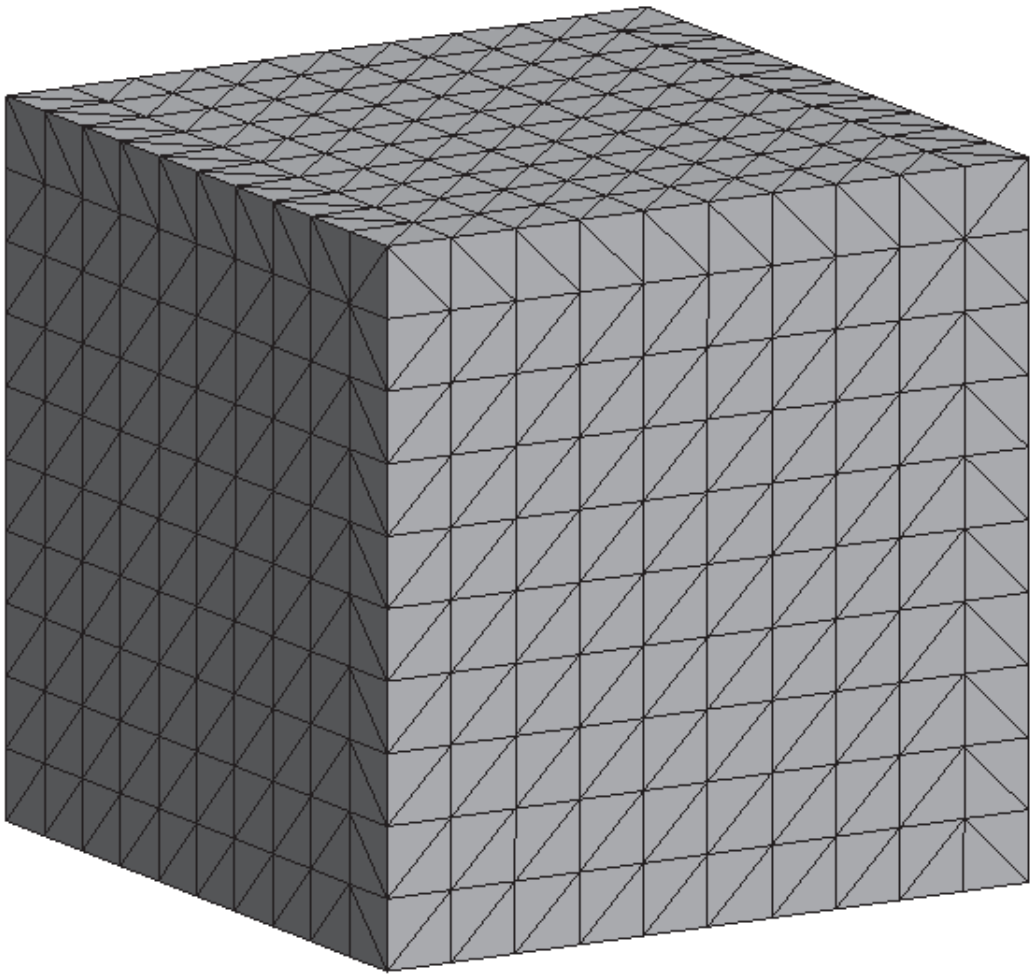


NOTE: The View style window can be integrated inside GiD interface, just double click on the upper bar of the window. To tear it off again, double click the upper bar again.

NOTE: Mesh styles can also be changed clicking on the icon , placed in the left icon bar. This style affects all sets of the model.

3 INITIATION TO PREPROCESSING

With this example, the user is introduced to the basic tools for the creation of geometric entities and mesh generation.



3.1 First steps

Before presenting all the possibilities that **GiD** offers, we will present a simple example that will introduce and familiarize the user with the **GiD** program.

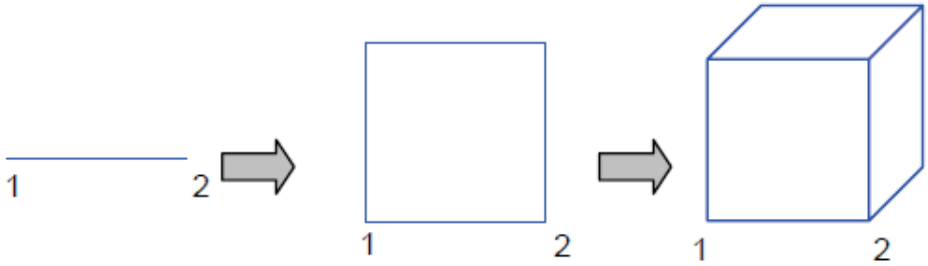
The example will develop a finite element problem in one of its principal phases, the preprocess, and will include the consequent data and parameter description of the problem. This example introduces creation, manipulation and meshing of the geometrical entities used in **GiD**.

First, we will create a line and the mesh corresponding to the line. Next, we will save the project and it will be described in the **GiD** data baseform. Starting from this line, we will create a square surface, which will be meshed to obtain a surface mesh. Finally, we will use this surface to create a cubic volume, from which a volume mesh can then be generated.

3.2 Creation and meshing of a line

We will begin the example creating a line by defining its origin and end points, points 1 and 2 in the following figure, whose coordinates are (0,0,0) and (10,0,0) respectively.

It is important to note that in creating and working with geometric entities, **GiD** follows the following hierarchical order: point, line, surface, and volume.



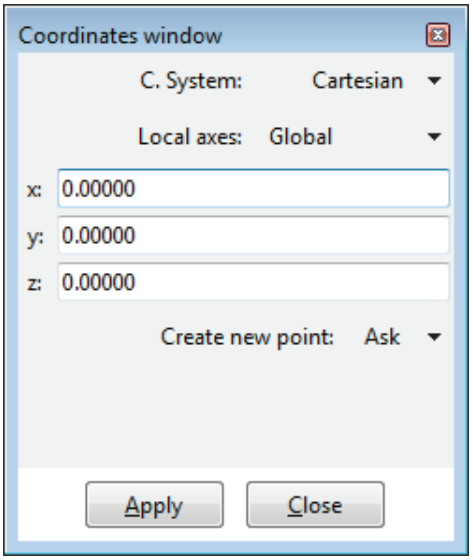
To begin working with the program, open **GiD**, and a new **GiD** project is created automatically.

From this new database, we will first generate points 1 and 2.

Next, we will create points 1 and 2. To do this, we will use an **Auxiliary Window** that will allow us to simply describe the points by entering coordinates. It is accessed by the following sequence: **Utilities->Tools->Coordinates window**

Then, from the Top Menu, select **Geometry->Create->Point**

In the coordinate window opened previously, enter the coordinates of point 1 in the "x", "y", "z" entries and click **Apply** or press **Enter** on the keyboard.



And create point 2 in the same way, introducing its coordinates in the **Coordinates window**.

The last step in the creation of the points, as well as any other command, is to press **Escape**, either via the **Escape** button on the keyboard or by pressing the central mouse button. Select **Close** to close the **Coordinates window**.

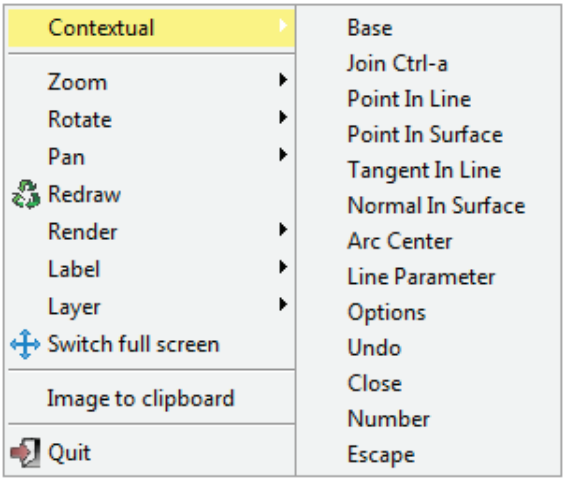
In order to view everything that has been created to this point, center the image on the

screen by choosing in the **Mouse Menu: Zoom->Frame**.

Now, we will create the line that joins the two points. Choose from the **Top Menu**: **Geometry->Create->Straight line.** Option in the **Toolbar** shown below can also be used.

Next, the origin point of the line must be defined. In the **Mouse Menu**, opened by clicking the right mouse button, select **Contextual->Join Ctrl-a.**

NOTE: It is important to note that the Contextual submenu in the Mouse Menu will always offer the options of the command that is currently being used. In this case, the corresponding submenu for line creation, has the following options:



NOTE: With option Join, a point already created can be selected on the screen. The command No Join is used to create a new point that has the coordinates of the point that is selected on the screen. We can see that the cursor changes form for the Join and No Join commands.


Cursor during use of **Join** command


Cursor during use of No **Join** command

Now, choose on the screen the first point, and then the second, which define the line. Finally, press **Escape** to indicate that the creation of the line is completed. Press **Escape** again to end the line creation function, if you don't press Escape you can continue creating lines.

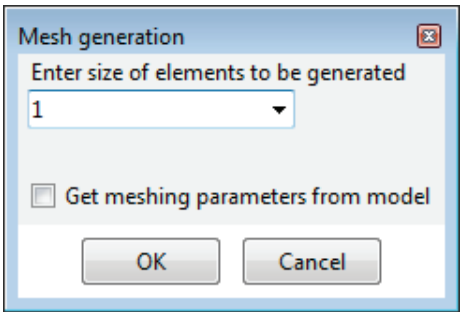
Once the geometry has been created, we can proceed to the line meshing. In this example, this operation will be presented in the simplest and most automatic way that **GiD** permits. To do this, from the **Top Menu** select: **Mesh->Generate mesh.**

And an **Auxiliary Window** appears, in which the size of the elements should be defined by

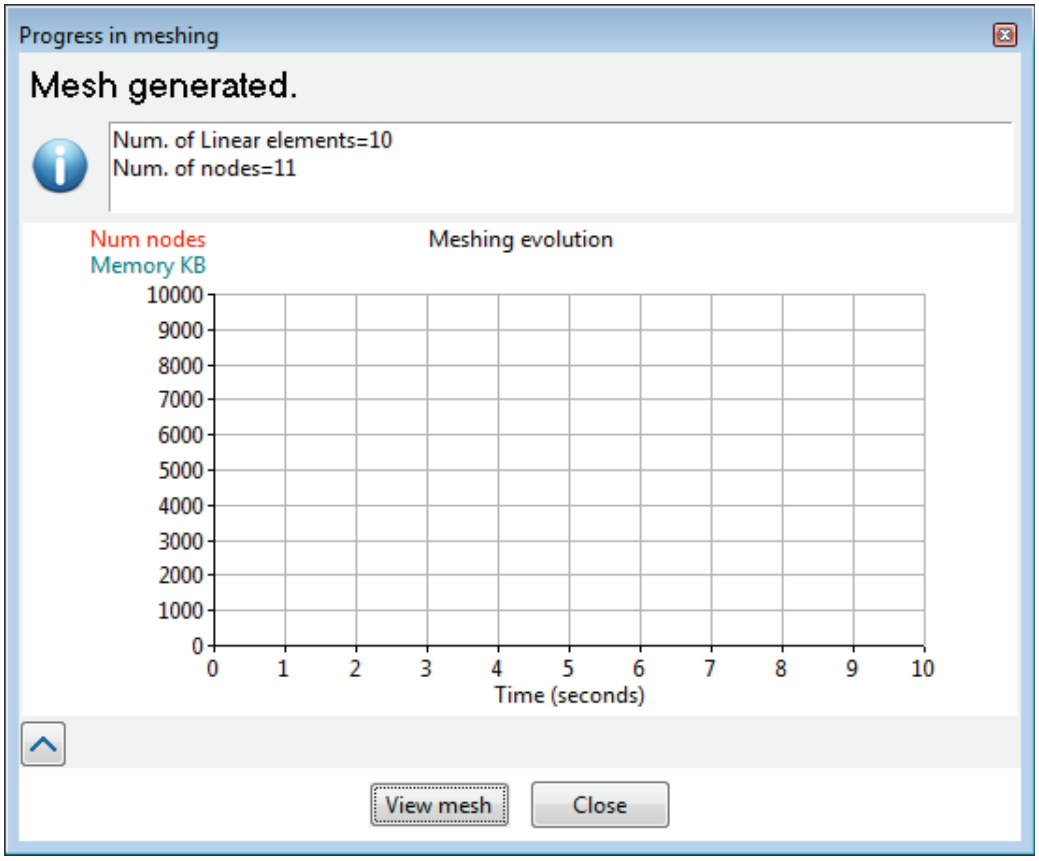
the user.

NOTE: The size of an element with two nodes is the length of the element. For, surfaces or volumes, the size is the mean length of the edge of the element.

In this example, the size of the element is defined in concordance with the length of the line, chosen for this case as size 1. Click **OK**.



Once the mesh has been generated a window with the mesh information appears. Click **View mesh**.

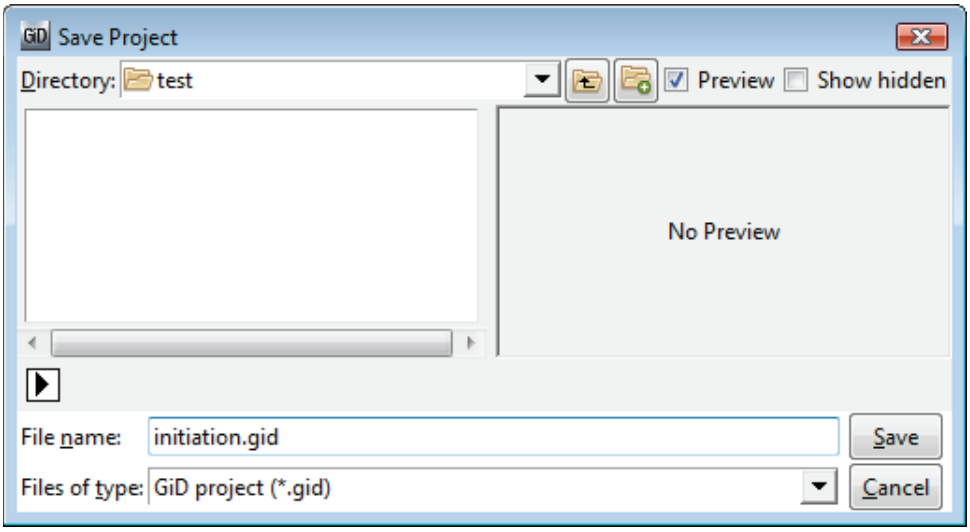


Automatically **GiD** generates a mesh for the line. The finite element mesh is presented on the screen in a grey color.

The mesh is formed by ten linear elements of two nodes. To see the numbering of the nodes and mesh elements, select from the **Mouse Menu: Label->All,** and the numbering for the 10 elements and 11 nodes will be shown, as below.

Once the mesh has been generated, the project should be saved. To save the example select from the **Top Menu: Files->Save.**

The program automatically saves the file if it already has a name. If it is the first time the file has been saved, the user is asked to assign a name. For this, an **Auxiliary Window** will appear which permits the user to browse the computer disk drive and select the location in which to save the file. Once the desired directory has been selected, the name for the current project can be entered in the space titled **File Name**. Save it as **initiation.gid**.



NOTE: Next, the manner in which **GiD** saves the information of a project will be explained. **GiD** creates a directory with a name chosen by the user, and whose file extension is **.gid**. **GiD** creates a set of files in this directory where all the information generated in the present example is saved. All the files have the same name of the directory to which they belong, but with different extensions. These files should have the name that **GiD** designates and should not be changed manually.

Each time the user selects option **save** the database will be rewritten with the new information or changes made to the project, always maintaining the same name.

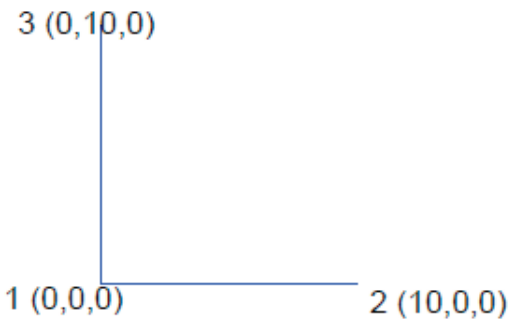
To exit **GiD**, simply choose **Files->Quit.**

To access the project that we have just created, simply open **GiD** and select from the **Top Menu: Files->Open.** An **Auxiliary Window** will appear which allows the user to access and open the directory **initiation.gid**.

3.3 Creation and meshing of a surface

We will now continue with the creation and meshing of a surface.

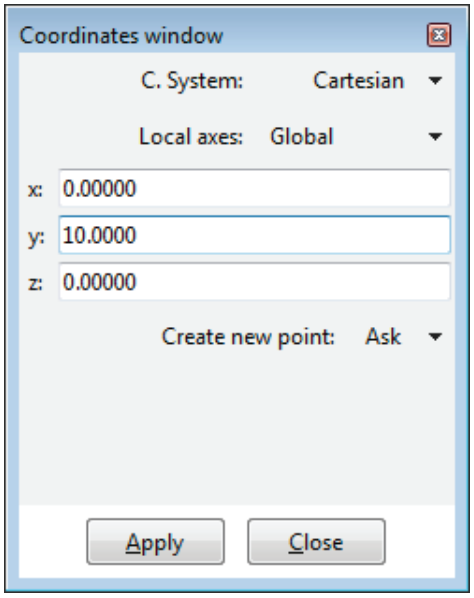
First, we will create a second line between points 1 and 3.



We will now generate the second line. We will now use again the **Coordinates Window** to enter the points. (**Utilities->Tools->Coordinates Window**)

Select the line creation tool in the toolbar.

Enter point (0,10,0) in the **Coordinates Window** and click **Apply**.



With option **Contextual->Join Ctrl-a** (mouse menu) click over point 1. A line should be created between (0,10,0) and (0,0,0). Press **Escape** twice.

With this, a right angle of the square has been defined.

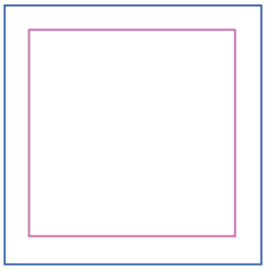
Center the image in the screen with **View->Zoom->Frame**.

Finish the square by creating point (10,10,0) and the lines that join this point with points 2 and 3.

Now, we will create the surface that these four lines define. To do this, access the create surface command by choosing: **Geometry->Create->NURBS surface->By contour**. This option is also available in the toolbar:

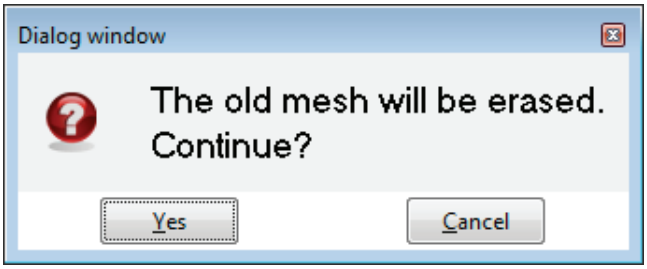
GiD then asks the user to define the 4 lines that describe the contour of the surface. Select the lines using the cursor on the screen, either by choosing them one by one or selecting them all with a window. Next, press **Escape** twice.

As can be seen below, the new surface is created and appears as a smaller, magenta-colored square drawn inside the original four lines.

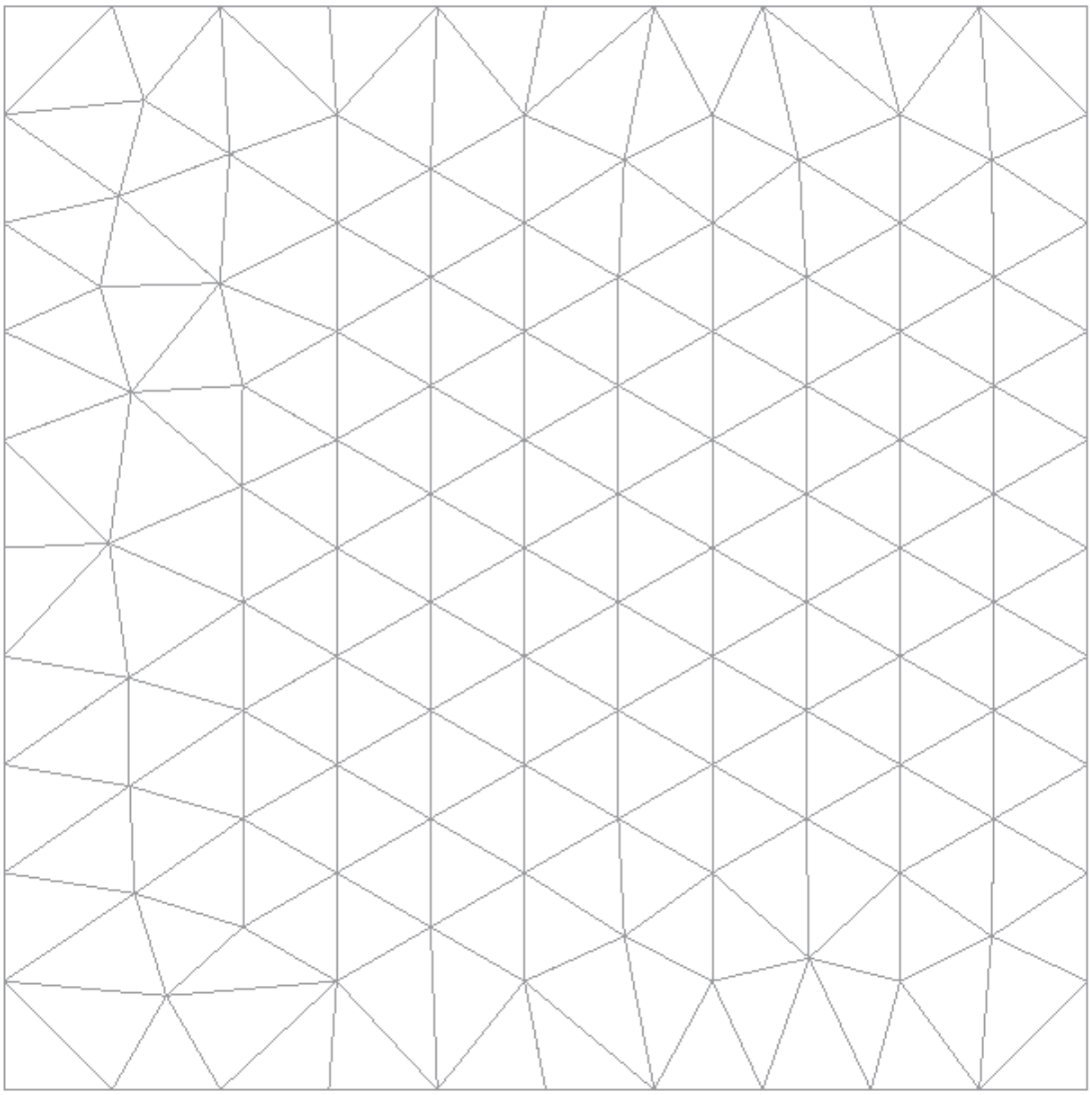


Once the surface has been created, the mesh can be created in the same way as was done for the line. From the **Top Menu** select: **Mesh->Generate mesh.**

A window appears asking if the previous mesh should be elliminated. Click **Yes**.



Another window appears which asks for the maximum size of the element, in this example defined as 1.

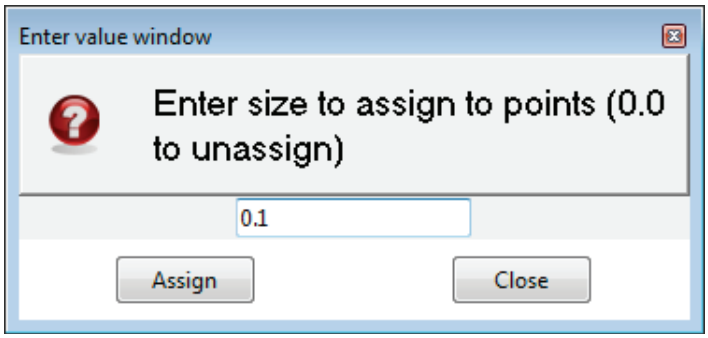


We can see that the lines containing elements of two nodes have not been meshed. Rather the mesh generated over the surface consists of planes of three-nodded, triangular elements.

NOTE: GiD meshes by default the entity of highest order with which it is working.

GiD allows the user to concentrate elements in specified geometry zones. Next, a brief example will be presented in which the elements are concentrated in the top right corner of the square.

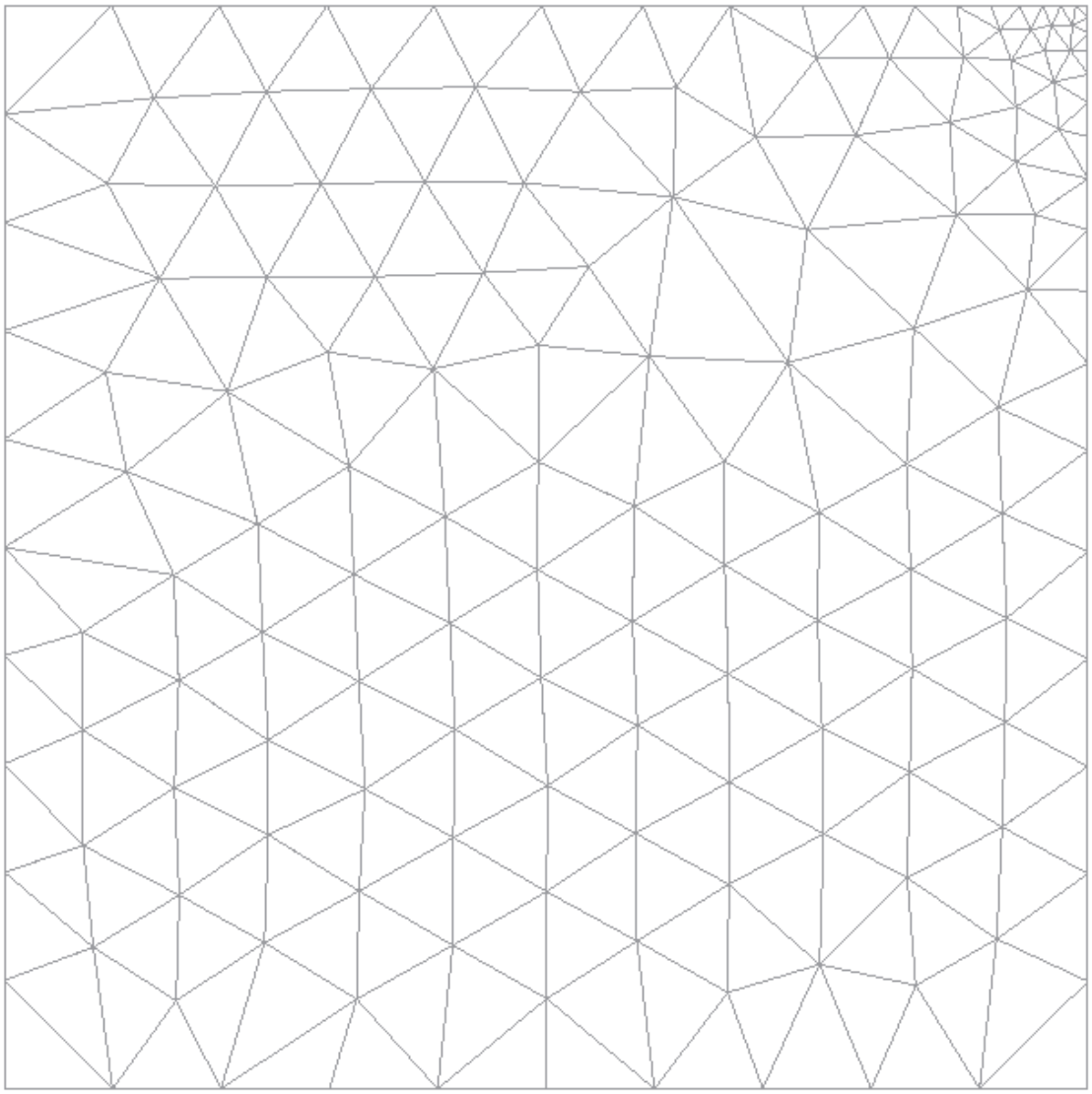
This operation is realized by assigning a smaller element size to the point in this zone than for the rest of the mesh. Select the following sequence: **Mesh->Unstructured->Assign sizes on points.** The following dialog box appears, in which the user can define the size:



Enter **0.1** and click **Assign.**

Select one of the four corners and press **Escape.** The same window comes up again, click **Close.**

We must now regenerate the mesh, erasing the mesh generated earlier, and we obtain the following:



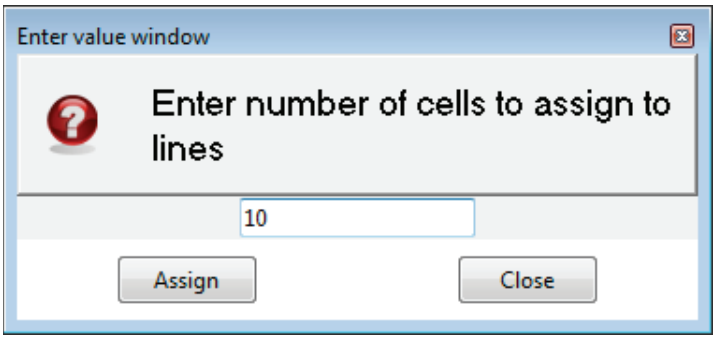
As can be seen in the figure above, the elements are concentrated around the chosen

point. Various possibilities exist for controlling the evolution of the element size, which will be presented later in the manual.

To generate a surface mesh in which the elements are presented uniformly, the user can select the option for a structured mesh. This guarantees that the same number of elements appears around a node and that the element size is as uniform as possible. To generate this type of mesh, choose: **Mesh->Structured->Surfaces->Assign number of cells.**

Using this command, the user should first select the **4-sided NURBS surface** that will be defined by the mesh and press **ESC.**

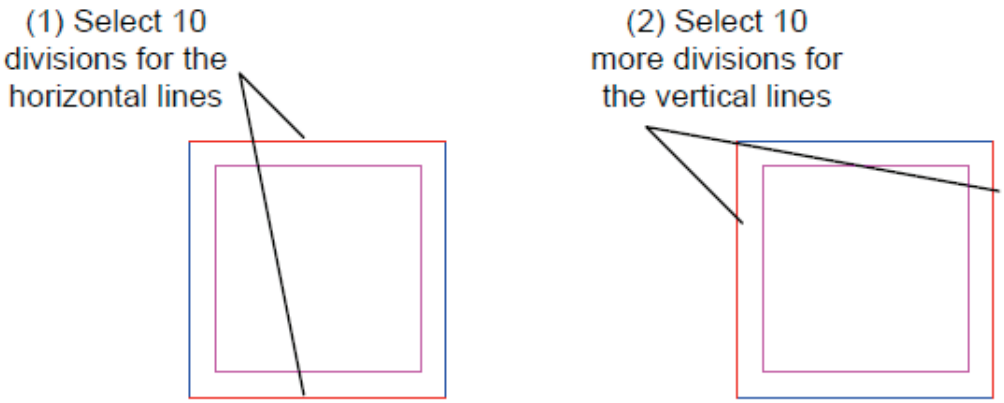
Then a window appears where the number of subdivisions for the surface limit lines should be entered.



Enter **10** and click **Assign** and select one of the **horizontal** lines, the parallel line is also selected. Press **ESC**.

The same window appears again, click **Assign** and select one of the **vertical** lines, the parallel one is also selected. Press **ESC**.

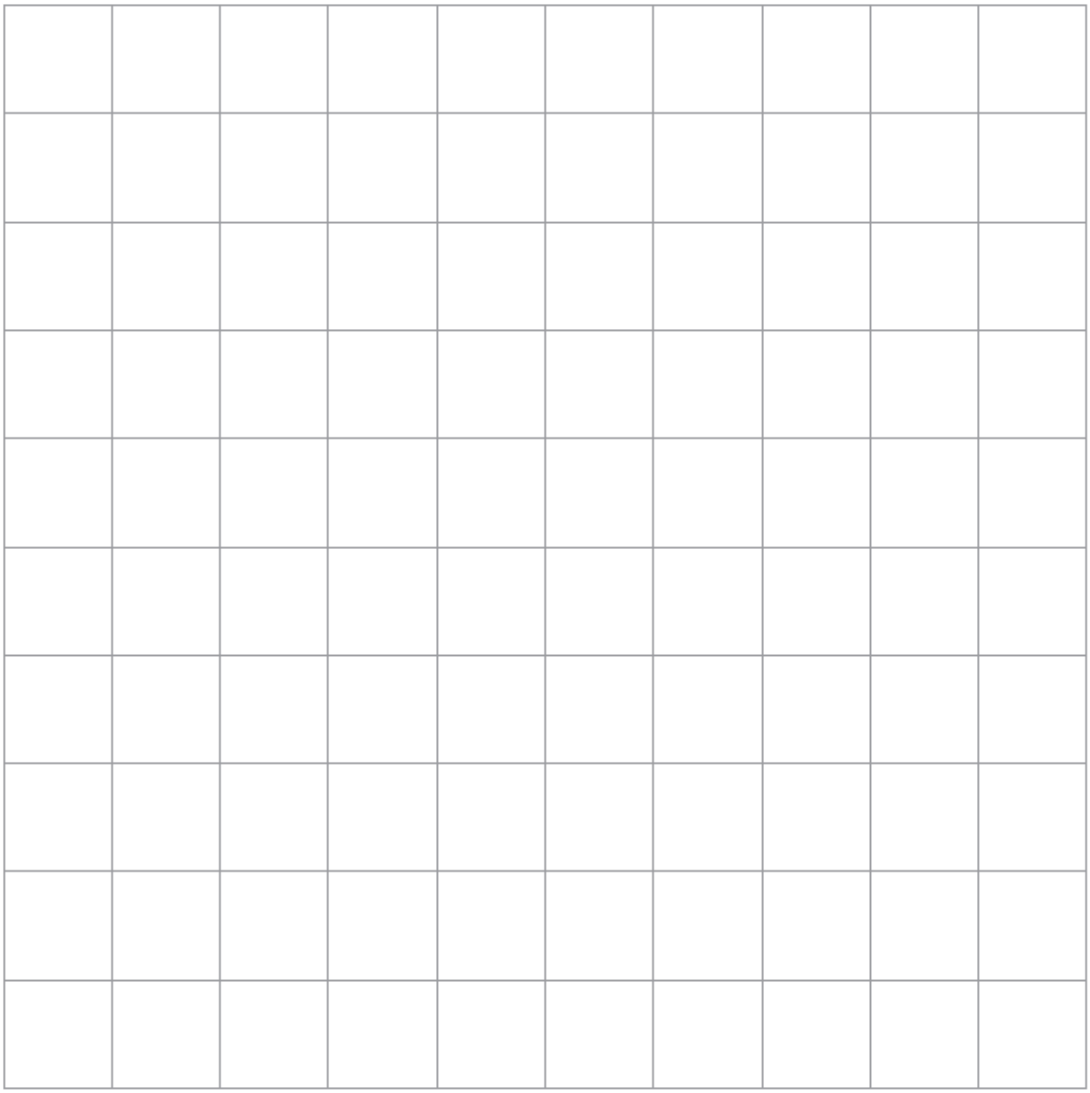
Click **Close** when the window appears again.



The number of divisions can be checked selecting **Mesh->Draw->Num of divisions**. To exit this visualization mode press **ESC.**

NOTE: GiD only generates structured meshes for surfaces of the type **4-sided surface** or **NURBS surface**.

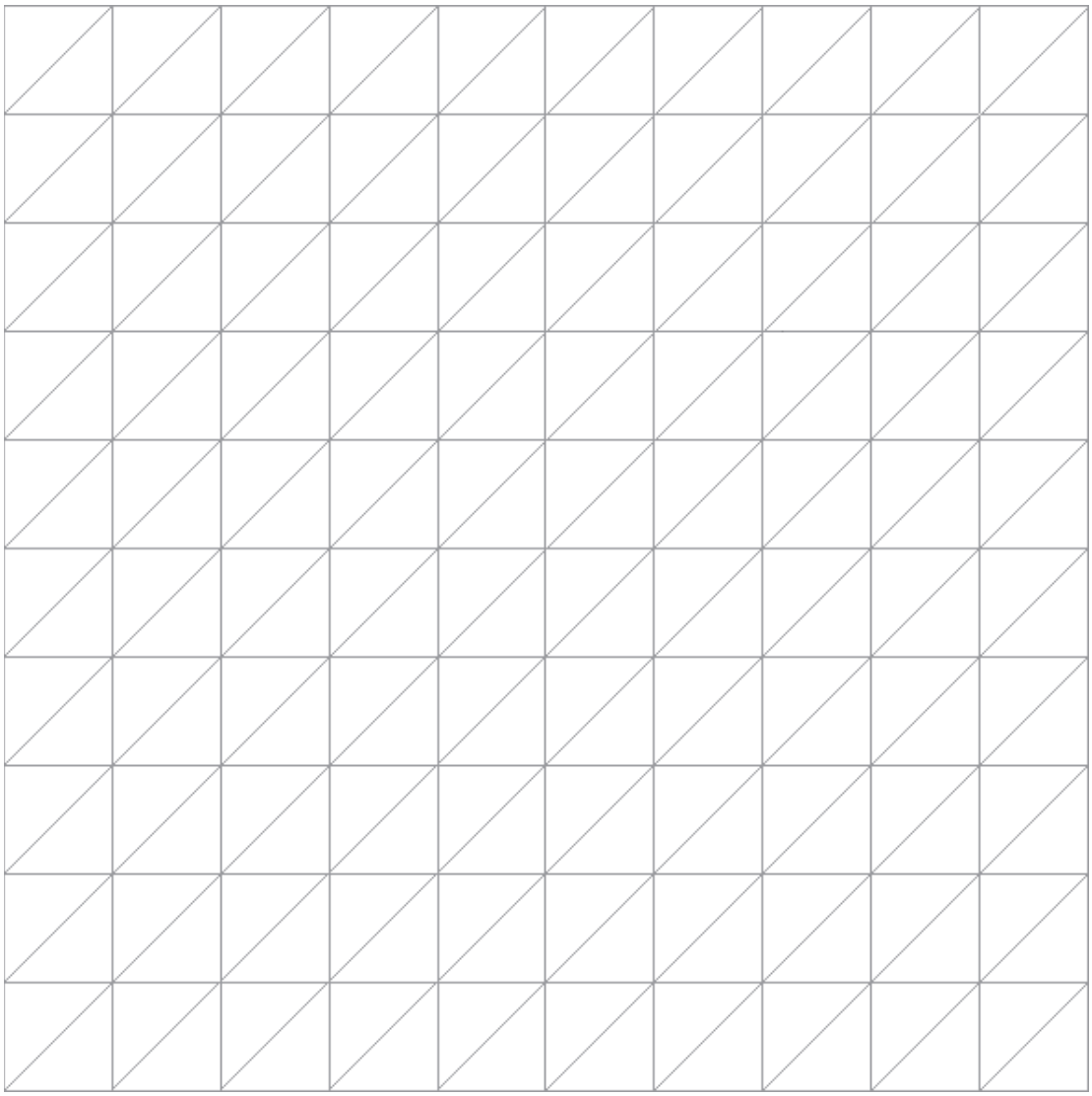
When this has been done, the mesh is generated in the same way as the unstructured mesh, by choosing **Mesh->Generate mesh.** Erase the old mesh and assign a general element size of 1, though in this case it is not necessary.



NOTE: Another way to get the same result is using the option **Mesh->Structured->Surfaces->Assign size**. With this option we set the element size. If we want to get 10 elements per line and the line measures 10 units, we should set 1 as size.

If we don't know how much measures a line we can use the option **Utilities->Distance** and select the 2 points defining the line.

We can see here that the default element type used by **GiD** to create a structured mesh is a square element of four nodes rather than a three-nodded, triangular element. To obtain triangular elements, the user can specifically define this type of element, by choosing **Mesh->Element type->Triangle,** and selecting the surface to mesh as a triangular element. Regenerate the mesh, and the following figure is obtained:

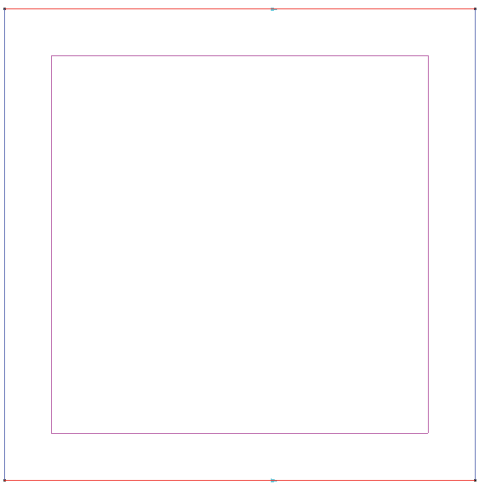


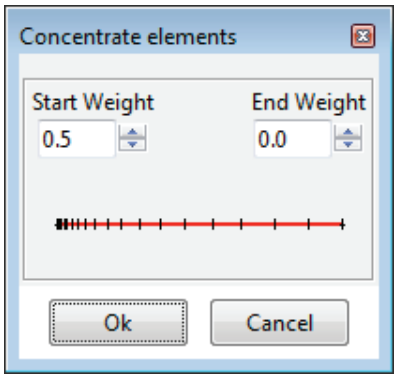
GiD also allows the user to concentrate elements in structured meshes. This can be done by selecting **Mesh->Structured->Lines->Concentrate elements.**

First, we must select the lines that need to be assigned an element concentration weight. The value of this weight can be either positive or negative, depending on whether the user wants to concentrate elements at the beginning or end of the lines. Next, a vector appears which defines the start and end of the line and which helps the user assign the weight correctly.

We want to concentrate the elements in the left zone of the square.

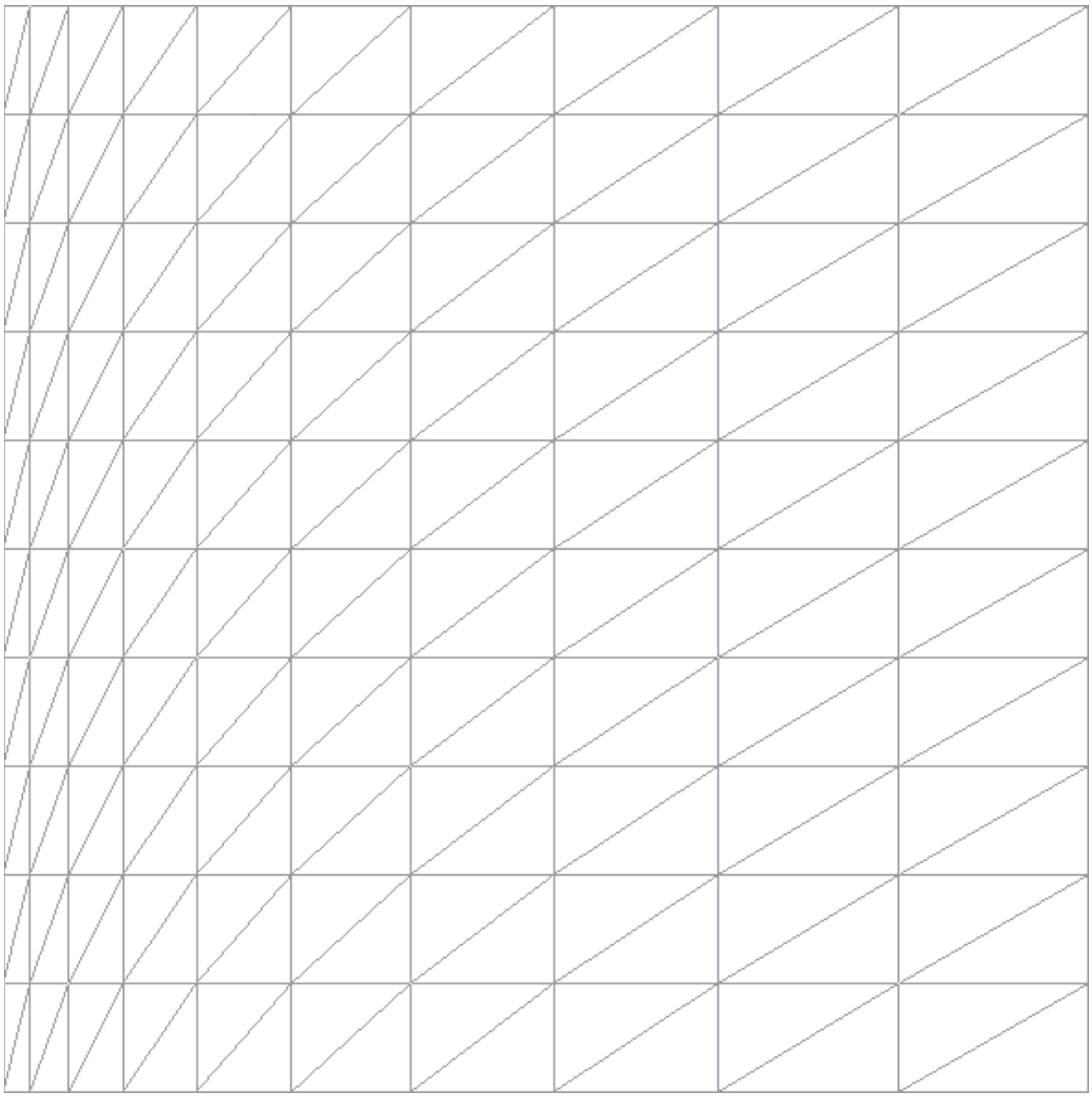
Select both **horizontal** lines and press **ESC**. A window appears to enter the weights values. Both lines should have the same direction so enter a weight of 0.5 to the beginning of the line and click **Ok**. Press **ESC** again to leave the function.





If lines have different direction, to obtain the same result, we should assign the weight for one line to the beginning and to the end for the other line.

From these operations, we obtain the following mesh:



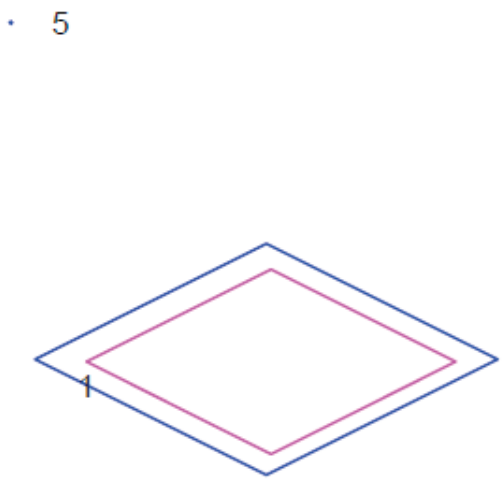
3.4 Creation and meshing of a volume

We will now present a study of entities of volume. To illustrate this, a cube and a volume mesh will be generated.

Without leaving the project, save the work done up to now by choosing **Files->Save,** and return to the geometry last created by choosing **Geometry->View geometry.**

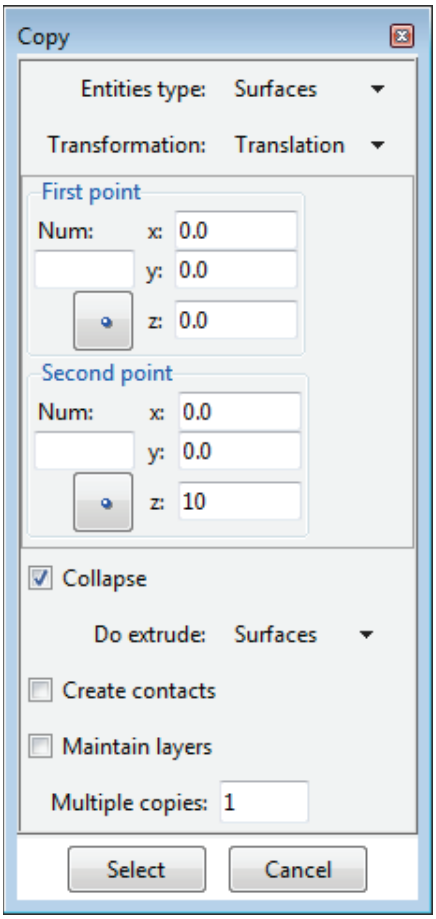
In order to create a volume from the existing geometry, firstly we must create a point that will define the height of the cube. This will be point 5 with coordinates (0,0,10), superimposed on point 1. To view the new point, we must rotate the figure by selecting from the **Mouse Menu: Rotate->Trackball.** This option is also available in the toolbar:

Rotate the figure until the following position is achieved and press **ESC**:



Next, we will create the upper face of the cube by copying from point 1 to point 5 the surface created previously. To do this, select the copy command, **Utilities->Copy.**

In the **Copy** window, we define the translation vector with the first and second points, in this case (0,0,0) and (0,0,10). Option **Do extrude surfaces** must be selected; this option allows us to create the lateral surfaces of the cube. Fill in the rest of variables as shown in the following image.

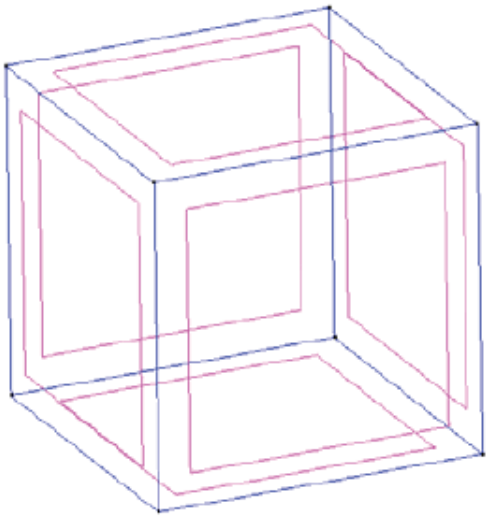


NOTE: In the **Copy** and **Move** windows, the button may be used to select existing points with the mouse, or alternativelly enter its number in the entry field.

NOTE: If we look at the **Copy Window,** we can see an option called **Collapse**. By activating this option, point 6 will be merged with point 5 when the entities are copied. By labeling the entities we could verify that only one point has been created.

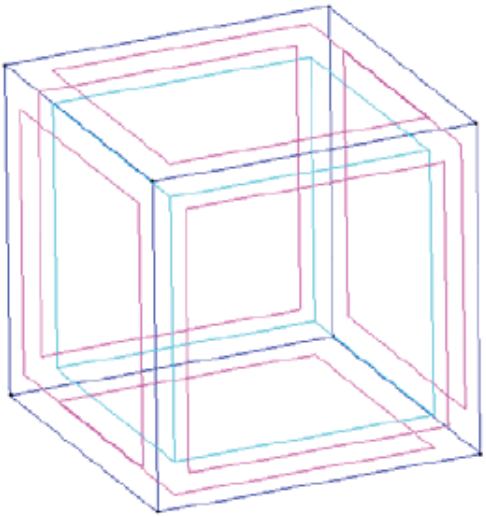
If the user does not choose option **Collapse**, when the entities are copied (in this case from point 1 to point 5) **GiD** would create a new point (point 6) with the same coordinates as point 5.

To finish the copy command click **Select**, select the surface and then press **ESC**. We obtain the following surfaces:

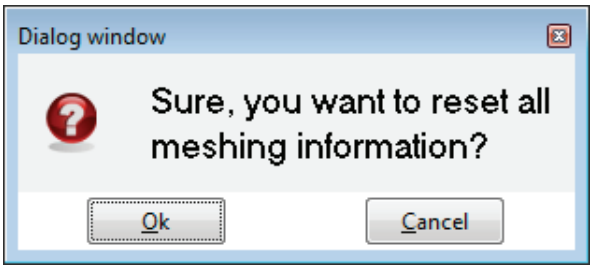


Now, we can generate the volume delimited by these surfaces. To create the volume, simply select the command **Geometry->Create->Volume->By contour** . This option is also available in the toolbar:

Select all the surfaces and press **ESC twice**. **GiD** automatically generates the volume of the cube. The volume viewed on the screen is represented by a cube with an interior color of sky blue.



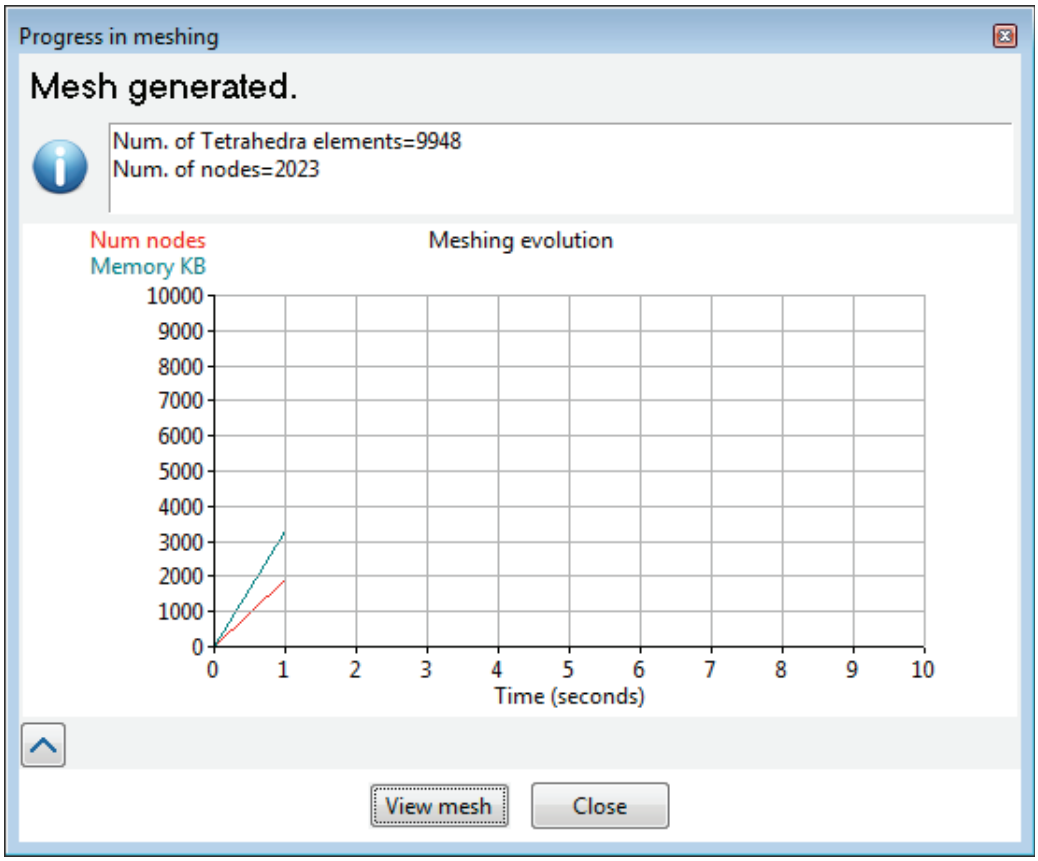
Before proceeding with the mesh generation of the volume, we should eliminate the information of the structured mesh created previously for the surface. Do this by selecting **Mesh->Reset mesh data,** and the following dialog box will appear on the screen:

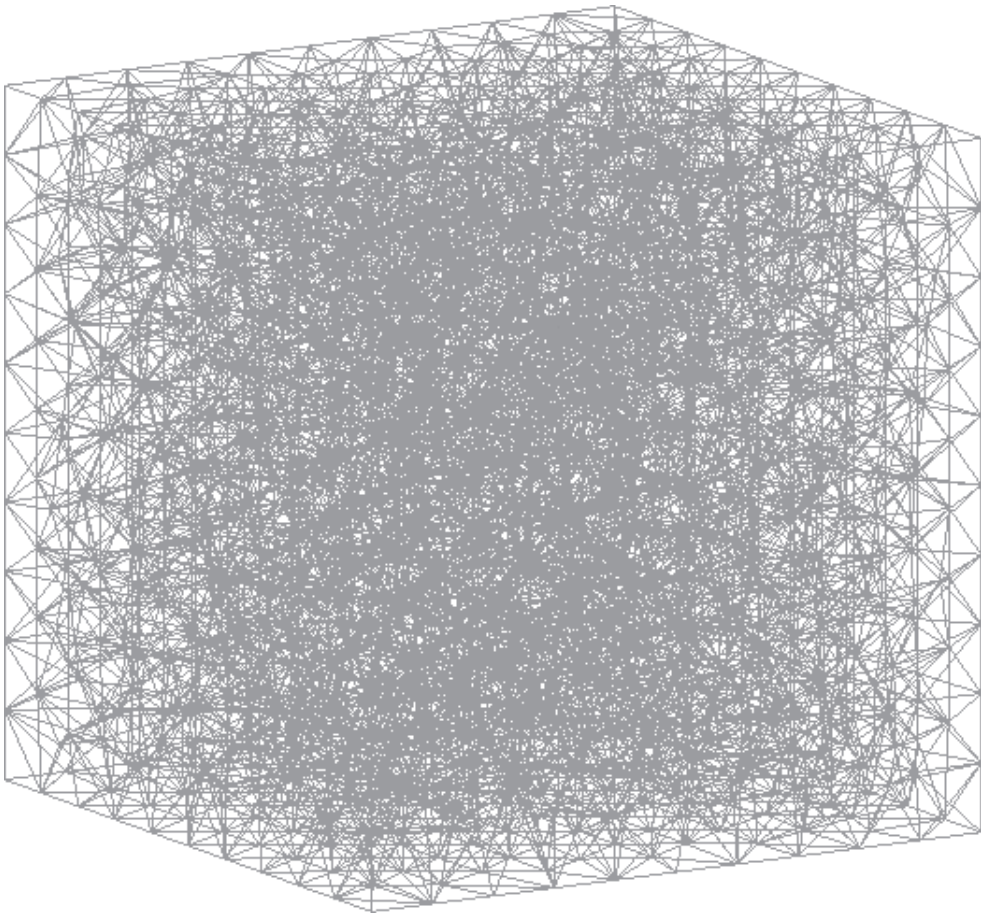


In which the user is asked to confirm the erasure of the mesh information.

NOTE: Another valid option would be to assign a size of 0 to all entities. This would eliminate all the previous size information as well as the information for the mesh, and the default options would become active.

Next, generate the mesh of the volume by choosing **Mesh->Generate mesh.** Another **Auxiliary Window** appears into which the size of the volumetric element must be entered. In this example, the value is 1.





The mesh generated above is composed of tetrahedral elements of four nodes, but **GiD** also permits the use of hexahedral, eight-nodded structured elements.

We will generate a structured mesh of the volume of the cube. This is done by selecting **Mesh->Structured->Volumes->Assign number of cells.**

Now select the volume to mesh and press **ESC**.

Then a window appears where the number of subdivisions for the volume limit lines should be entered.

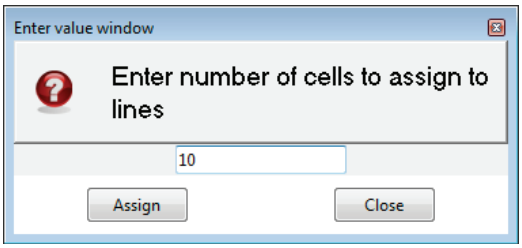
Enter **10** and click **Assign** and select one of the lines in **X** axis, the parallel lines are also selected. Press **ESC**.

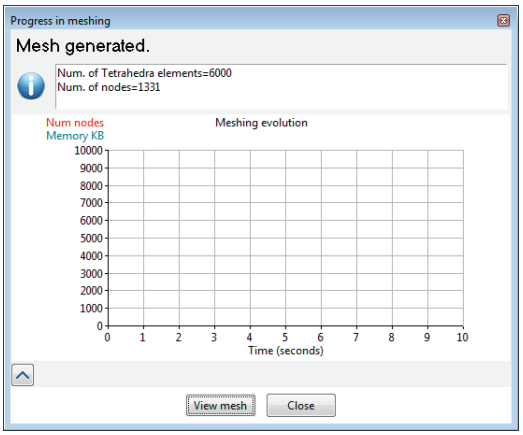
The same window appears again, click **Assign** and select one of the lines in **Y** axis, the parallel ones are also selected. Press **ESC**.

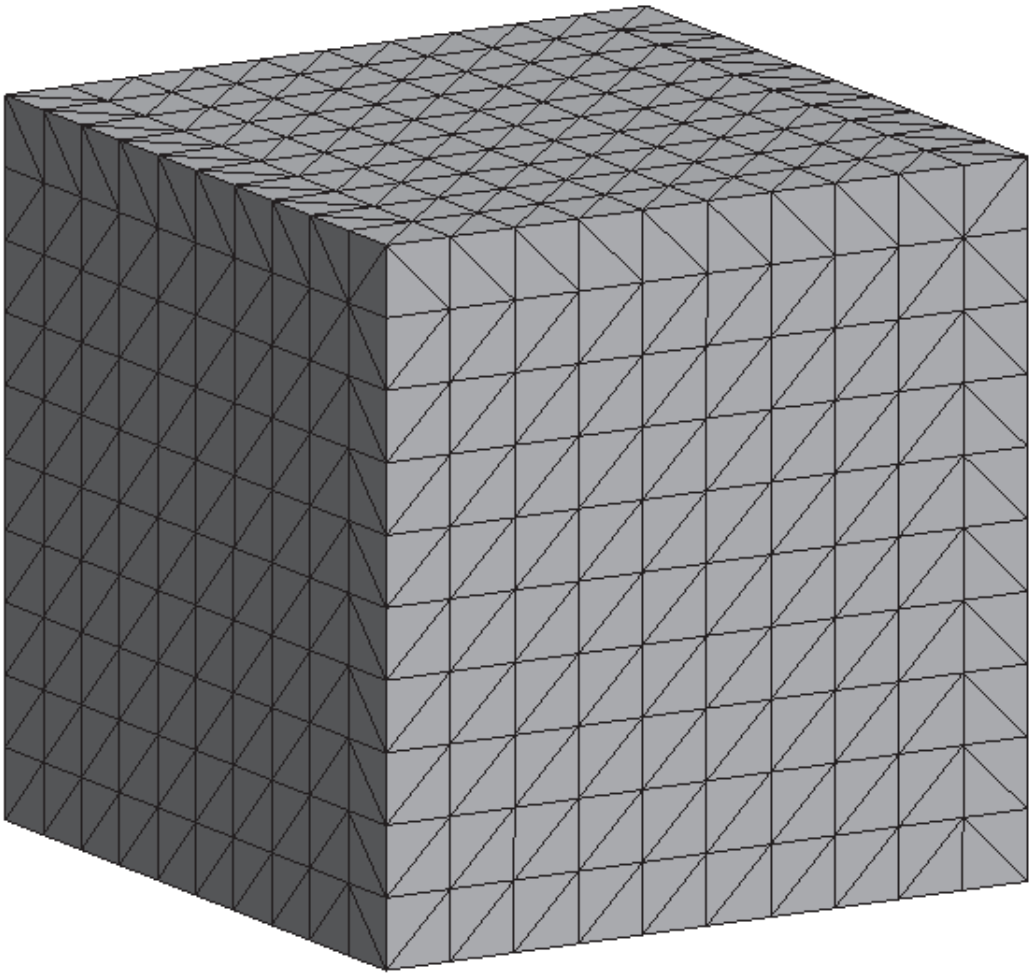
Again click **Assign** and select one of the lines in **Z** axis, the parallel ones are also selected. Press **ESC**.

Click **Close** when the window appears again.

Then, create again the mesh.







NOTE: GiD only allows the generation of structured meshes of 6-sided volumes.

With this example, the user has been introduced to the basic tools for the creation of geometric entities and mesh generation.

4 IMPLEMENTING A MECHANICAL PART

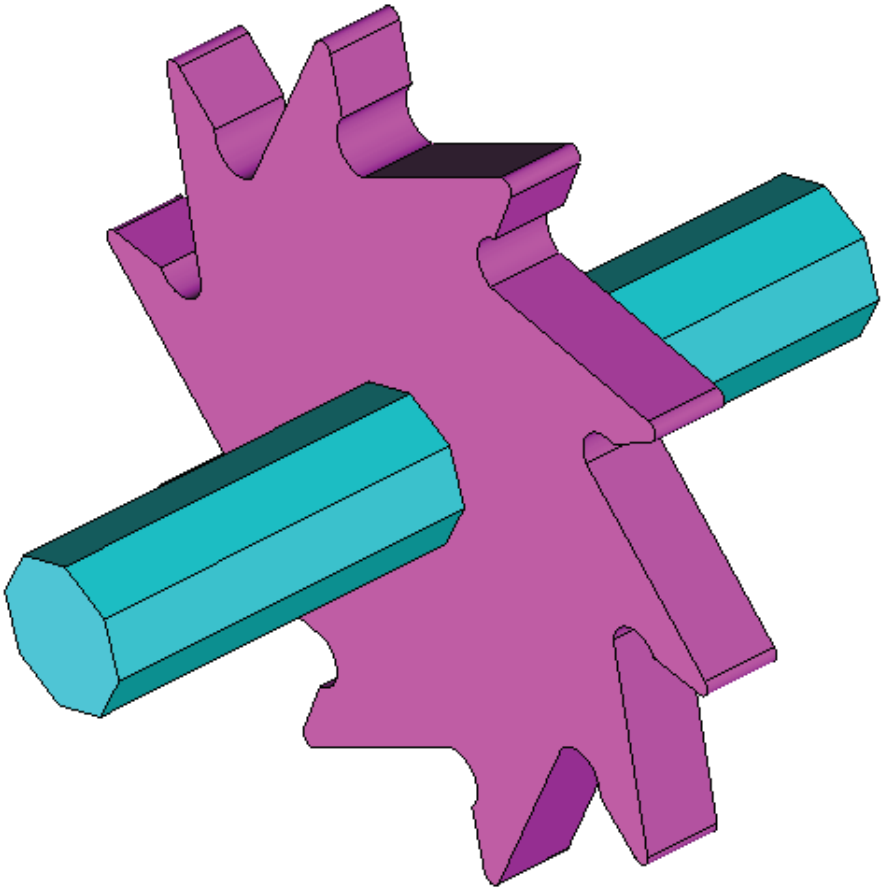
2D TOOLS, BASIC 3D TOOLS AND MESHING

IMPLEMENTING A MECHANICAL PART

The objective of this case study is implementing a mechanical part in order to study it through meshing analysis. The development of the model consists of the following steps:

- Creating a profile of the part
- Generating a volume defined by the profile
- Generating the mesh for the part

At the end of this case study, you should be able to handle the 2D tools available in GiD as well as the options for generating meshes and visualizing the prototype.



4.1 Working by layers

4.1.1 Defining the layers

A geometric representation is composed of four types of entities, namely points, lines, surfaces, and volumes.

A layer is a grouping of entities. Defining layers in computer-aided design allows us to work

collectively with all the entities in one layer.

The creation of a profile of the mechanical part in our case study will be carried out with the help of auxiliary lines. Two layers will be defined in order to prevent these lines from appearing in the final drawing. The lines that define the profile will be assigned to one of the layers, called the "profile" layer, while the auxiliary lines will be assigned to the other layer, called the "aux" layer. When the design of the part has been completed, the entities in the "aux" layer will be erased.

4.1.2 Creating two new layers

1 . Open the layer management window. This is found in **Utilities->Layers and groups**.
2 . Create two new layers called "aux" and "profile."
3 . Choose ☐aux☐ as the activated layer. From now on, all the entities created will belong to this layer.

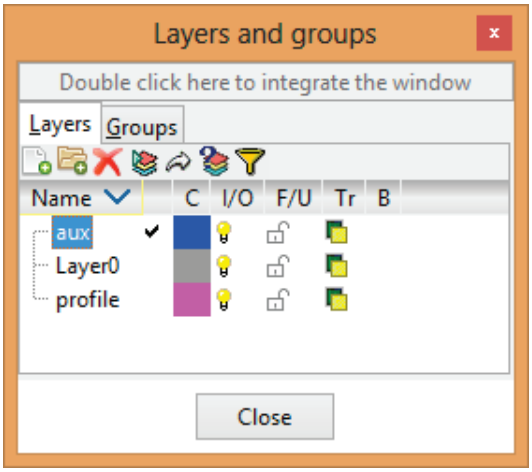
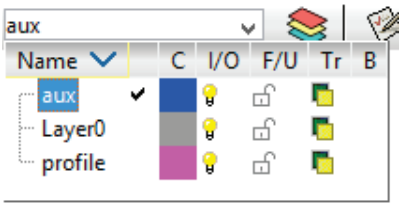


Figure 1. The layers window

NOTE: You can also access to the layers information through the standard bar. The layer in use is selected in the combobox.



4.2 Creating a profile

In our case, the profile consists of various teeth. Begin by drawing one of these teeth, which will be copied later to obtain the entire profile.

4.2.1 Creating a size-55 auxiliary line

1 . Choose the **Line** option, by going to **Geometry->Create->Straight line** or by going to the GiD Toolbar[1].
2 . Enter the coordinates of the beginning and end points of the auxiliary line[2]. For our

example, the coordinates are (0,0) and (55,0), respectively. Besides creating a straight line, this operation implies creating the end points of the line.

3 . Press **ESC** [3]to indicate that the process of creating the line is finished. Press **ESC** again to end the line creation function.

4 . If the entire line does not appear on the screen, use the **Zoom Frame** option, which is located in the GiD toolbar and in **Zoom** in the mouse menu.

Figure 2. Creating a straight line

NOTE: The **Undo** option, located in **Utilities->Undo**, enables you to undo the most recent operations. When this option is selected, a window appears in which all the operations to be undone can be selected.

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[1] The GiD Toolbar is a window containing the icons for the most frequently executed operations. For information on a particular tool, click on the corresponding icon with the right mouse button.

[2] The coordinates of a point may be entered on the command line, not enclosed in parentheses, either with a space or a comma between them. If the Z coordinate is not entered, it is considered 0 by default. After entering the numbers, press **Return**. Another option for entering a point is using the **Coordinates Window**, found in **Utilities->Tools->Coordinates Window**.

[3] Pressing the **ESC** key is equivalent to pressing the center mouse button.

4.2.2 Dividing the auxiliary line near coordinates (40, 0)

1 . Choose **Geometry->Edit->Divide->Lines->Near point.** This option will divide the line at the point ("element") on the line closest to the coordinates entered.

2 . Enter the coordinates of the point that will divide the line. In this example, the coordinates are (40, 0). On dividing the line, a new point (entity) has been created.

3 . Select the line that is to be divided by clicking on it.

4 . Press **ESC** to indicate that the process of dividing the line is finished. Press **ESC** again to finish the dividing function.

Figure 3. Division of the straight line near "point" (coordinates (40,0))

4.2.3 Creating a 3.8-radius circle around point (40, 0)

1 . Choose the option **Geometry->Create->Object->Circle**.
2 . The center of the circle (40, 0) is a point that already exists. To select it, go to **Contextual->Join Ctrl-a** in the mouse menu (right-click). The pointer will become a square, which means that you may click an existing point.
3 . The **Enter Normal** window appears. Set the normal as Positive Z and press **OK**.
4 . Enter the radius of the circle. The radius is 3.8 [4]. Two circumferences are visualized; the inner circumference represents the surface of the circle.

Press **ESC** to indicate that the process of creating the circle is finished.

Figure 4. Creating a circle around a point (40, 0)

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[4] In GiD the decimals are entered with a point, not a comma.

4.2.4 Rotating the circle -3 degrees around a point

1 . Use the **Move** window, which is located in **Utilities->Move**.
2 . Within the **Move** menu and from among the **Transformation** possibilities, select **Rotation**. The type of entity to receive the rotation is a surface, so from the **Entities type** menu, choose **Surfaces**.
3 . Enter -3 in the **Angle** box and check the **Two dimensions** option. (Provided we define positive 2D rotation in the mathematical sense, which is counter-clockwise, -3 degrees equates to a clockwise rotation of 3 degrees).
4 . Enter the point (0, 0, 0) under **First Point**. This is the point that defines the center of rotation.
5 . Click **Select** to select the surface that is to rotate, which in this case is that of the circle.
6 . Press **ESC** (or **Finish** in the **Move window**) to indicate that the selection of surfaces to rotate has been made, thus executing the rotation.

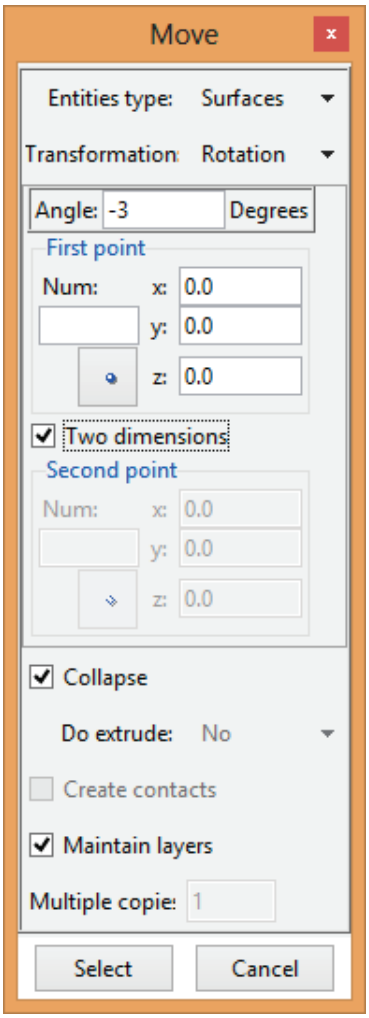


Figure 5. The move window

4.2.5 Rotating the circle 36 degrees around a point and copying it

1 . Use the **Copy** window, located in **Utilities->Copy**.

2 . Repeat the rotation process explained in section Rotating the circle -3 degrees around a point -pag. 46-, but this time with an angle of 36 degrees.

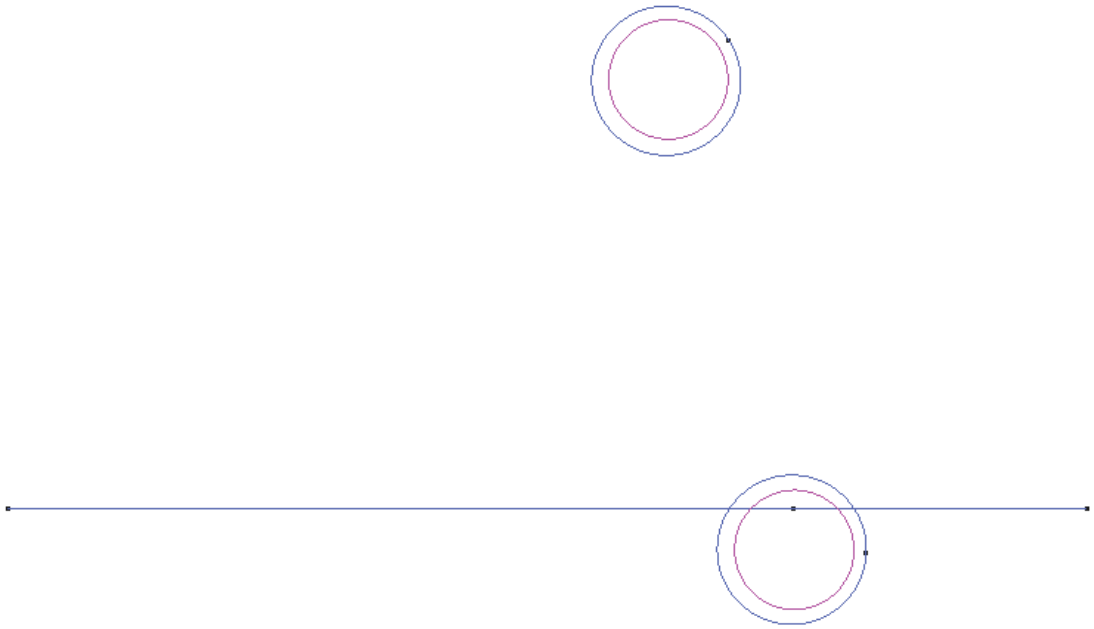


Figure 6. Result of the rotations

NOTE: The **Move** and **Copy** operations differ only in that **Copy** creates new entities while **Move** displaces entities.

4.2.6 Rotating and copying the auxiliary lines

1 . Use the **Copy** window, located in **Utilities->Copy**.

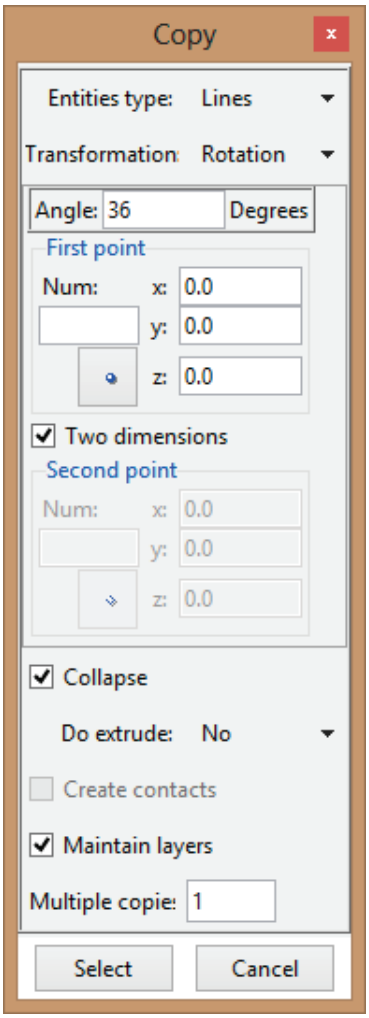


Figure 7. The copy window

2 . Repeat the rotating and copying process from section for the two auxiliary lines. Select the option **Lines** from the **Entities type** menu and enter an angle of 36 degrees.
3 . Select the lines to copy and rotate. Do this by clicking **Select** in the **Copy** window.
4 . Press **ESC** to indicate that the process of selecting lines is finished, thus executing the task.

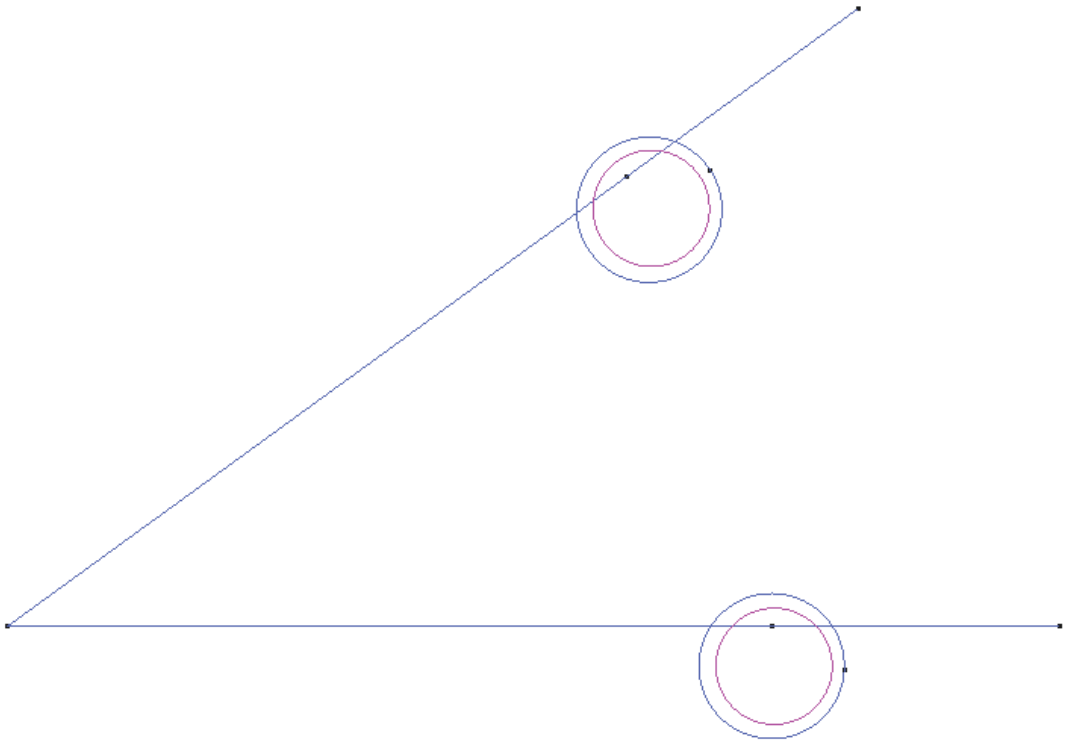


Figure 8. Result of copying and rotating the line

5 . Rotate the line segment that goes from the origin to point (40, 0) by 33 degrees and copy it.

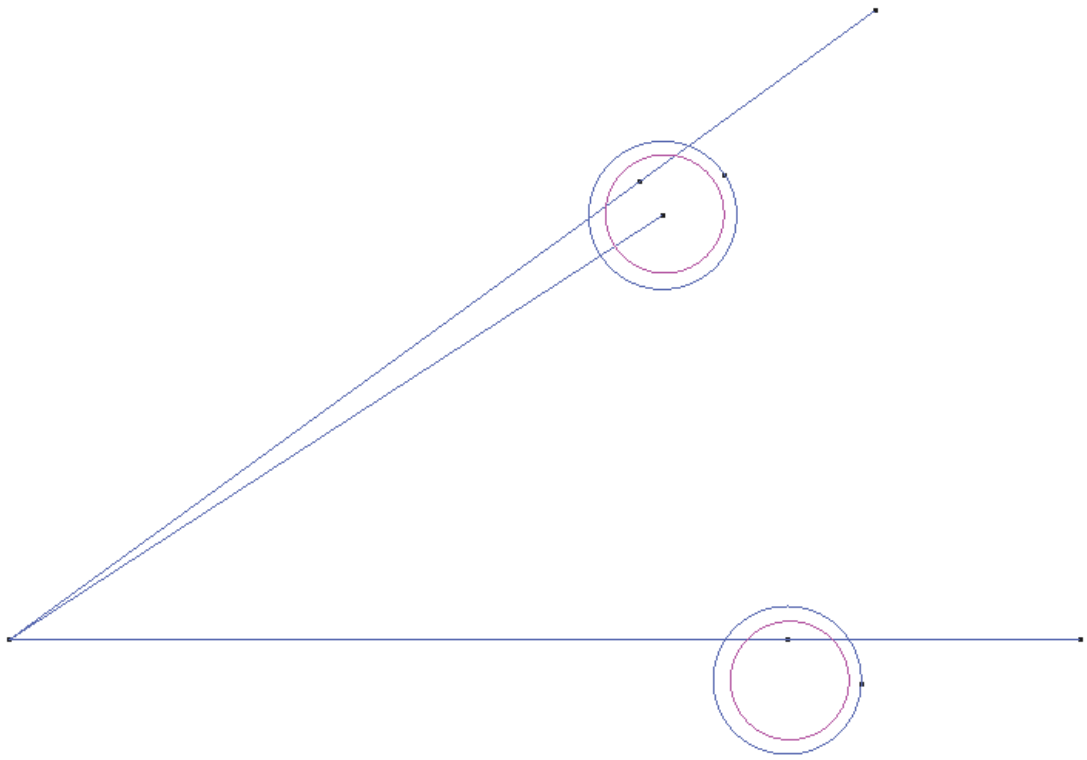


Figure 9. Result of the copy by rotation

NOTE:In the **Copy** window, the button may be used to select existing points with the mouse, or alternativelly enter its number in the entry field.

4.2.7 Intersecting lines

1 . Choose the option **Geometry->Edit-> Intersection->Lines.**
2 . Select the upper circle
3 . Select the line resulting from the 33-degree rotation (see next figure)

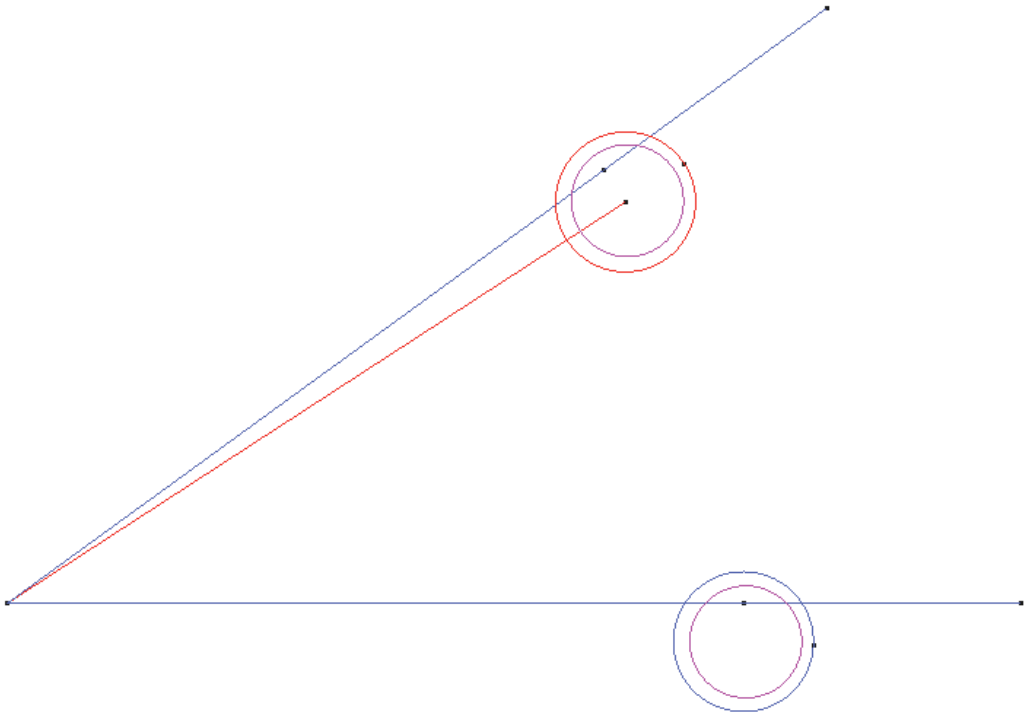


Figure 10. The two lines selected

4 . Press **ESC** to conclude the intersection of lines.
5 . A confirmation window appears, click **Ok**.
6 . Press **ESC** to finish the intersection function.
7 . Create a line (**Geometry->Create->Straight line**) between the existent point (55, 0) and the point generated by the intersection.
8 . Choose the option **Geometry->Edit-> Intersection->Lines** in order to make another intersection between the lower circle and the line segment between point (40, 0) and point (55, 0) (see next figure)

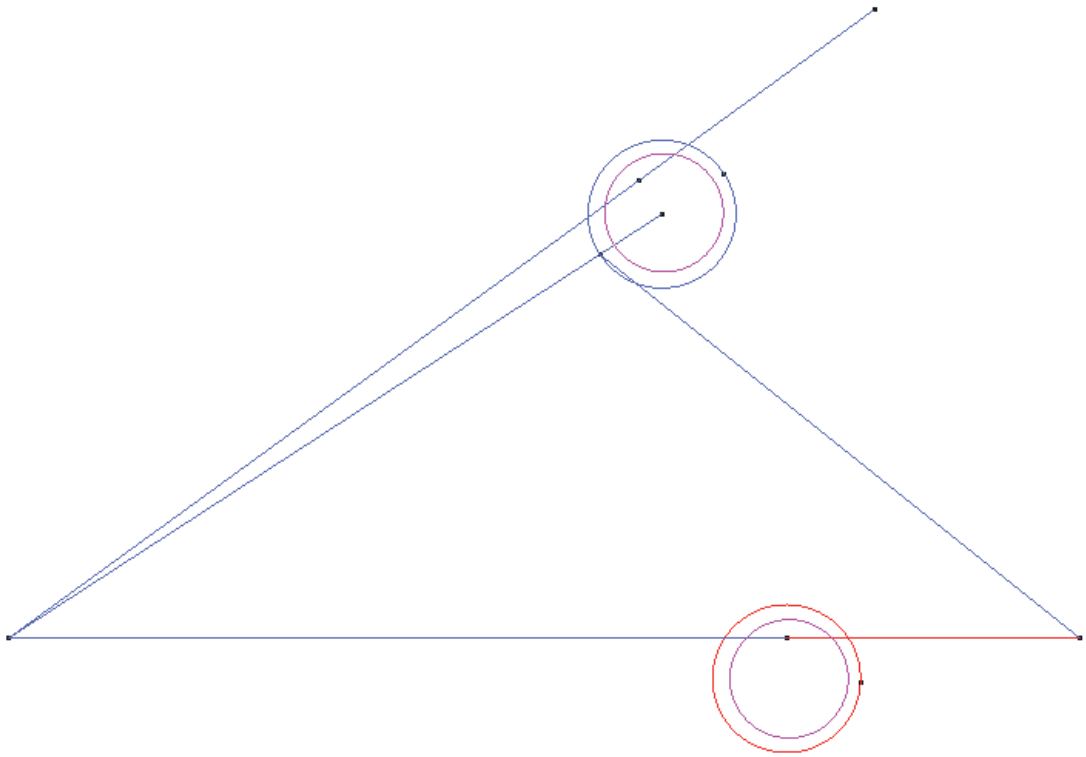


Figure 11. Intersecting lines

9 . Then continue selecting to make an intersection between the upper circle and the farthest segment of the line that was rotated 36 degrees (see next figure)

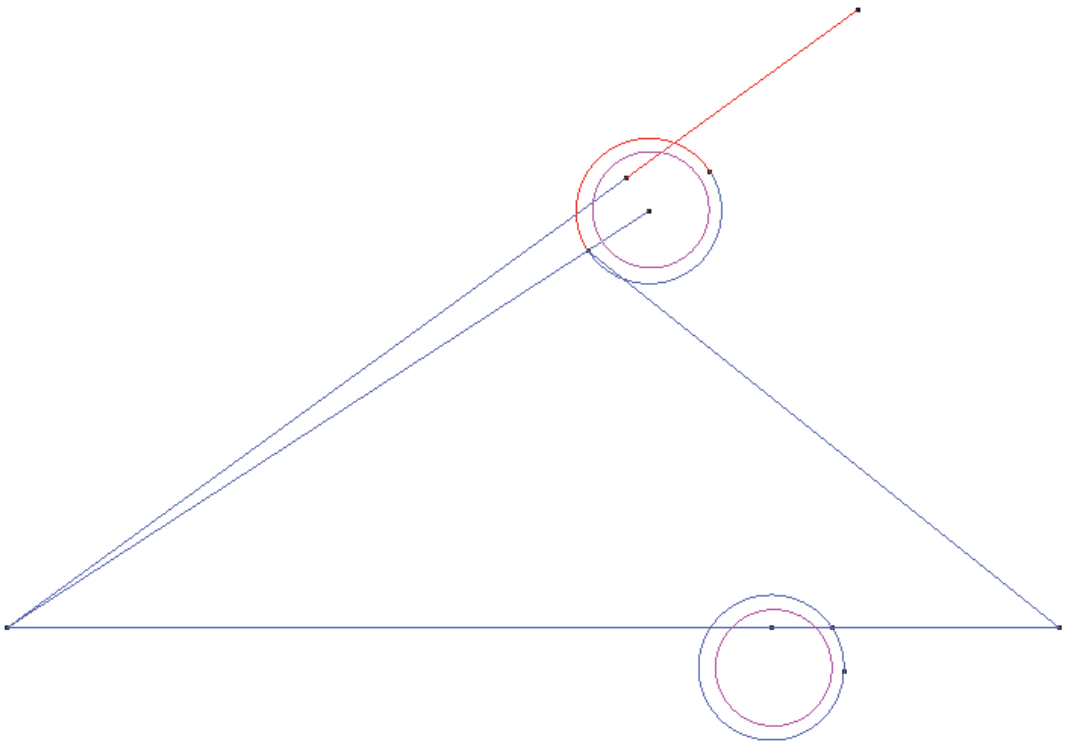


Figure 12. Intersecting lines

4.2.8 Creating an arc tangential to two lines

1 . Choose **Geometry->Create->Arc->Fillet curves**.
2 . Enter a radius of 1.35 in the command line.
3 . Now select the two line segments shown in next figure. Then press **ESC** to indicate that the process of creating the arcs is finished.

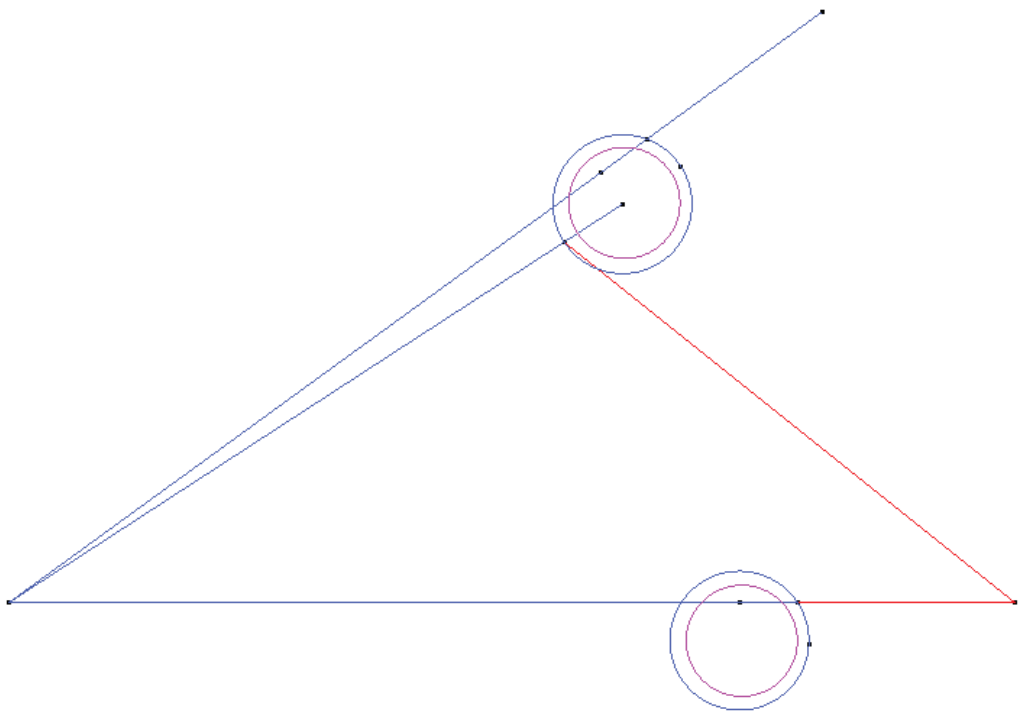


Figure 13. The line segments to be selected

4.2.9 Translating the definitive lines to the "profile" layer

The auxiliary lines will be eliminated and the "profile" layer will contain only the definitive lines.

1 . Select the "profile" layer in the **Layers** window.
2 . We will move the lines defining the profile to the "profile" layer:
   - Click on the icon (**Send To)** and select **Lines**

   Be sure that 'Also lower entities' is chequed, to send to this layer also the points of the lines.

3 . Select only the lines that form the profile (see next figure).
4 . To conclude the selection process, press the **ESC** key or click **Finish** in the **Layers** window.

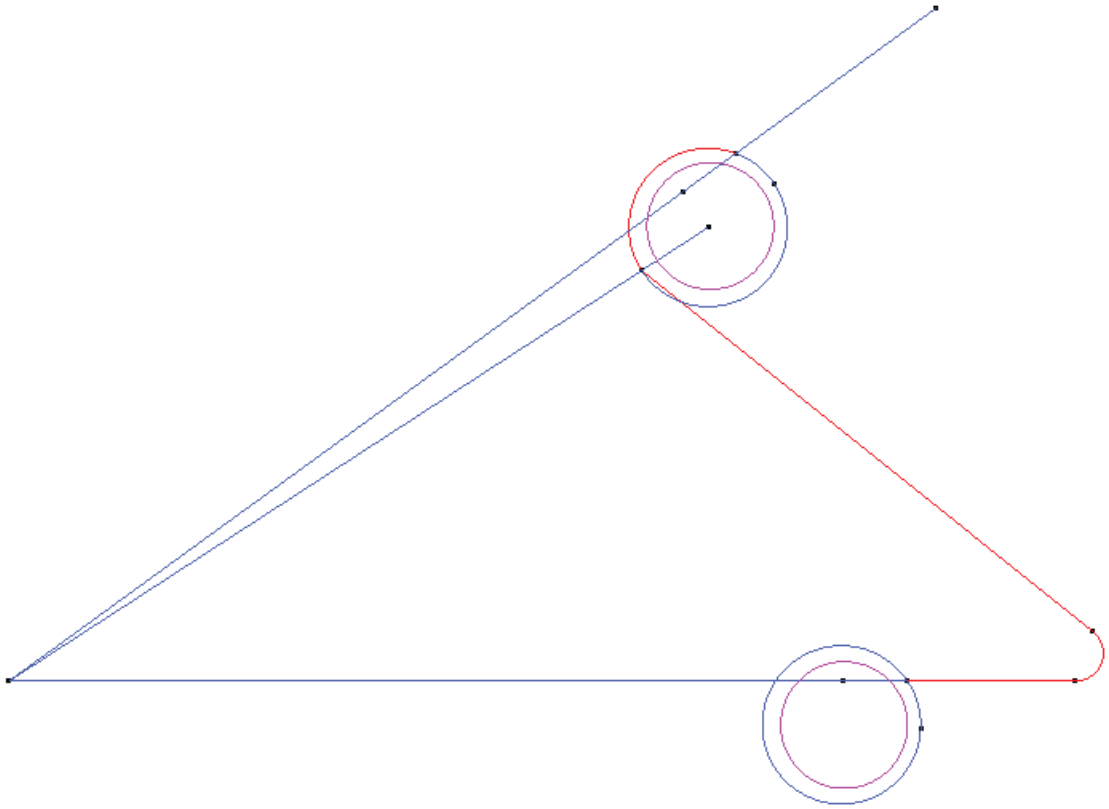


Figure 14. Lines to be selected

4.2.10 Deleting the "aux" layer

1 . Select the "profile" layer and set it off.
   - Click on the light bulb icon

2 . Choose **Geometry->Delete->All Types** (or use the GiD Toolbar).
3 . Select all the lines and surfaces that appear on the screen.
4 . Press **ESC** to conclude the selection of elements to delete.
5 . Select the "aux" layer and delete it.
   - Click in the icon
6 . Select the "profile" layer and set it on.

NOTE: To cancel the deletion of elements after they have been selected, open the mouse menu, go to **Contextual** and choose **Clear Selection**.

NOTE: Elements forming part of higher level entities may not be deleted. For example, a point that defines a line may not be deleted.

NOTE: A layer containing information may not be deleted. First the contents must be deleted.

4.2.11 Rotating and obtaining the final profile

1 . Make sure that the activated layer is the "profile" layer. (Use the option **To use**).
2 . In the **Copy** window, select the line rotation (**Lines,Rotation**).
3 . Enter an angle of 36 degrees. Make sure that the center is point (0, 0, 0) and that you are working in two dimensions.
4 . In the **Multiple Copies** box enter 9. This way, 9 copies will be made, thus obtaining the 10 teeth that form the profile of the model (9 copies and the original).
5 . Click **Select** and select the lines defining the profile. Press the **ESC** key or click **Finish** in the **Copy** window in order to conclude the operation. The result is shown in next figure.

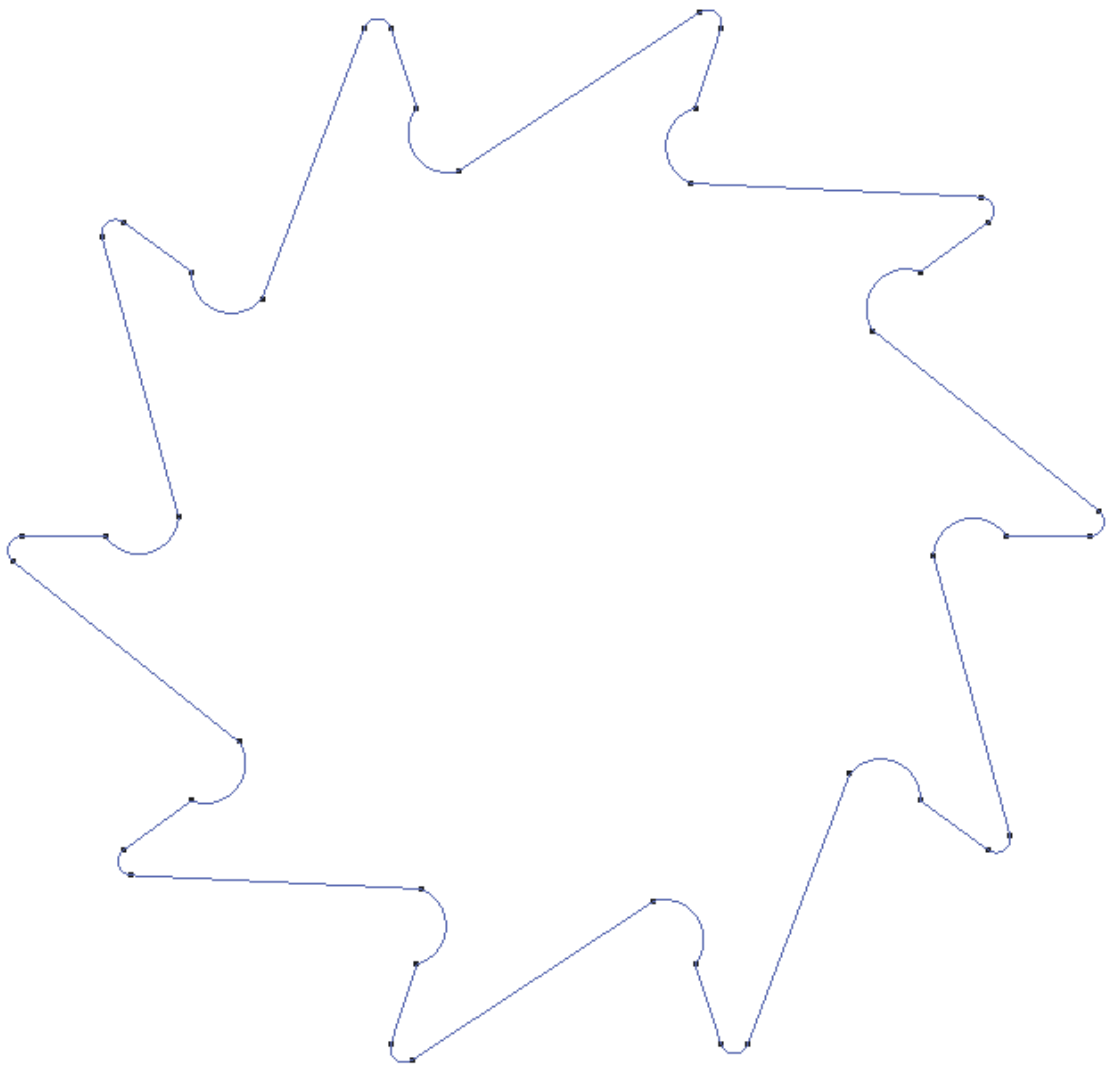


Figure 15. The part resulting from this process

4.2.12 Creating a surface

1 . Create a NURBS surface. To do this, select the option **Geometry->Create->NURBS surface->By contour.** This option can also be found in the GiD Toolbar.
2 . Select the lines that define the profile of the mechanical part and press **ESC** to create the surface.
3 . Press **ESC** again to exit the function.

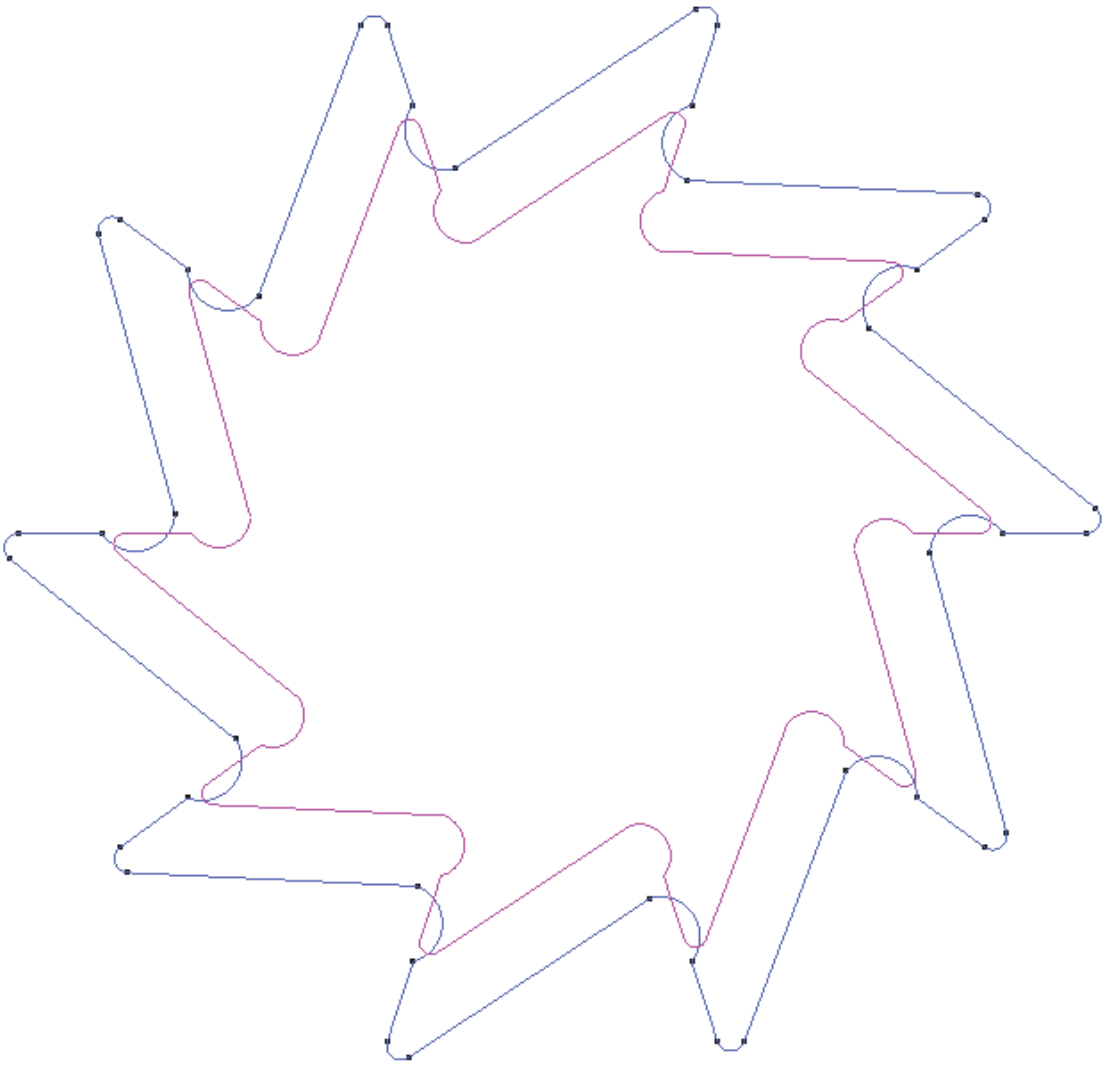


Figure 16. Creating a surface by contour

NOTE: To create a surface there must be a set of lines that define a closed contour.

4.3 Creating a hole in the mechanical part

In the previous sections we drew the profile of the part and we created the surface. In this section we will make a hole, an octagon with a radius of 10 units, in the surface of the part. First we will draw the octagon.

1 . Select from the menu **Geometry->Create->Object->Polygon** to create a regular polygon.
2 . Enter 8 as the number of sides of the polygon.
3 . Enter (0,0,0) as the center of the polygon. (use Ctrl-a keys to swap to select new point mode if required)
4 . Select Positive Z as the normal of the polygon, this mean a normal direction (0,0,1)
5 . Enter 10 as the radius of the polygon and press **ENTER**. Press **ESC** to finish the action.

We get the result as shown in figure 20. As we only need the boundary we should remove the associated surface. Select the option **Geometry->Delete->Surfaces** and then select

the surface of the octagon. Press **ESC** to finish.

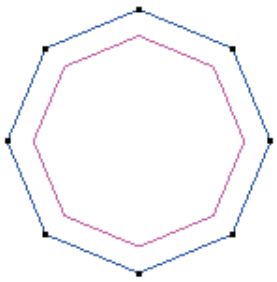


Figure 17. Regular 8-sided polygon

4.3.1 Creating a hole in the surface of the mechanical part

1 . Choose the option **Geometry->Edit->Hole NURBS surface**.
2 . Select the surface in which to make the hole (Figure 18).
3 . Select the lines that define the hole (Figure 19) and press **ESC**.

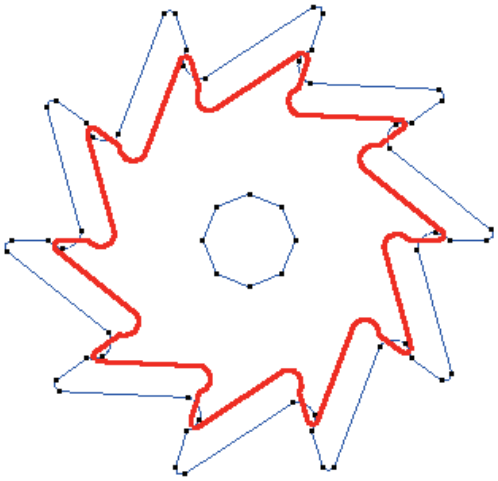


Figure 18. The selected surface in which to create the hole

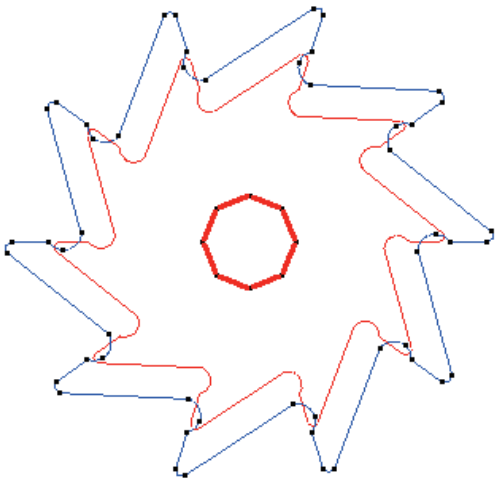


Figure 19. The selected lines that define the hole

4 . Again, press **ESC** to exit this function.

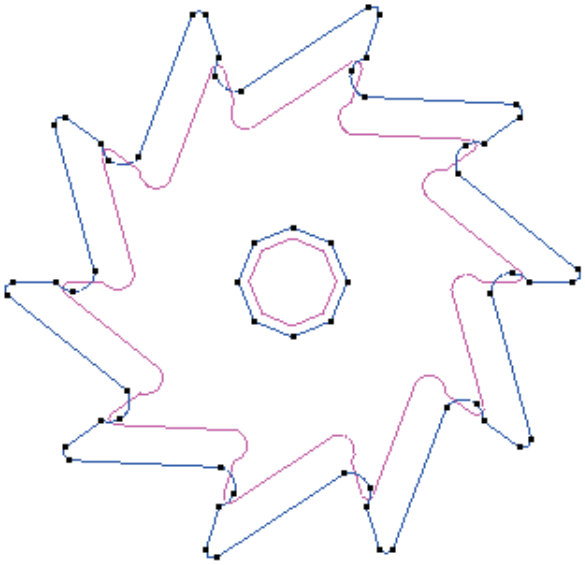


Figure 20. The model part with the hole in it

4.4 Creating volumes from surfaces

The mechanical part to be constructed is composed of two volumes: the volume of the wheel (defined by the profile), and the volume of the axle, which is a prism with an octagonal base that fits into the hole in the wheel. Creating this prism will be the first step of this stage. It will be created in a new layer that we will name "prism".

4.4.1 Creating the "prism" layer and translating the octagon to this layer

1 . In the **Layers** window, create a new layer named "prism".
2 . Select the "prism" layer and double-click it to choose as the activated layer.
3 . Right-click on "prism" layer and select **Send To->Lines**. Select the lines that define the octagon. Press **ESC** to conclude the selection.

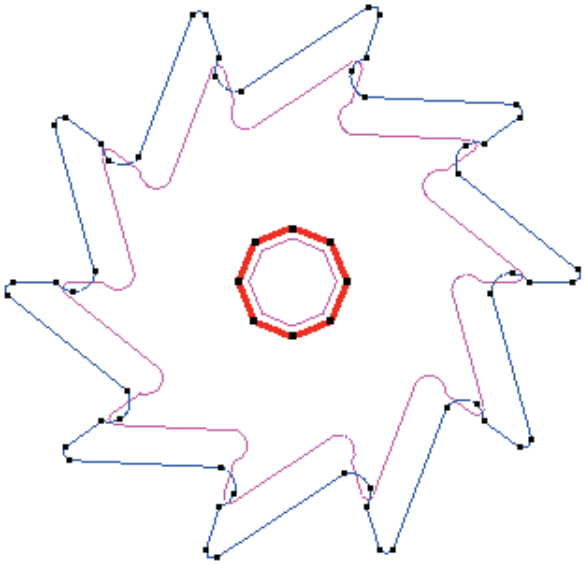


Figure 21. The lines that form the octagon

4 . Select the "profile" layer and set it **Off**.

4.4.2 Creating the volume of the prism

1 . First copy the octagon a distance of -50 units relative to the surface of the wheel, which is where the base of the prism will be located. In the **Copy** window, choose **Translation** and **Lines**. Since we want to translate 50 units, enter two points that define the vector of this translation, for example (0, 0, 0) and (0, 0, 50). (Make sure that the Multiple Copies value is 1, since the last time the window was used its value was 9).

2 . Choose **Select** and select the lines of the octagon. Press **ESC** to conclude the selection.

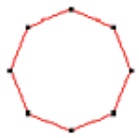


Figure 22. Selection of the lines that form the octagon

3 . Since the Z axis is parallel to the user's line of vision, the perspective must be changed to visualize the result. To do this, use the **Rotate Trackball** tool, which is located in the GiD Toolbox and in the mouse menu. (or press <Caps> key and drag the righ-mouse button to rotate the view)

Figure 23. Copying the octagon and changing the perspective

4 . Choose **Geometry->Create->NURBS surface->By contour**. Select the lines that form the displaced octagon and press **ESC** to conclude the selection. Again, press **ESC** to exit the function of creating the surfaces.

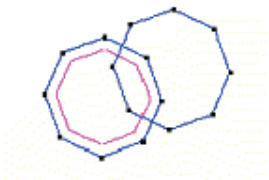


Figure 24. The surface created on the translated octagon

5 . In the **Copy** window, choose **Translation** and **Surfaces**. Make a translation of 110 units. Enter two points that define a vector for this translation, for example (0, 0, 0) and (0, 0, -110).

6 . To create the volume defined by the translation, select **Do Extrude Volumes** in the

Copy window.

7 . Click **Select** and select the surface of the octagon. Press **ESC**. The result is shown in next figure.

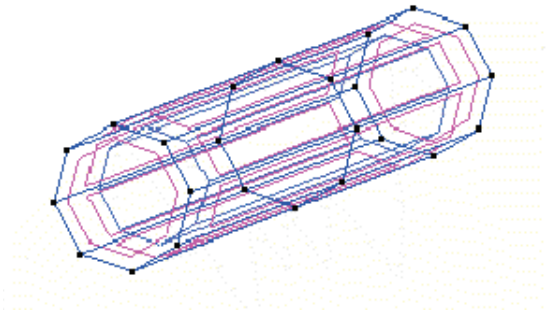


Figure 25. Creation of the volume of the prism

8 . Choose the option **Render->Flat** from the mouse menu to visualize a more realistic version of the model. Then return to the normal visualization using **Render->Normal**.

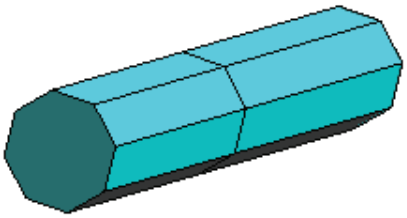


Figure 26. Visualization of the prism with the option RenderFlat.

NOTE: The **Color** option in the **Layers** window lets you define the color and the opacity of the selected layer. This color is then used in the rendering of elements in that layer.

4.4.3 Creating the volume of the wheel

1 . Visualize the "profile" layer and activate it. The volume of the wheel will be created in this layer. Set off the "prism" layer in order to make the selection of the entities easier.

2 . In the **Copy** window, choose **Translation** and **Surfaces**. A translation of 10 units will be made. To do this, enter two points that define a vector for this translation, for example (0, 0, 0) and (0, 0, -10).

3 . Choose the option **Do Extrude Volumes** from the **Copy** window. The volume that is defined by the translation will be created.

4 . Make sure that the **Maintain Layers** option is not checked, hence the new entities created will be placed in the layer to use; otherwise, the new entities are copied to the same layers as their originals

5 . Click **Select** and select the surface of the wheel. Press **ESC**.

6 . Select the two layers and click them **On** so that they are visible.

7 . Choose **Render->Flat** from the mouse menu to visualize a more realistic version of the model.

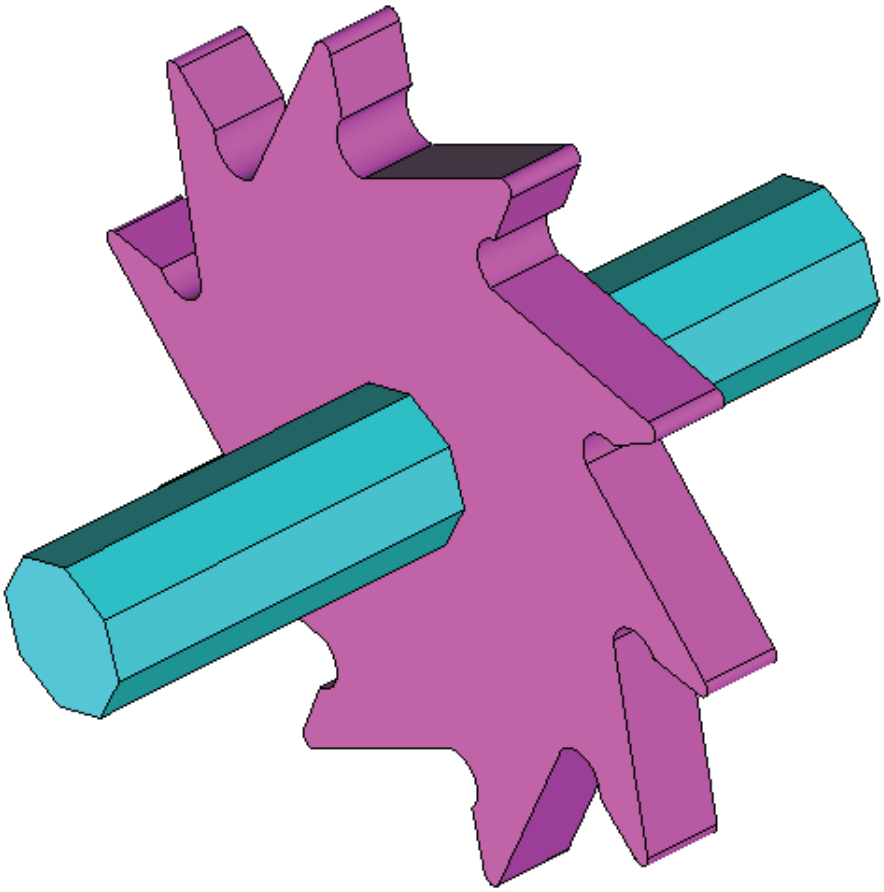


Figure 27. Image of the wheel

4.5 Generating the mesh

Now that the part has been drawn and the volumes created, the mesh may be generated. First we will generate a simple mesh by default.

Depending on the form of the entity to be meshed, GiD performs an automatic correction of the element size. This correction option, which by default is activated, may be modified in the **Meshing->Main** branch of the **Preferences** window, under the option **Automatic correct sizes**. Automatic correction is sometimes not sufficient. In such cases, it must be indicated where a more precise mesh is needed. Thus, in this example, we will increase the concentration of elements along the profile of the wheel by following two methods: 1) assigning element sizes around points, and 2) assigning element sizes around lines.

4.5.1 Generating a coarse mesh

1 . Choose **Mesh->Generate mesh**.
2 . A window comes up in which to enter the desired edge element size of the mesh to be generated. Set a big size of 10 units to have a coarse mesh and click **OK**.

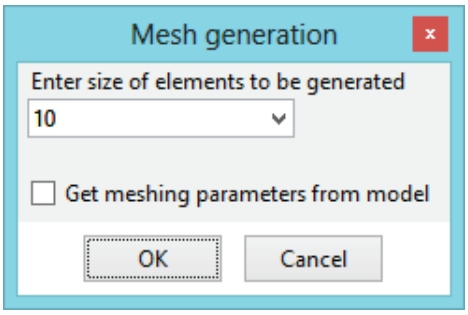


Figure 28. Choosing elements size

3 . A window appears showing how the meshing is progressing. Once the process is finished it show information about the mesh that has been generated. Click **View mesh** to visualize the resulting mesh.

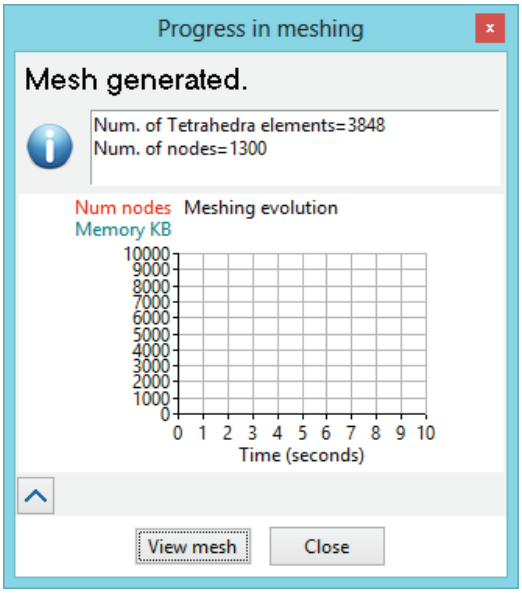


Figure 29. Mesh generated information

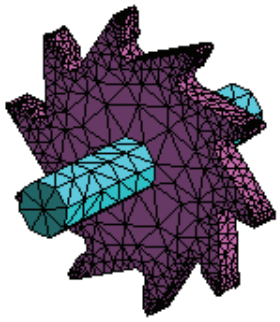


Figure 30. The mesh generated

4 . Use the **Mesh->View mesh boundary** option to see only the contour of the volumes meshed without the interiors. This visualization mode may be combined with the various rendering methods.

5 . A window appears asking if we want to maintain this visualization mode. Click **No**. To exit the mesh boundary visualization mode press **ESC**.

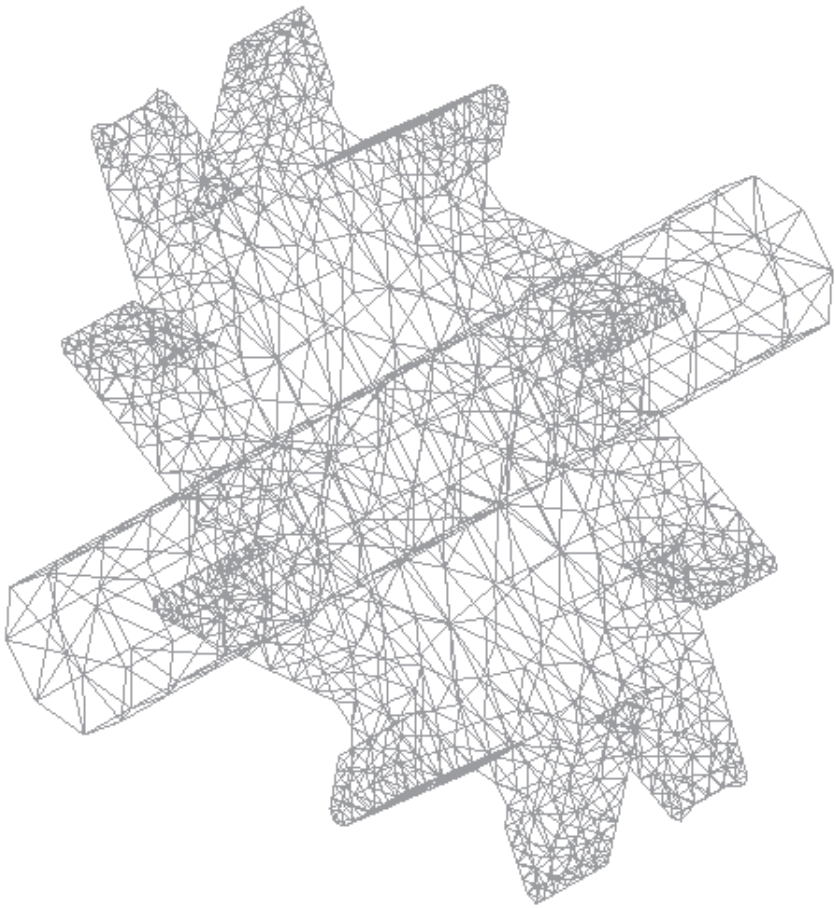


Figure 31. Mesh visualized with the Mesh->View mesh boundary option

6 . Visualize the mesh generated with the various rendering options in the **Render** menu, located in the mouse menu.

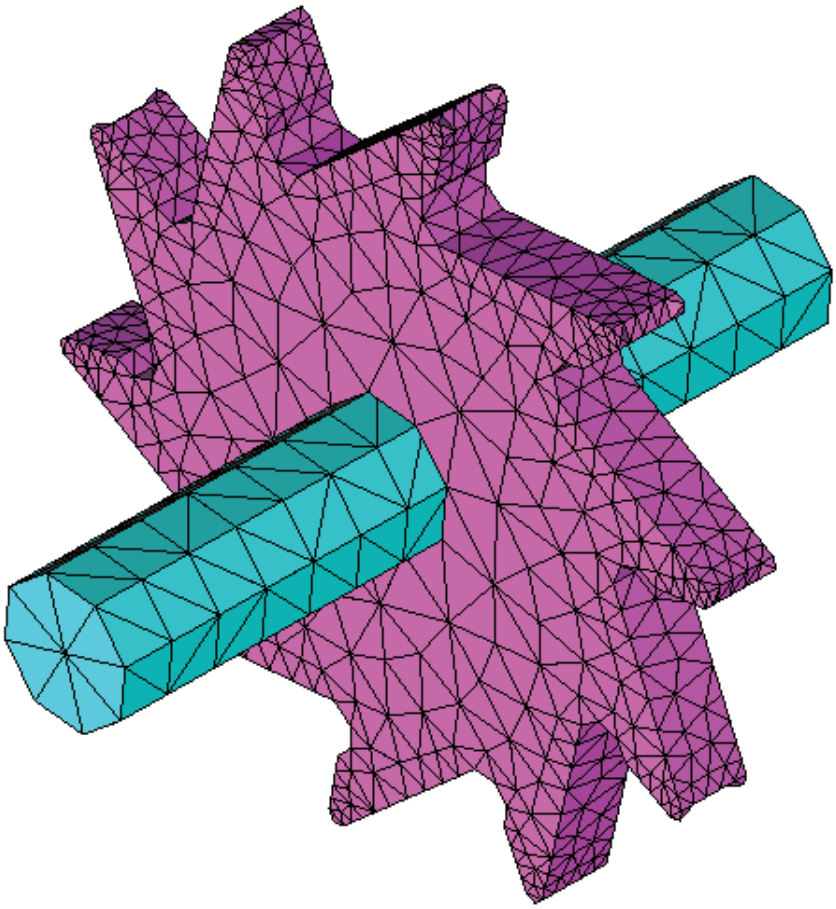


Figure 32. Mesh visualized with Mesh->View mesh boundary combined with Render->Flat.

7 . Choose **View->Mode->Geometry** to return to the normal visualization.

NOTE: To visualize the geometry of the model use **View->Mode->Geometry**. To visualize the mesh use **View->Mode->Mesh**.

4.5.2 Generating the mesh with assignment of size around points

1 . Choose **View->Rotate->Plane XY (Original)**. This way we will have a side view, and **View->Mode->Geometry** and **Render->Normal** to see the geometry like the image

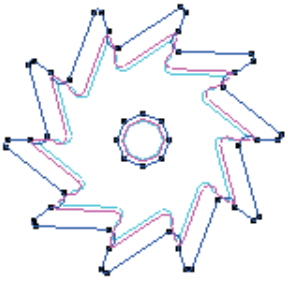


Figure 33. Side view of the part.

2 . Choose **Mesh->Unstructured->Assign sizes on points**. A window appears in which to enter the element size around the point to be selected. Enter 0.7 and click **Assign**.

3 . Select only the points on the wheel profile (see next figure). One way of doing this is to select the entire part and then deselect the points that form the prism hole. Press **ESC** to conclude the selection process.

4 . The window appears again, click **Close** to finish.

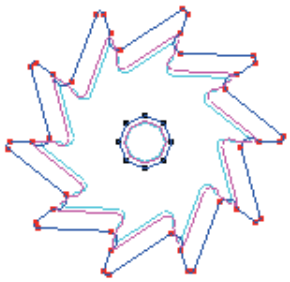


Figure 34. The selected points of the wheel profile

5 . Choose **Mesh->Generate mesh**.

6 . A window opens asking if the previous mesh should be eliminated. Click **Yes**. Another window appears in which the desired element size should be entered. Leave the previous value of 10 unaltered.

Figure 35. Erasing old mesh

7 . A third window shows the meshing process. Once it has finished, click **OK** to visualize the resulting mesh.

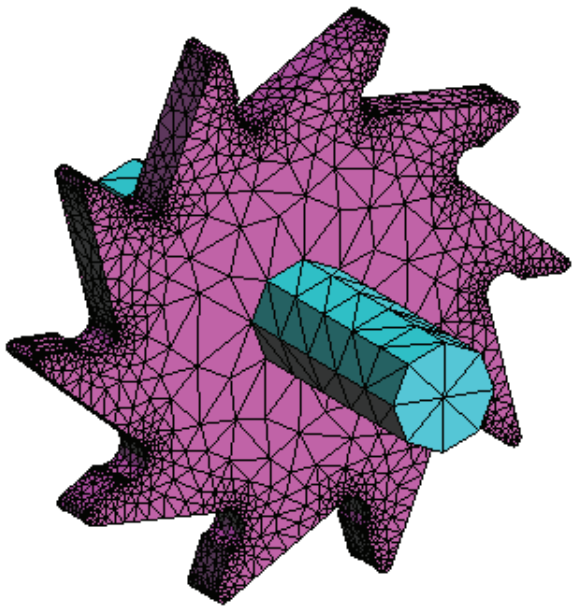


Figure 36. Mesh with assignment of sizes around the points on the wheel profile

8 . A greater concentration of elements has been achieved around the points selected.
9 . Choose **View->Mode->Geometry** to return to this visualization.

4.5.3 Generating the mesh with assignment of size around lines

1 . Open the **Preferences** window, which is found in **Utilities**, and select the **Meshing->Main** branch. In this window there is an option called **Unstructured size transitions** which defines the size gradient of the elements. A high transition number means a fast grown of small sizes. Select a transition size of **0.8** to have a fast transition and then obtain few elements. Click **Apply**.
2 . Choose **Mesh->Reset mesh data** to delete the previously assigned sizes.
3 . Choose **Mesh->Unstructured->Assign sizes on lines**. A window appears in which to enter the element size around the lines to be selected. Enter size 0.7 and click **Assign**.
4 . Select only the lines of the wheel profile (see next figure) in the same way as in previous section and press **ESC**.
5 . The window appears again, click **Close** to finish.

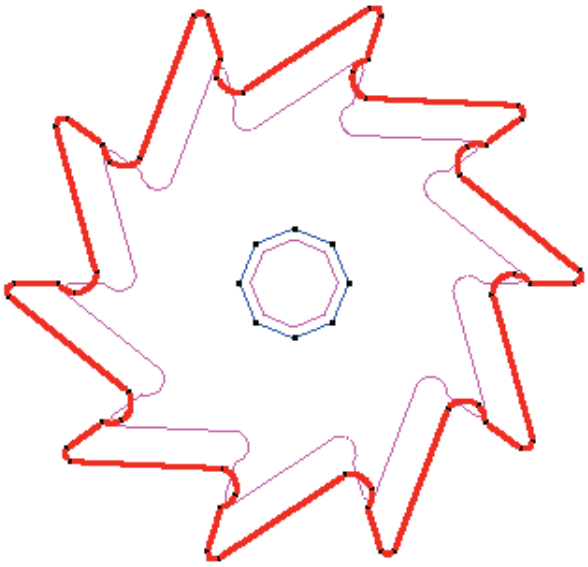


Figure 37. Selected lines of the wheel profile

6 . Choose **Mesh->Generate mesh**. A window appears asking if the previous mesh should be eliminated. Click **Yes**.

7 . Another window opens in which the maximum element size should be entered. Leave the last value unaltered and click **View mesh**.

8 . A greater concentration of elements has been achieved around the selected lines. In contrast to the case in previous section, this mesh is more accurate since lines define the profile much better than points do.

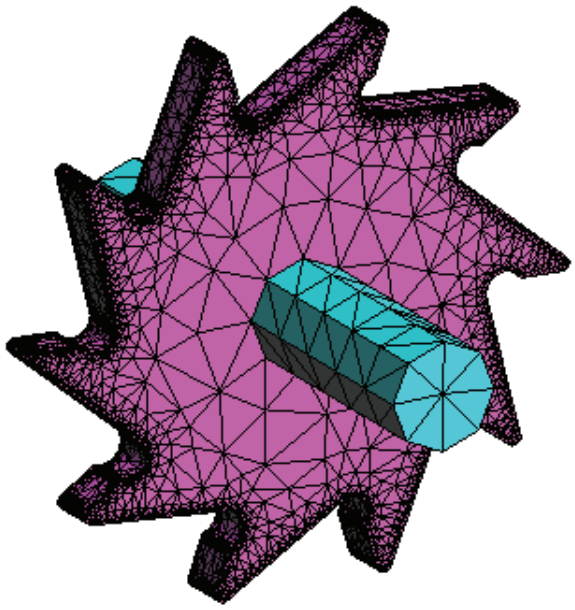


Figure 38. Mesh with assignment of sizes around lines

5 IMPLEMENTING A COOLING PIPE

ADVANCED 2D & 3D TECHNIQUES AND MESHING

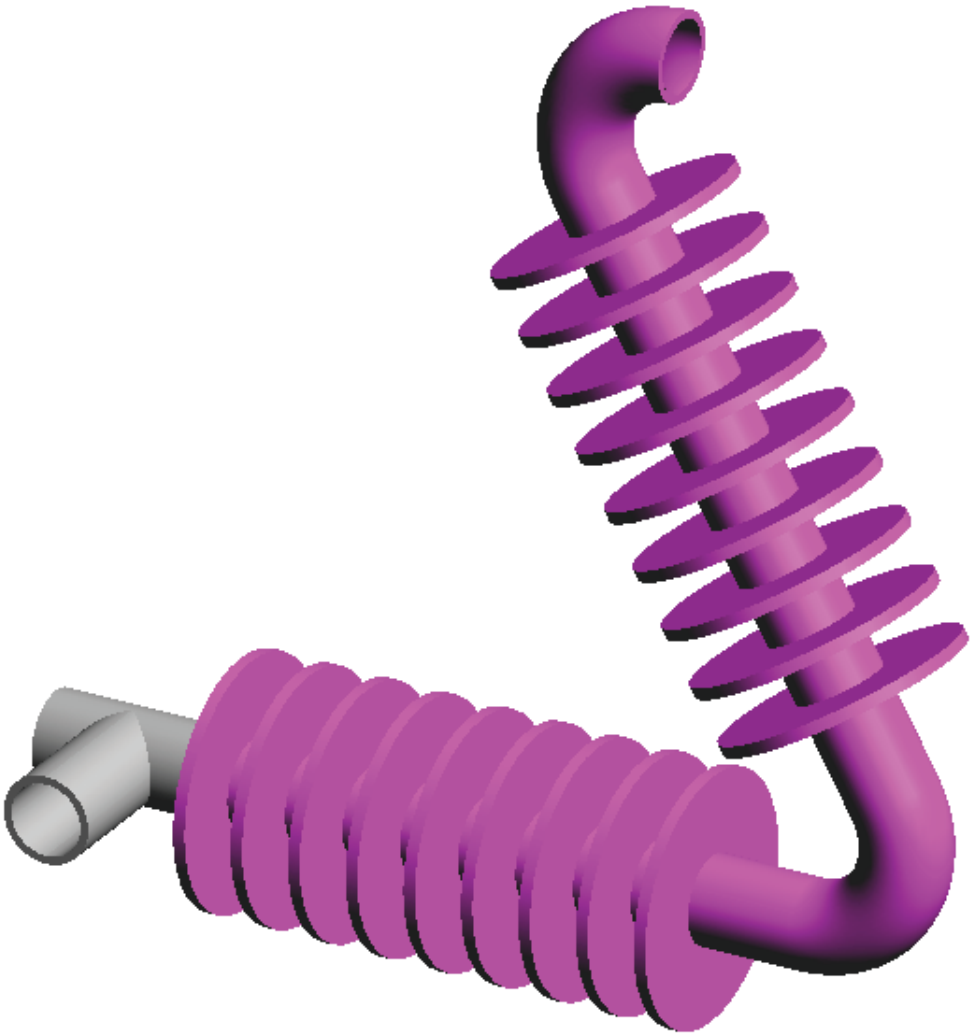
IMPLEMENTING A COOLING PIPE

This case study shows the modeling of a more complex piece and concludes with a detailed explanation of the corresponding meshing process. The piece is a cooling pipe composed of two sections forming a 60-degree angle.

The modeling process consists of four steps:

- Modeling the main pipes
- Modeling the elbow between the two main pipes, using a different file
- Importing the elbow to the main file
- Generating the mesh for the resulting piece

At the end of this case study, you should be able to use the CAD tools available in GiD as well as the options for generating meshes and visualizing the result.



5.1 Working by layers

Various auxiliary lines will be needed in order to draw the part. Since these auxiliary lines must not appear in the final drawing, they will be in a different layer from the one used for the finished model.

Create the layers called "part1", "union" and delete the layer "Layer0"

Choose "part1" as the activated 'layer to use'. From now on, all the entities created will belong to this layer.

5.2 Creating a component part

In this section the entire model, except the T junction, will be created. The model to be created is composed of two pipes forming a 60-degree angle. To start with, the first pipe will be created. This pipe will then be rotated to create the second pipe.

5.2.1 Creating the profile

1 . Choose the **Line** option, located in **Geometry->Create->Straight line.**
2 . Enter the following new points in the command line: (0, 11), (8, 11), (8, 31), (11, 31), (11, 11) and (15, 11). Press **ESC** twice to indicate that the process of creating lines is finished.

Figure 1. Profile of one of the disks around the pipe

3 . From the **Copy** window, choose **Lines** and **Translation**. A translation defined by points A (0, 11) as first point and B (15, 11) as second point will be made. In the **Multiple copies** option, enter 8 (the number of copies to be added to the original). Be sure than the 'Collapse' option is set, and then Select the lines that have just been drawn and press **ESC**.

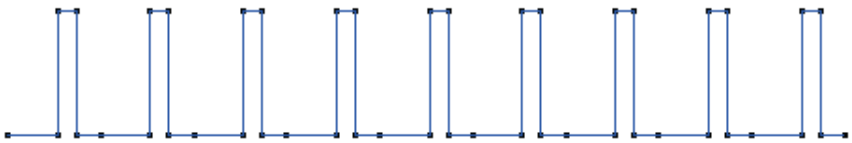


Figure 2. The profile of the disks using Multiple copies

4 . Create a line using **Geometry->Create->Straight line.** Use the contextual option **Join** or press **<Ctrl-a>** and select the last point on the profile (at the right part of the profile). Now choose the option **No join Ctrl-a** and enter new point (160, 11) in the command line. Press **ESC** twice to finish the process of creating lines.
5 . Again, choose the **Line** option and enter the new points (0, 9) and (160, 9). Press **ESC** twice to conclude the process of creating lines.

5.2.2 Creating the surfaces by revolution

Rotation of the profile will be carried out in two rotations of 180 degrees each.

1 . From the **Copy** window, select **Lines** and **Rotation**. Enter an angle of 180 degrees and from the **Do extrude** menu, select **Surfaces**. The axis of rotation is that defined by the line that goes from point (0, 0) to point (200, 0). Enter these two points as the **First Point** and **Second Point** (Two dimensions must be unchecked). Be sure to enter 2 in **Multiple copies**. and select all lines and press **ESC** when the selection is finished.

2 . Rotate the view from the mouse menu **Rotate->Trackball** and choose **Render->Flat** to visualize a more realistic version of the model.

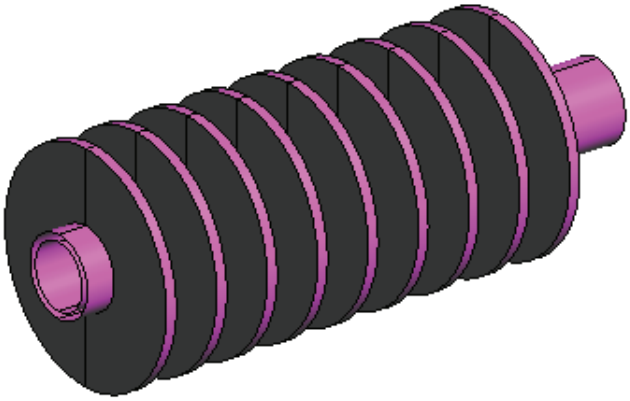


Figure 3. The pipe with disks, created by rotating the profile.

3 . Return to the normal visualization with Render->Normal. This option is more comfortable to work with. To return to the side view (elevation), choose in the mouse menu Rotate->Plane XY (Original).

5.2.3 Creating the union of the main pipes

1 . Choose the **Zoom->In** option from the mouse menu. Magnify the right end of the model and rotate the view to facilitate the selection.

2 Set "union" as current layer to use, with a <Double-click>

3 . From the **Copy** window, select **Lines** and **Rotation**. Enter an angle of 120 degrees and select the rotation center (160, 25) as First point. Since the rotation may be done in 2D, choose the option **Two Dimensions**. From the **Do extrude** menu, select **Surfaces** and be sure that **Multiple copies** is 1and **Maintain layers** is unset, then the new entities will be created in the layer to use instead of the layer of the source curves.

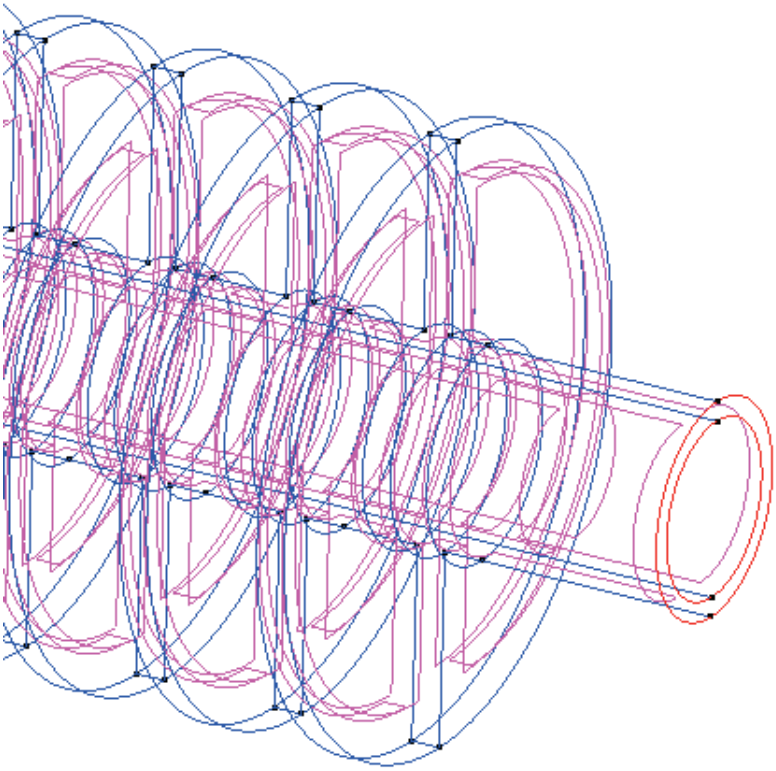


Figure 4. The lines to be selected

4 . Click **Select** and select the four lines that define the right end of the pipe (see figure above). Press **ESC** when the selection is finished.

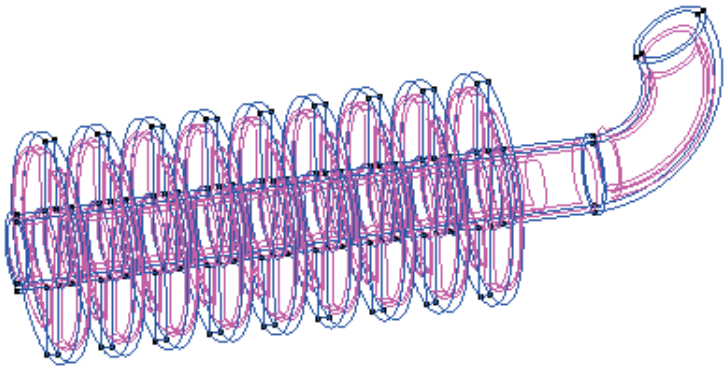


Figure 5. Result of the extrusion by rotation

5.2.4 Copying the main pipe

IMPLEMENTING A COOLING PIPE>Creating a component part>Copying the main pipe

Align uses a rigid body movement defined by three source points and its destination points.

1 . From the **Copy** window, select **Surfaces** and **Align**. Choose the **Two Dimensions** option. The source points S1, S2 and its destination points D1, D2 are highlighted in the image. Ensure the **Do Extrude** menu is set to **No**. and set Maintain layers.

NOTE: In the **Copy** window, the button may be used to select existing points with the mouse, or alternativelly enter its number in the entry field.

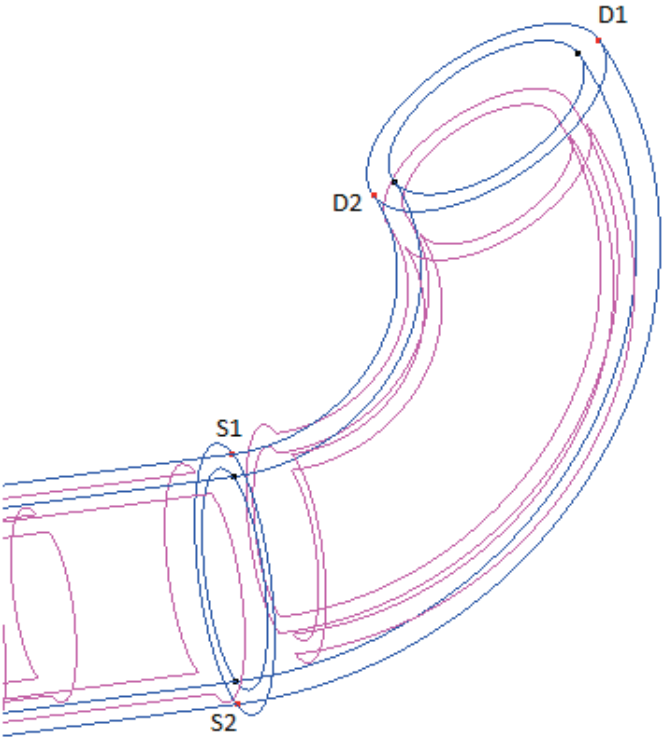


Figure 6. pairs of points to define the 'Align' movement

2 . Click **Select** and select all the surfaces of the layer "part1" and press **ESC** when the selection is finished.

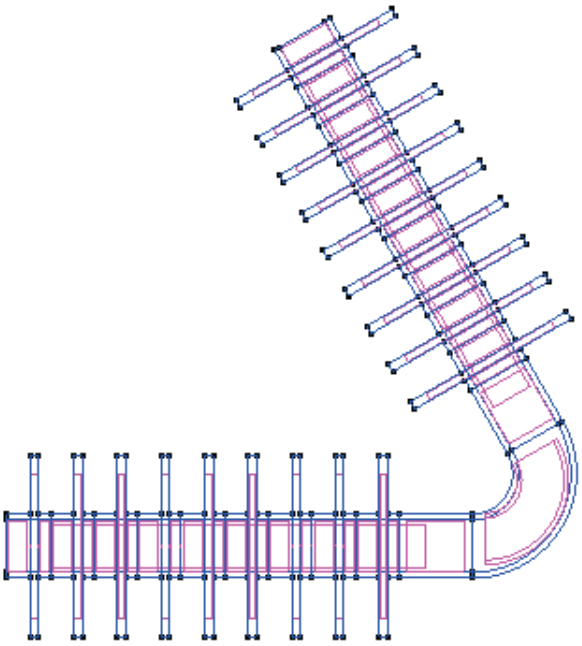


Figure 7. Geometry of the two pipes and its union

5.2.5 Creating the end of the pipe

1 . From the **Copy** window, select **Surfaces** and **Rotation**. Enter an angle of 180 degrees. Since the rotation may be done in 2D, choose the option **Two Dimensions**. The center of rotation is the upper right point of the pipe elbow. Make sure the **Do Extrude** menu is set to **No**.
2 . Click **Select** and select the surfaces that join the two pipe sections and press **ESC**.
3 . Select **Utilities->Move** window, select **Surfaces** and **Translation**. The points defining the translation vector are circled in next figure.

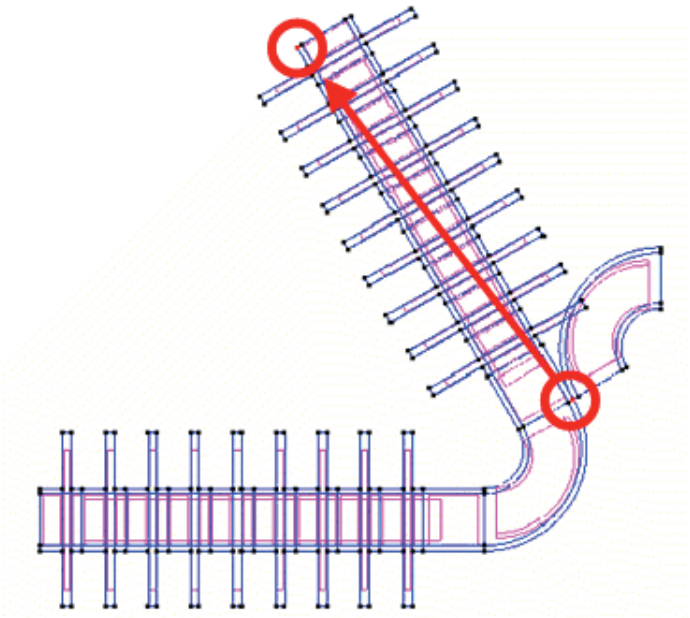


Figure 8. The circled points define the translation vector.

4 . Click **Select** and select the surfaces created in point 1. Press **ESC.** The result should be as is shown.

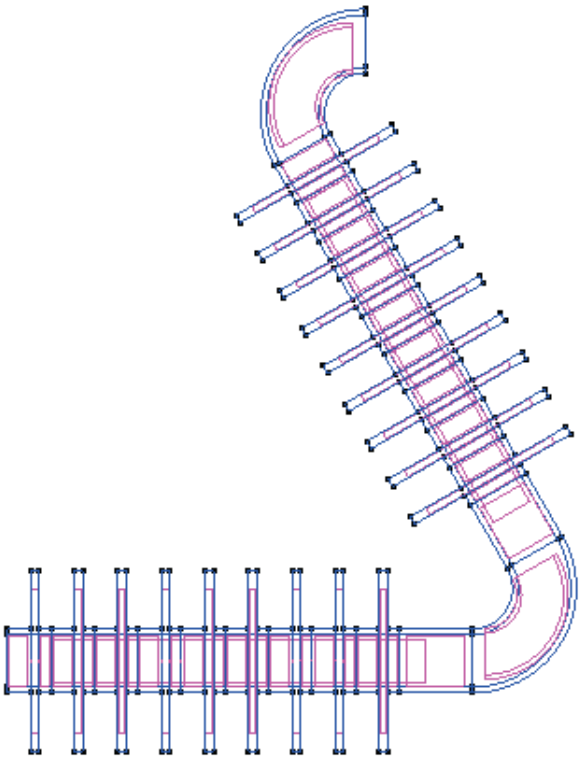


Figure 9. The final position of the translated elbow.

5 . To create a ring surface, choose **Geometry->Create->NURBS Surface->By contour** and select the four lines that define the opening of the pipe (see next figure). Press **ESC** twice.

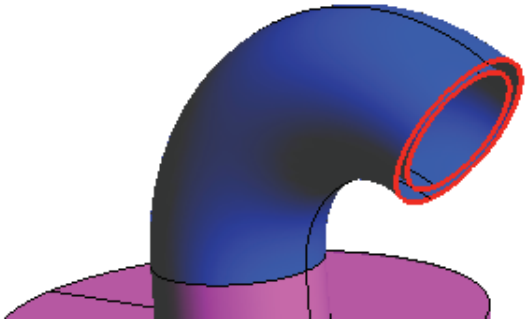


Figure 10. Opening at the end of the pipe

From the **Files** menu, choose **Save** in order to save the file. Enter a name for the file and click **Save**.

5.3 Creating the T junction

Now, an intersection composed of two pipe sections will be created in a separate file. Then this file will be imported to the original model to create the entire piece.

5.3.1 Creating one of the pipe sections

1 . Choose **Files->New**, thus starting work in a new file.

2 . Rename the layer 'Layer0' to 'pipe1' and create two new childs layers "inner" and "outer". Set 'pipe1//inner' as layer to use with a <Double-click>

3 . Choose **Geometry->Create->Point** and enter new point (0, 9)
4 set 'pipe1//outer' as layer to use and create the new point (0, 11). Press **ESC** to conclude the creation of points.
5 . From the **Copy** window, select **Points** and **Rotation**. Enter an angle of 180 degrees and from the **Do extrude** menu, select **Lines**. The axis of rotation is the x axis. Enter two points defining the axis, one in **First Point** and the other in **Second Point**, for example, (0, 0, 0) and (1, 0, 0) , check **Maintain layers**, and set **Multiple copies** to 2.
6 . Click **Select** and select the two points just created. Press **ESC**.

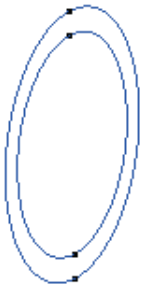


Figure 11. the current model

7 . Create a surface: choose **Geometry->Create->NURBS Surface->By contour** and select the four lines. Press **ESC** twice.
8 . From the **Copy** window, choose **Surfaces** and **Translation**. In **First Point** and **Second Point**, enter the points defining the translation vector. Since the pipe section must measure 40 length units, the vector is defined by points (0, 0, 0) and (-40, 0, 0).
9 . From the **Do extrude** menu, choose the **Volumes** option, and set **Multiple copies** to 1.
10 . Click **Select** to select the surface. Press **ESC** to conclude the selection process.

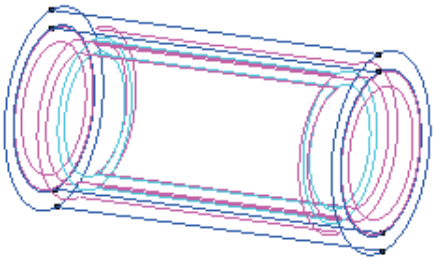


Figure 12. Creating a pipe by extruding the ring

5.3.2 Creating the other pipe section

1 . Create a new layer named "pipe2" with two child layers "inner" and "outer". Set "pipe2//inner" as the 'layer to use', and set off the layers "pipe1"
2 . Choose **Geometry->Create->Point** and enter points (-20, 9) and (-20, 11). Press **ESC** to conclude the creation of points.
3 . Change the layer of the second point to "pipe2//outer"
4 . From the **Copy** window, select **Points** and **Rotation**. Enter an angle of 180 degrees and from the **Do extrude** menu, select **Lines**. Since the rotation can be done on the **xy** plane, choose **Two Dimensions**. The center of rotation is the coordinates (-20, 0, 0), and set **Multiple copies** to 2
5 . Click **Select** and select the two points just created.

6 . Create a surface: choose **Geometry->Create->NURBS Surface->By contour** and select the four lines. Press **ESC** twice.
7 . From the **Copy** window, select **Surfaces** and **Translation**. In **First Point** and **Second Point** enter the points defining the translation vector. Since this pipe section must also measure 40 length units, the vector is defined by points (0, 0, 0) and (0, 0, 40).
8 . From the **Do extrude** menu, select the **Volumes** option and set **Multiple copies** to 1.
9 . Click **Select** to select the surface and press **ESC** to conclude the selection.

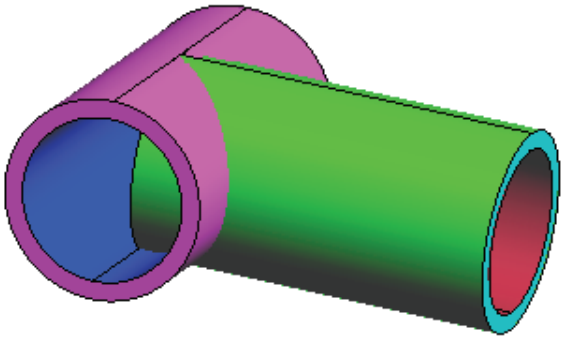


Figure 13. A rendering of the two overlapping pipes

5.3.3 Creating the lines of intersection

1 . Set off the layers "outer" to facilitate the selection
2 . Choose **Geometry->Edit->Intersection->Surfaces**.
3 . Select the three inner surfaces of the pipes that are intersecting.

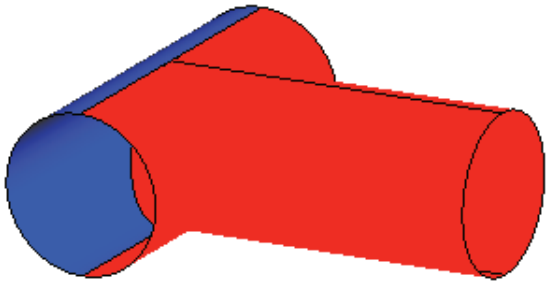


Figure 14. The inner surfaces to be intersected

4 . Repeat the process with the three outer surfaces of the pipes that are intersecting.
Now the intersection lines are created and some surfaces are splitted by these lines.

5.3.4 Deleting surfaces and close a volume

1 . Choose **Geometry->Delete->Volumes** and select the two volumes, to be able to delete some of its unwanted surfaces.
2 . Choose **Geometry->Delete->Surfaces** and select the small surfaces inside the first pipe. Select **Lower Entities** in the contextual menu, to delete its dependencies also. Press **ESC** to conclude the process of selection.

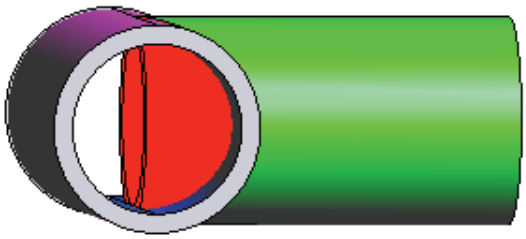


Figure 15. Surfaces to be deleted

3 . Use **Geometry->Create->Volume->By contour** and select all surfaces

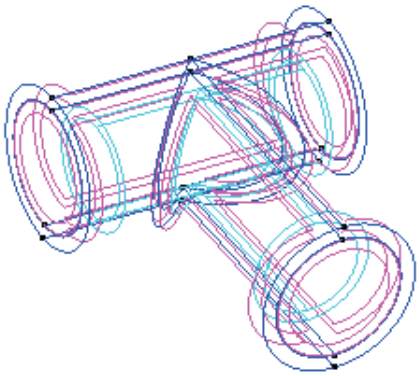


Figure 16. The volume of a T junction

4 . From the **Files** menu, select **Save** to save the file. Enter a name for the file and click **Save**.

5.4 Importing the T junction to the main file

The two parts of the model have been drawn. Now they must be joined so that the final volume may be created and a mesh of the volume may be generated.

5.4.1 Importing a GiD file

1 . Choose **Open** from the **Files** menu. Select the file where the first part, created in section Creating a component part -pag. 70-, was saved. Click **Open**.

2 . Choose **Files->Import->Insert GiD model** from the menu. Select the file where the second part, created in section Creating the T junction -pag. 75-, was saved. Click **Open**.

3 . The T junction appears. Bear in mind that the lines which define the end of the first pipe (background) of the T junction, and which have been imported, were already present in the first file. Notice that the lines are duplicated. This overlapping will be remedied by collapsing the lines.

4 . Check duplicated lines with the tool **View->Higherentities->Lines**

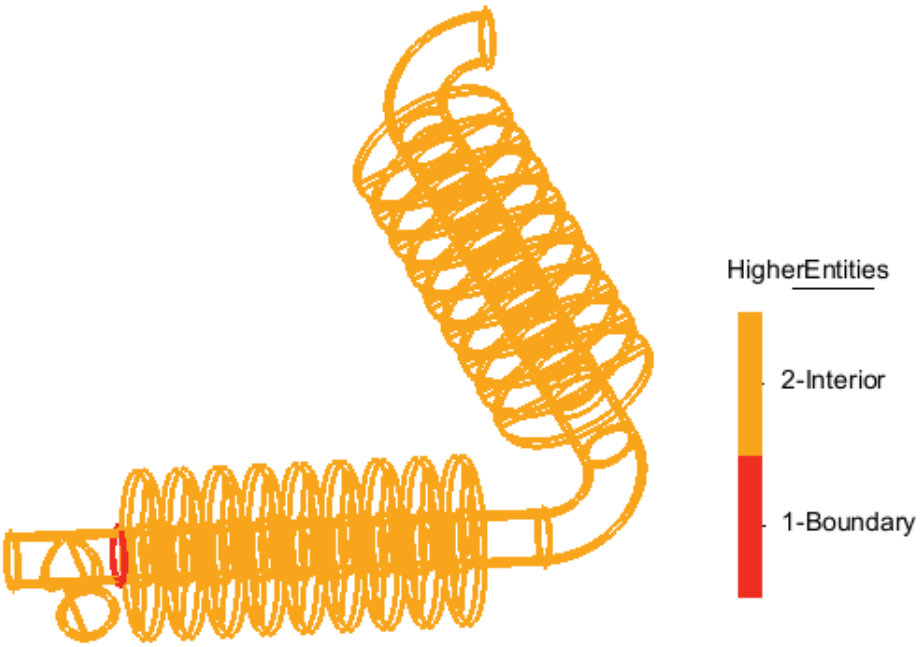


Figure 17. Importing the T junction file to the main file. Some entities are duplicated and must be collapsed.

5 . Choose the option **Geometry->Edit->Collapse->Lines**. Select the overlapping lines and press **ESC**.

5.4.2 Creating the final volume

Now we have a volume of the T junction, and we want to create another volume with the rest of the piece, connected to the first volume. Two volumes are connect if they share some surface. we will reuse the ring surface of the first volume for the new volume.

1 . Set off the layers "part1" and "union"
2 . Send the shared surface to the "part1" layer, to facilitate the selection of the new volume boundary: select "part1", use **Send to->Surfaces** and select the surface of the image and press **Escape**

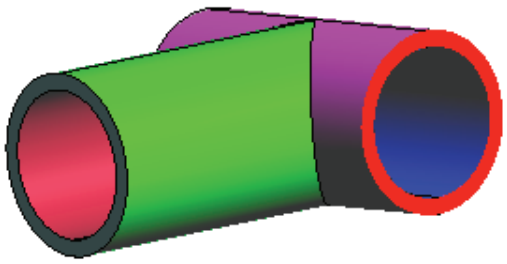


Figure 18. Surface to be shared

3 . Set off the layers "pipe1" and "pipe2" and set on "part1" and "union", and send "part1" as layer to use, to create the new volume in this layer.
4 . Choose **Geometry->Create->Volume->By contour** and select all the visible surfaces to define the volume. Press **ESC** to conclude the selection process.
5 . Choose **Render->Smooth** to visualize a more realistic version of the model.

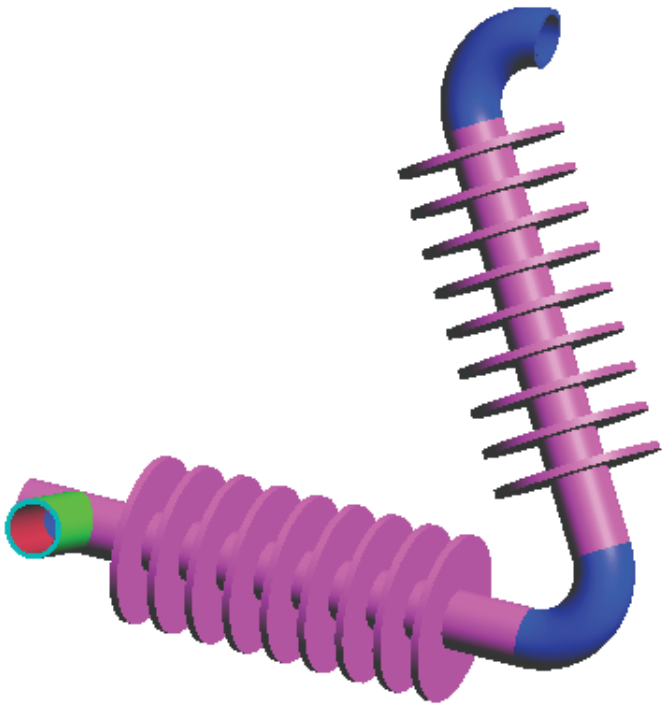


Figure 19. A rendering of the finished piece of equipment

5.5 Generating a mesh

Now that the model is finished, it is ready to be meshed.

Generate a coarse mesh is a good test to check that the model is correct and is valid to be used in a numerical simulation. We will use default meshing settings.

1 . Choose **Mesh->Generate mesh**.
2 . A window opens in which to enter the edge size of the mesh to be generated. Set a value of 5 units and click **OK**.
3 . When the meshing process is finished, a window appears with information about the mesh, press **View mesh** in order to be showed.

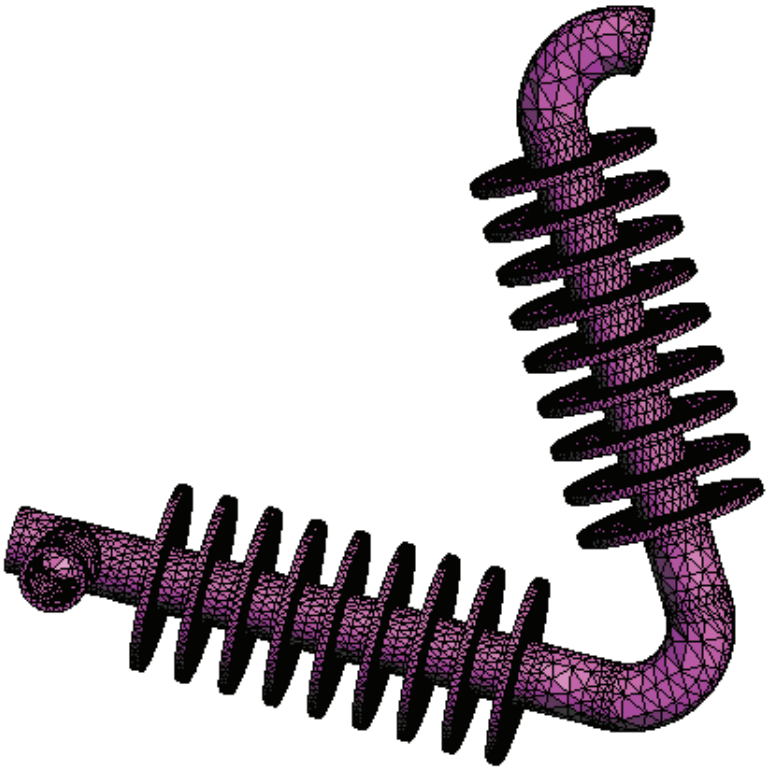


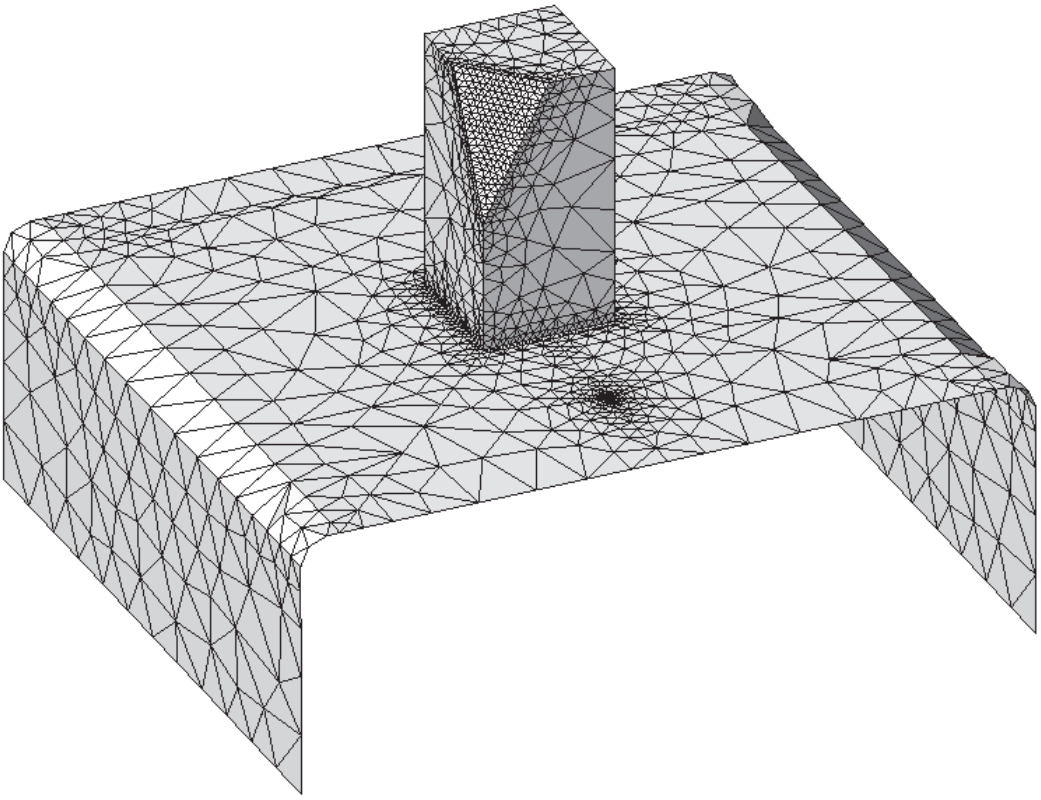
Figure 19. The volume mesh of tetrahedra

6 ASSIGNING MESH SIZES

ASSIGNING SIZES TO THE ELEMENTS OF A MESH

The objective of this example is to mesh a mechanical piece using the various options in GiD for assigning sizes to elements, and the different surface meshers available. In this example a mesh is generated for each of the following methods for assigning sizes, using different surface meshers:

- Assigning sizes around points
- Assigning sizes around lines
- Assigning sizes on surfaces
- Assigning sizes with Chordal Error



6.1 Introduction

In order to carry out this example, start by opening the project "ToMesh4.gid”. This project contains a geometry that will be meshed using four different methods, each one resulting in a different density of elements in certain zones.

6.1.1 Reading the initial project

1 . Open the project "☐**ToMesh4.gid**"☐.
2 . The geometry appears on the screen. It is a set of surfaces.
3 . Change the render mode (from the mouse menu, or from the status bar) and rotate the model in order to get a better perception of the geometry of the model.
4 . Finally, return to the normal visualization, selecting **Render->Normal**. This mode is

more user-friendly.

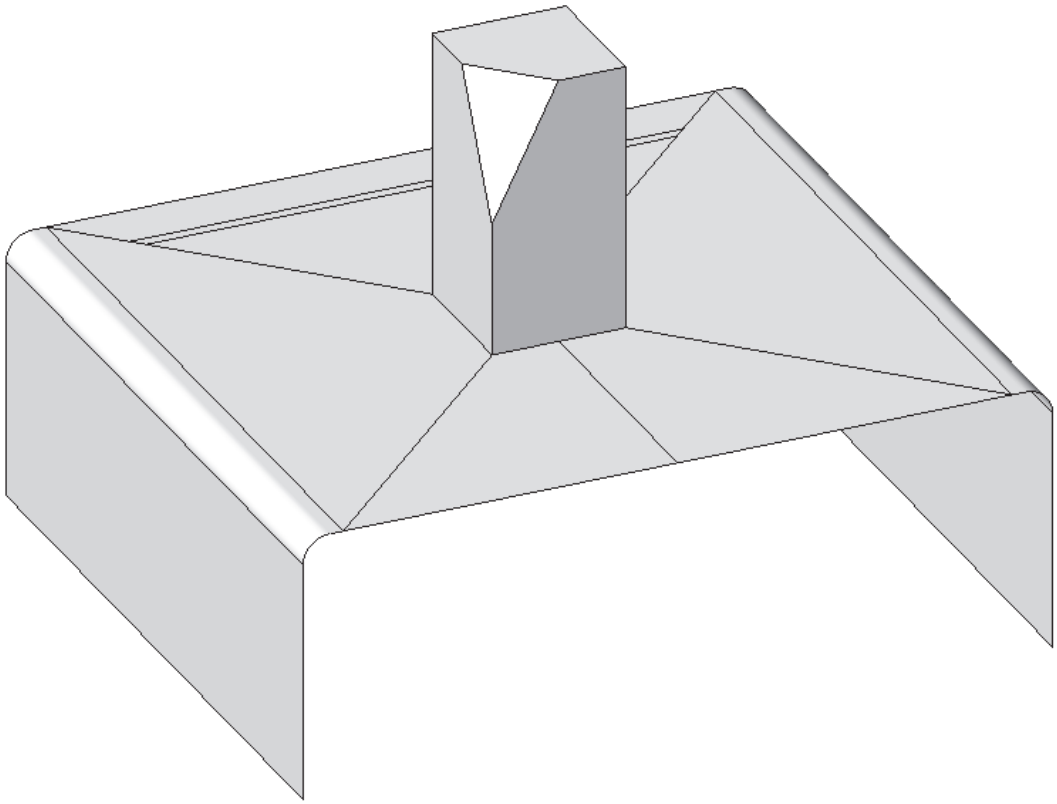


Figure 1. The geometrical model of ToMesh4.gid project

6.2 Element-size assignment methods

GiD automatically corrects element sizes according to the shape of the entity to be meshed and its surrounding entities. This default option may be changed by going to the **Utilities** menu, selecting **Preferences**, and then **Automatic correct sizes**[2] inside **Meshing** branch[3] .

Sometimes, however, this type of correction is not sufficient and it is necessary to indicate where on the mesh greater accuracy is needed. In these cases, GiD offers various options and methods allowing sizes to be assigned to elements.

To be sure that all the preferences are the ones used in this tutorial and get the same mesh as result, set the default values for all the preferences:

- Press **Default values** bottom button in the **Meshing** branch of the **Preferences** window and **Close** the window.

---

[2] The different options are: **None**, no size correction is made; **Normal**, a size correction is made according to the sizes of geometrical entities and the compatibility between meshing sizes of neighboring entities; **Hard**, the Normal correction is made and, furthermore, an automatic chordal error criteria is applied to assign sizes to surfaces which are the contours

of some volume in order to improve volume meshes.

[3] Similar options to **Automatic correct sizes** but to execute them manually one time can be found on **Mesh->Untructured->Correct Sizes...**

6.2.1 Assign general mesh size witth default options

To generate the mesh using the default options:

1 . Select **Mesh->Generate Mesh**.
2 . A window appears showing the maximum element size. This is the general mesh size that will be used for meshing the whole model. Leave this default size unaltered and click **OK**.
3 . A meshing process window opens. Then another window appears with information about the mesh generated. Click **View Mesh** to visualize the mesh (see Figure 2).

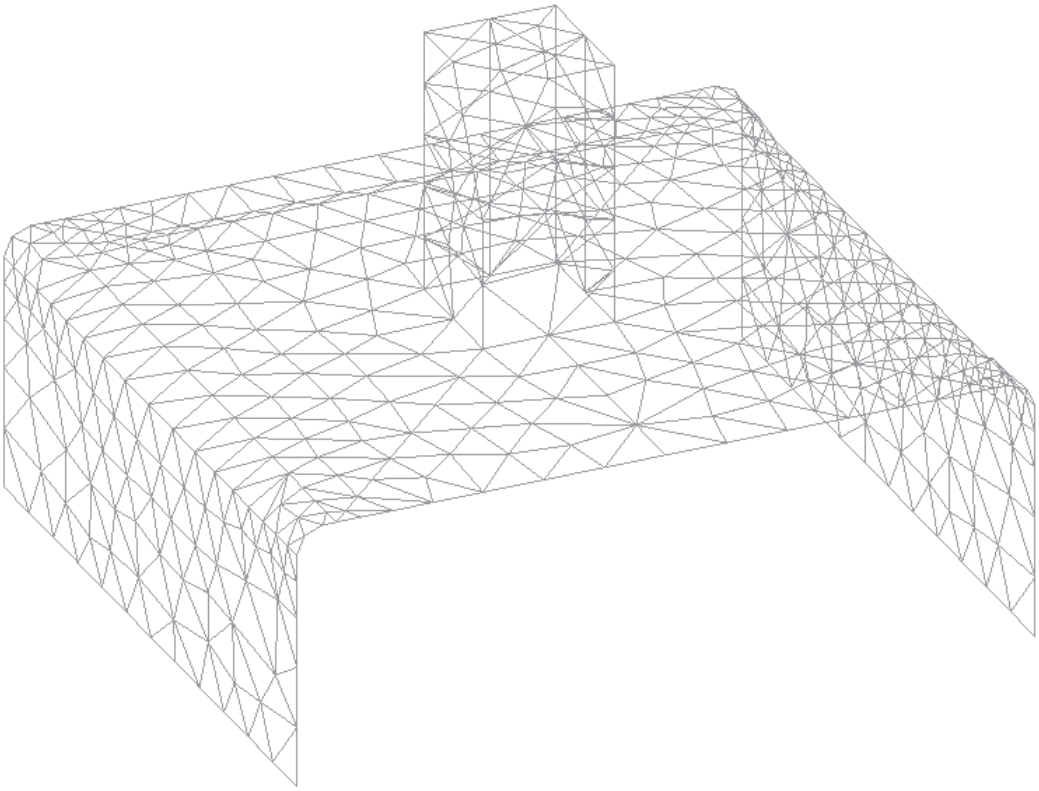


Figure 2. Meshing by default

Note that in the zone highlighted in Figure 3, elements are smaller than in the rest of the model. This is because of the shape of the surface placed there. When all meshing preferences are set by default, as for this example, the RFAST surface mesher is used. In this way, geometrical entities are meshed hierarchically: first of all lines are meshed, then the surfaces, and finally the volumes. The line elements size depends on the shape of surfaces (as can be seen in this example). Later on we will see an example using RJUMP mesher, where element sizes are distributed differently.

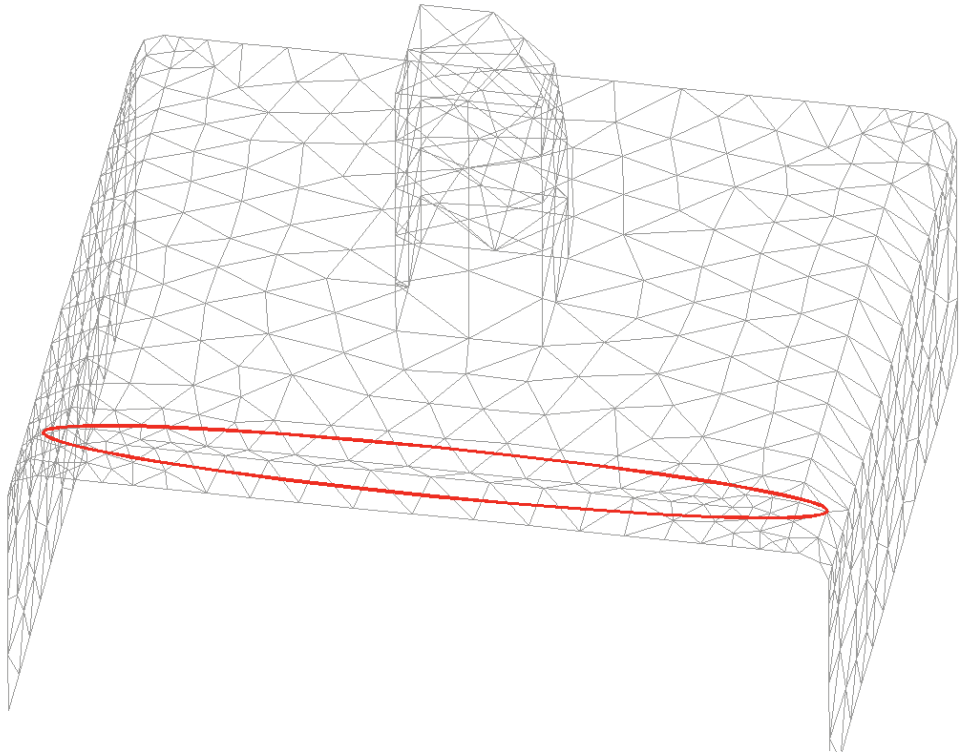


Figure 3. Meshing by default. Zone where elements are smaller because of the surface shape.

6.2.2 Assign size to points

1 . Select **Mesh->Unstructured->Assign size on points**. A window appears in which to enter the element size around the points to be chosen. Enter **0.1** and click **Assign**.
2 . Select the point indicated in Figure 4. Press **ESC** [4] to indicate that the selection of points is finished, and **Close** the window.
3 . Select **Mesh->Generate Mesh**.
4 . A window opens asking whether the previous mesh should be eliminated. Click **Yes**.
5 . GiD then asks you to enter the general maximum element size. Leave the default value unaltered and click **OK**.
6 . Click **View mesh** in the pop up window to see the result.

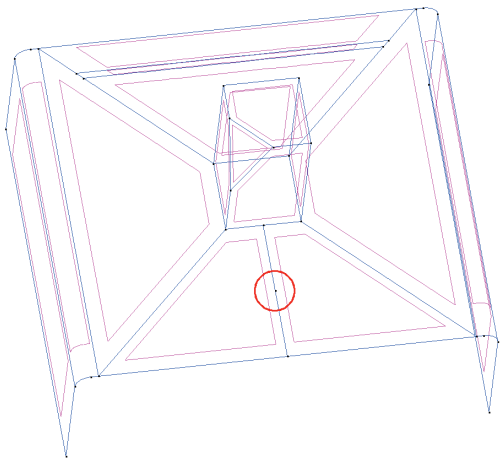


Figure 4. Geometry of the model. The point around which the mesh will be concentrated.

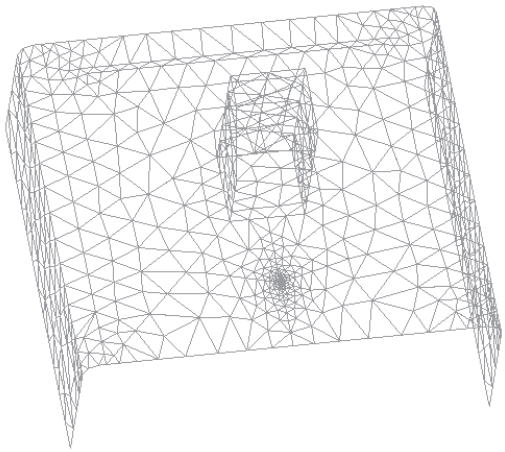


Figure 5. The mesh with a concentration of elements around the point.

7 . A concentration of elements appears around the chosen point, given the selected size (0.1) of these elements (see Figure 5).

One can control the way the size of the elements changes from a finer to a coarser region:

8 . Go to **Utilities** and open **Preferences** window.In the **Meshing** branch there is the option **Unstructured Size Transitions**. This option defines the transition gradient of element sizes (size gradient), whose values are between 0 and 1. The greater the size gradient, the greater the change in space. To test this, enter the value **0.4** and click **Accept**.

9 . Again, generate the mesh (**Mesh->Generate Mesh**) with the same general mesh size.

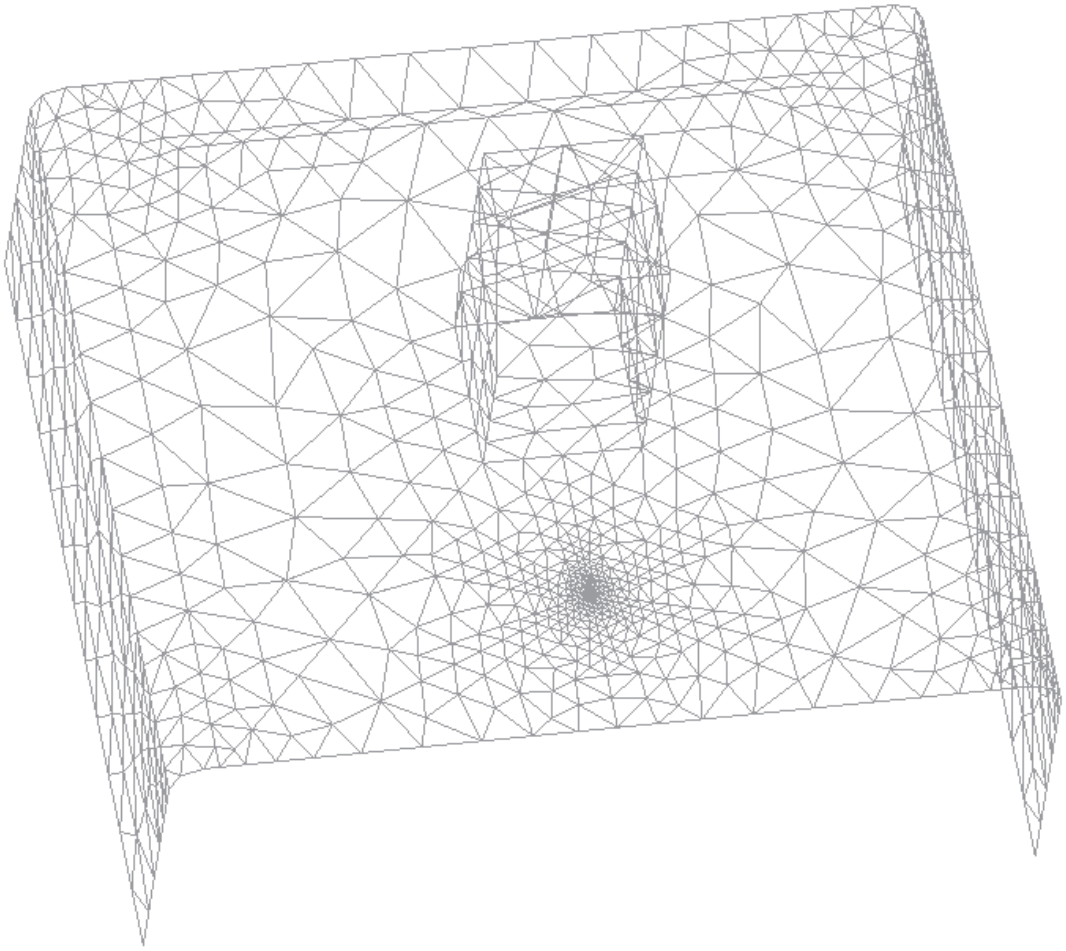


Figure 6. Mesh with the elements concentrated around a point, with a size gradient of 0.4.

10 . The size gradient (0.4) results in a higher density around the point (see Figure 6).
11 . Now go back and enter 0.6 in **Unstructured Size Transitions**. This will result in a mesh more suitable for our objectives. Click **Accept**.

---

[4] Instead of pressing the **ESC** key, the center mouse button or the mouse wheel can also be used.

6.2.3 Assign size to lines

We are going to set an specific mesh size to some of the lines:

1 To see entity numbers select the **Label** option (see Labels -pag. 15-). Select all the lines in order to see their numbers.
2 Select **Mesh->Unstructured->Assign sizes on lines**. In the window that appears, enter the size of the elements around the lines that will be chosen. Enter **0.5** and click **Assign**.
3 Select the lines defining the base of the prism (i.e. lines 1, 2, 3, 4 and 40).
4 Press **ESC** to indicate that the selection of lines is finished, and **Close** the window.
5 Then gnerate the mesh again with the same general mesh size as before.

6 This results in a high concentration of elements around the chosen lines, given that the selected element size (0.5) is much smaller than that of the rest of the elements in the model (see Figure 7).

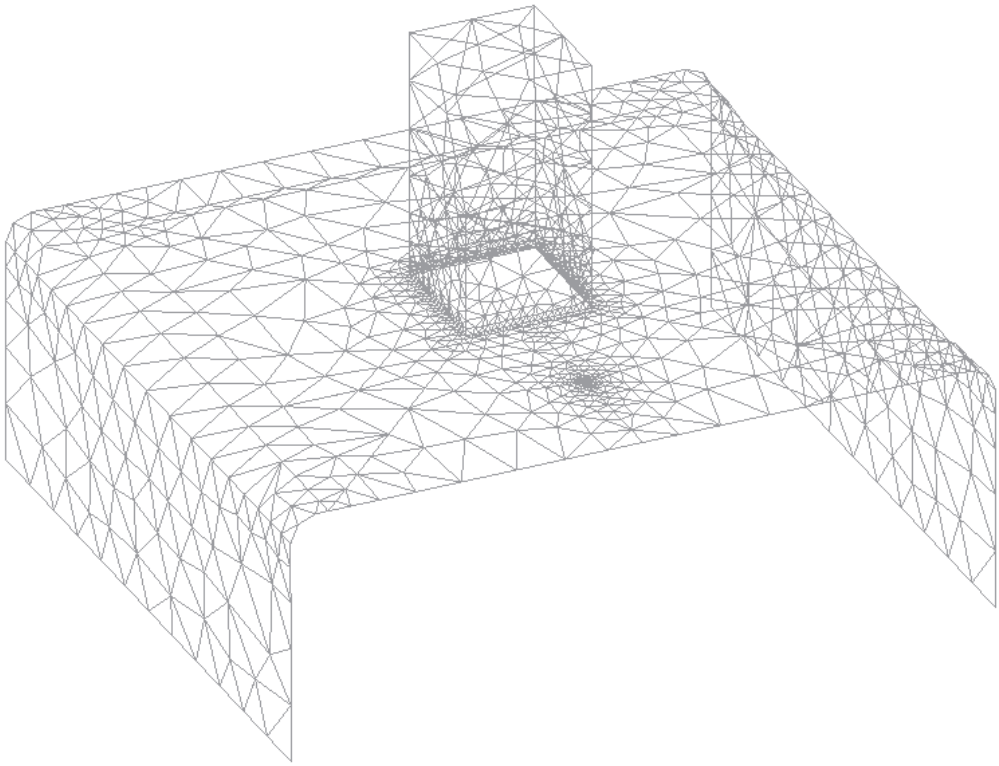


Figure 7. Mesh with a concentration of elements around lines.

6.2.4 Assign size to surfaces

Now we are going to set a specific mesh size tto the triangular surface resulting from the section of one of the vertexes of the prism (surface number 1).

1 To detect the surface one the Label option can be chosen, but also the Signal one (see Signal -pag. 17-).
2 Select **Mesh->Unstructured->Assign sizes on surfaces**. In the window that appears, enter the size of the elements to be assigned on the surfaces that will be chosen. Enter **0.5** and click **Assign**.
3 Select surface number 1, press **ESC** and **Close** the window.
4 Generate again the mesh with the same general mesh size.
5 This results in a high concentration of elements on the choosen surface due to the value selected (0.5) (see Figure 8).

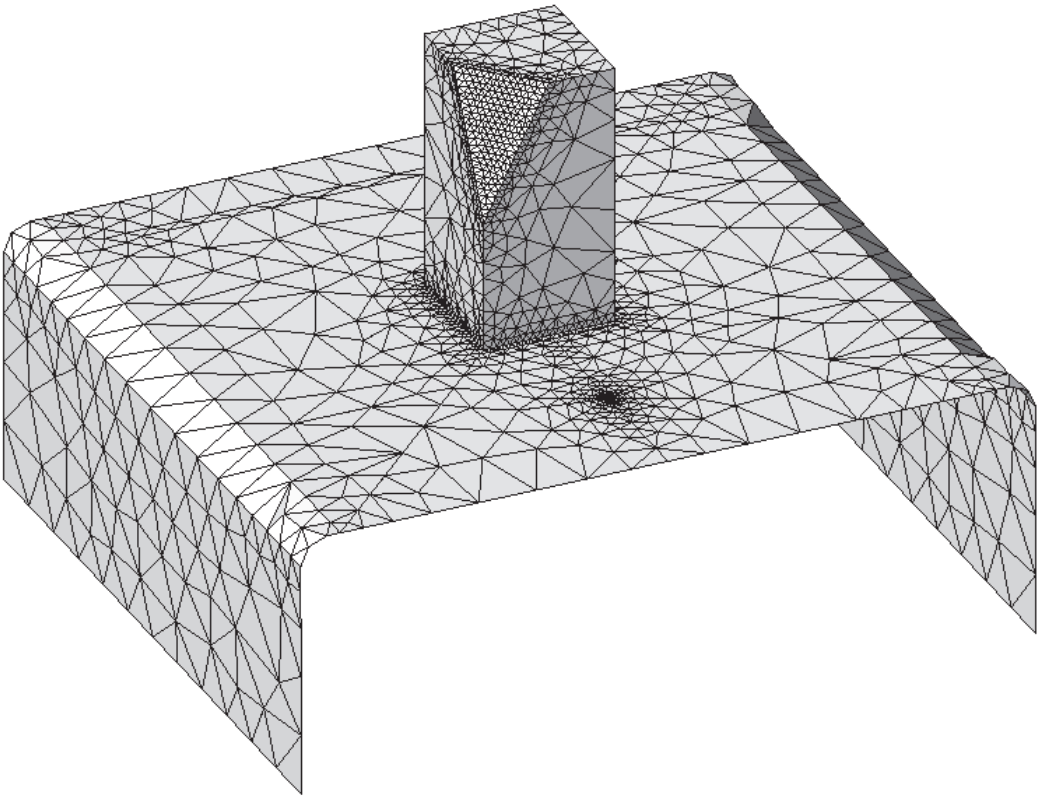


Figure 8. Mesh with a concentration of elements on a surface.

6.2.5 Assignment following chordal error criterion

In this section, an automatic size assignment is set taking into account a given maximum allowed chordal error.

1 Select **Mesh->Unstructured->Sizes by chordal error...**
2 The following window appears

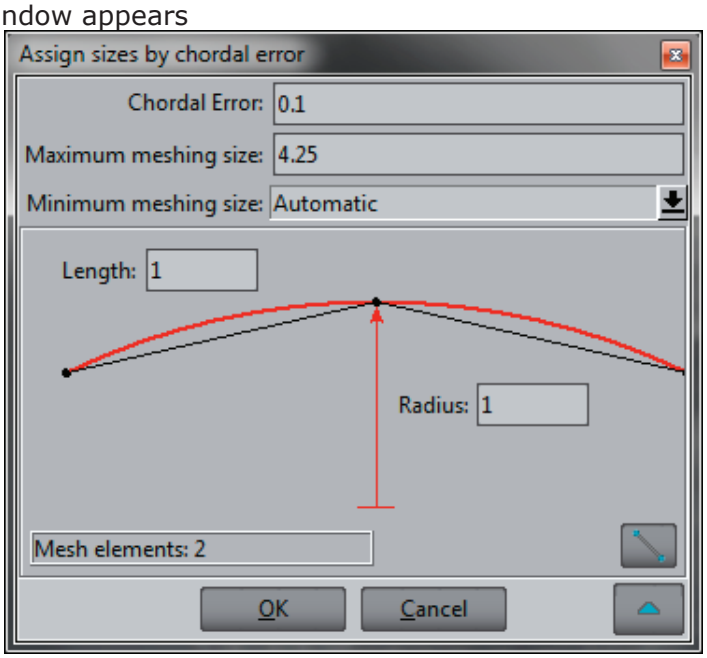


Figure 9. Assign sizes by chordal error window

3 . Enter **0.05** as chordal error. This error is the maximum distance between the element generated and the real object (geometry).
4 . Enter **4** as maximum meshing size.
5 . Enter **0.1** as minimum meshing size.
6 . If the right bottom button is clicked some extra information appears. We can select a curved line and see how the mesh will look like in this line. Click on the "line" icon and select line 34 and try to change the chordal error value. Leave it at **0.05.**
7 . Press **OK**.
8 To see the sizes that GiD has assigned automatically, you can select the **Draw->Sizes->Surfaces** option in the **Mesh** menu.
9 Generate the mesh with the same general mesh size.
10 The resulting mesh has a high concentration of elements in curved areas. Now our approximation is significantly improved (see Figure 10).

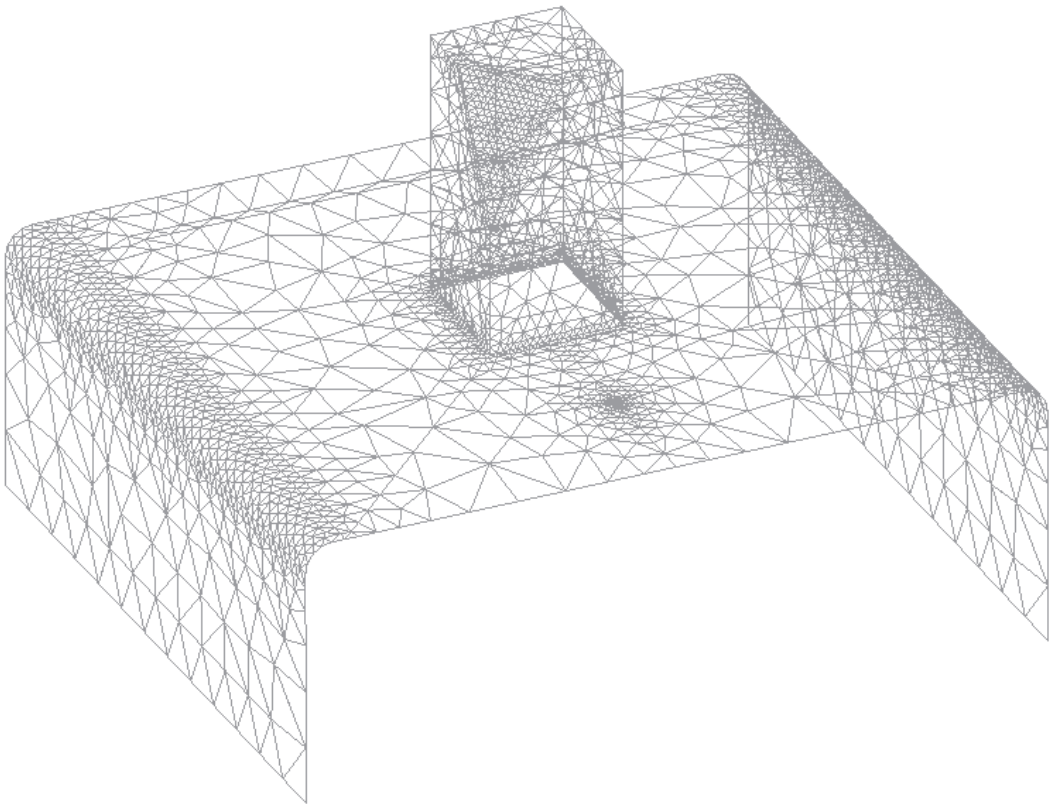


Figure 10. Mesh using sizes assignment by chordal error. Here there is a greater concentration of elements in the curved zones.

6.3 Rjump mesher

The RJump mesher is a surface mesher that meshes patches of surfaces (in 3D space) and is able to skip the inner lines of these patches when meshing. By default, the RJump mesher skips the contact lines between surfaces (and points between lines) that are tangent enough.

By selecting **Mesh->Draw->Skip entities (Rjump)**, the entities that the actual mesh is going to skip and the ones that it is not going to skip are displayed in different colors. In this chapter we will see the properties of this mesher.

6.3.1 RJump default options

1 . Select **Mesh->Reset mesh data** to reset all mesh sizes introduced previously.
2 . A window appears advising that all the mesh information is going to be erased. Press **Ok**.
3 . Set the **Default Values** in the **Meshing** branch of the **Preferences** window.
4 . Select **RJump** as the unstructured mesher to use (Preferences-Meshing) and click **Apply**.
5 . Generate the mesh with the default general mesh size.
6 . In the generated mesh, the contact lines between surfaces that are tangent enough do not have nodes; contact points between lines tangent enough are also skipped when meshing (see Figure 11).

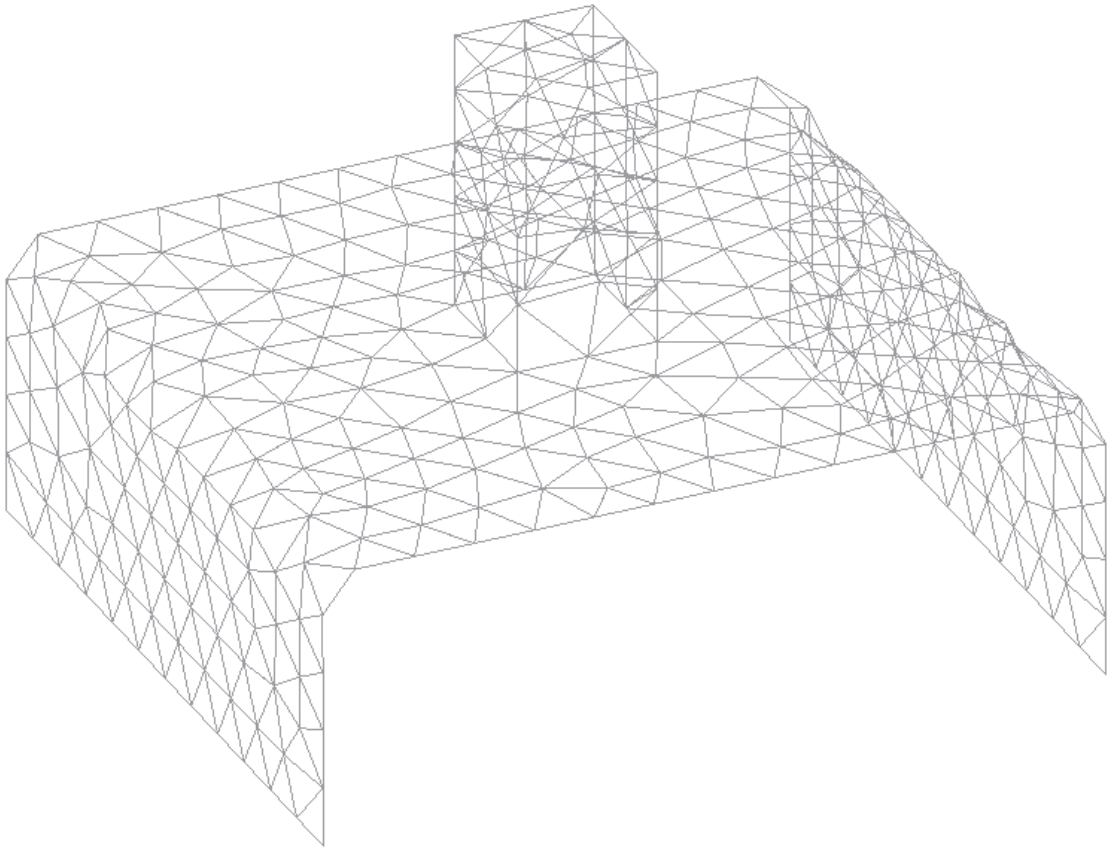


Figure 11. Mesh using the RJump mesher.

Note that the smaller elements shown in Figure 3 do not appear in this mesh, because of the properties this mesher.

Using the RJump mesher it is possible to assign sizes to different entities. As an example, select **Mesh->Unstructured->Sizes by chordal error...**.

7 . In the window enter **0.05** as chordal error.
8 . Enter **10** as maximum meshing size and **0.1** as minimum meshing size.
9 . Press **OK**.
10 . Again, generate the mesh with the same default general mesh size.
11 This results in a high concentration of elements in curved areas, without the nodes in

the lines and points that mesher skips. Now our approximation is significantly improved (see Figure 12).

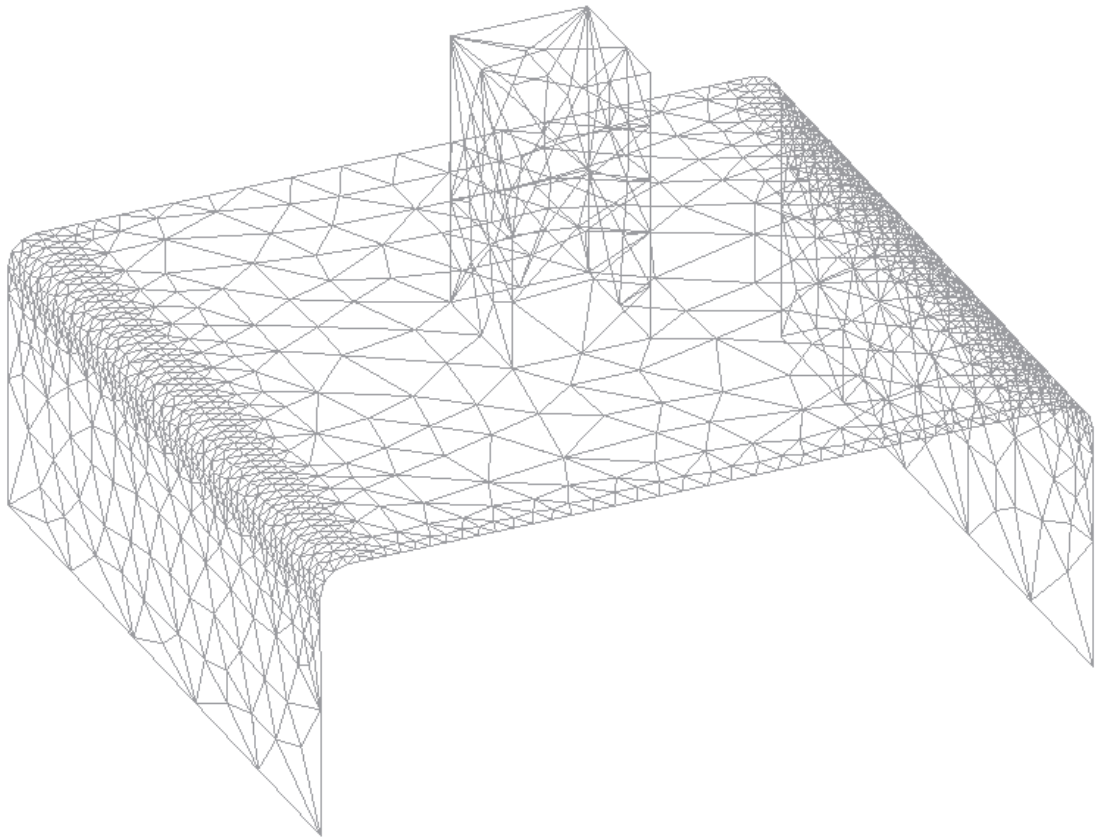


Figure 12. Mesh using the RJump mesher and assigning sizes by chordal error.

6.3.2 Force to mesh some entity

If there is a line or a point that the RJump mesher would usually skip, but it is required for you to be meshed, you can specify the entity so that it is not skipped. As an example, we will force Rjump to mesh line number 43, in order to concentrate elements around point number 29, as it was done in section Assign size to points -pag. 86-.

1 . Select **Mesh->Mesh criteria->No skip->Lines**, and select line number 43. Press **ESC**.
2 . Select **Mesh->Draw->Skip entities (Rjump)** to display the entities that will and will not be skipped in different colors. As is shown in Figure 13, line 43 will now not be skipped; the rest of the lines are unaffected, and RJump will either skip or mesh them according to its criteria.

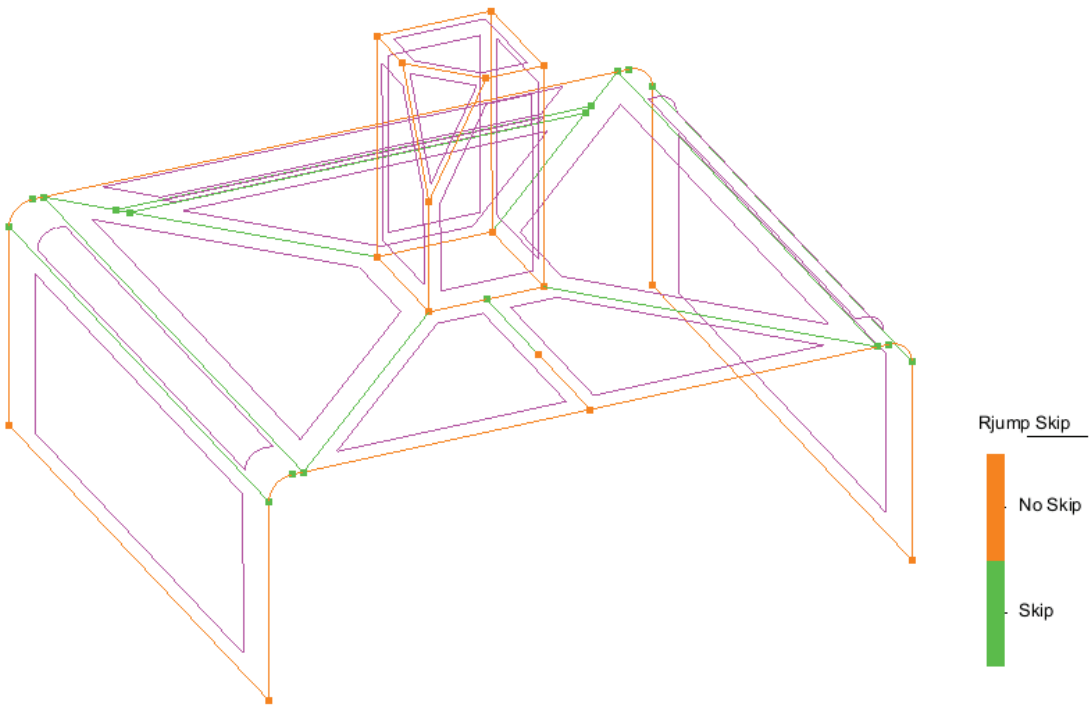


Figure 13. Entities that will be skipped and not skipped using the RJump mesher.

3 . Select **Mesh->Unstructured->Assign sizes on points**. A window appears in which to enter the element size around the points to be chosen. Enter 0.1 and click **Assign**.

4 . Select the point indicated in Figure 4 (point number 29). Press **ESC** to indicate that the selection of points is finished and **Close** the window.

5 . Generate the mesh again with the default general mesh size.

6 The resulting mesh is depicted in Figure 11. A high concentration of elements around point number 29 can be appreciated. Note that there are nodes on line number 43 because we have forced RJump not to skip this line (see Figure 14).

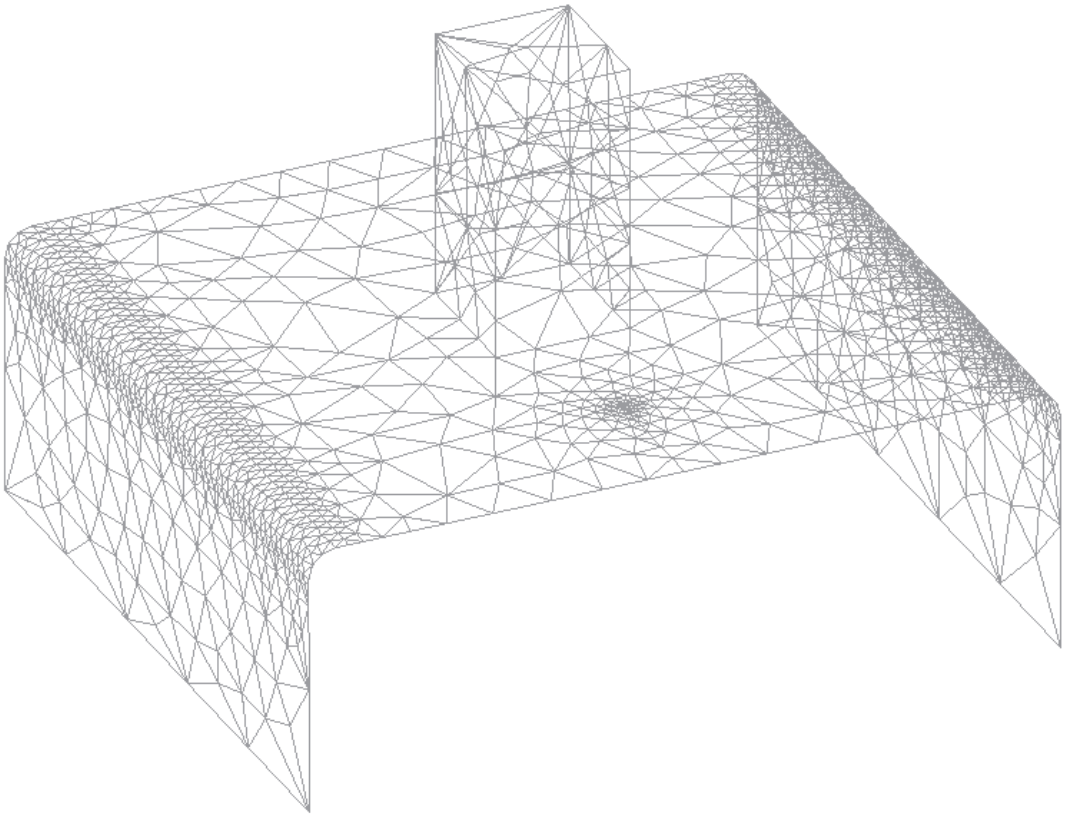


Figure 14. Mesh using the RJump mesher, assigning sizes by chordal error and forcing an entity to be meshed.

In this last example we have forced the mesher not to skip an entity, but it may be interesting in some models to allow the mesher only to skip a few entities, meshing almost all or them. In this case, a different surface mesher can be selected (in the **Preferences** window).

One option is the RSurf mesher which meshes all the lines and point except the ones set explicitally to be skipped using the **Mesh->Mesh criteria->Skip** option. Here, because RJump is not selected, no entity will be skipped automatically according to tangency with neighboring entities.

The next example shows how to work like this.

7 . Select **Mesh->Reset mesh data** to reset all mesh sizes introduced previously. (A window opens advising that all the mesh information is going to be erased. Press **Ok**.)
8 . Set **RSurf** as the unstructured surface mesher in the **Meshing** branck of the **Preferences** window and click Apply.
9 . Select **Mesh->Mesh criteria->Skip->Lines**, and select lines 48 and 53. Press **ESC**.
10 . Generate the mesh with the default general mesh size.
11 . The result is a mesh similar to the first example obtained in chapter 2 (see Figure 2), but the smaller elements highlighted in Figure 3 do not appear because lines 48 and 53 (which were meshed before) are now skipped when meshing (see Figure 15).

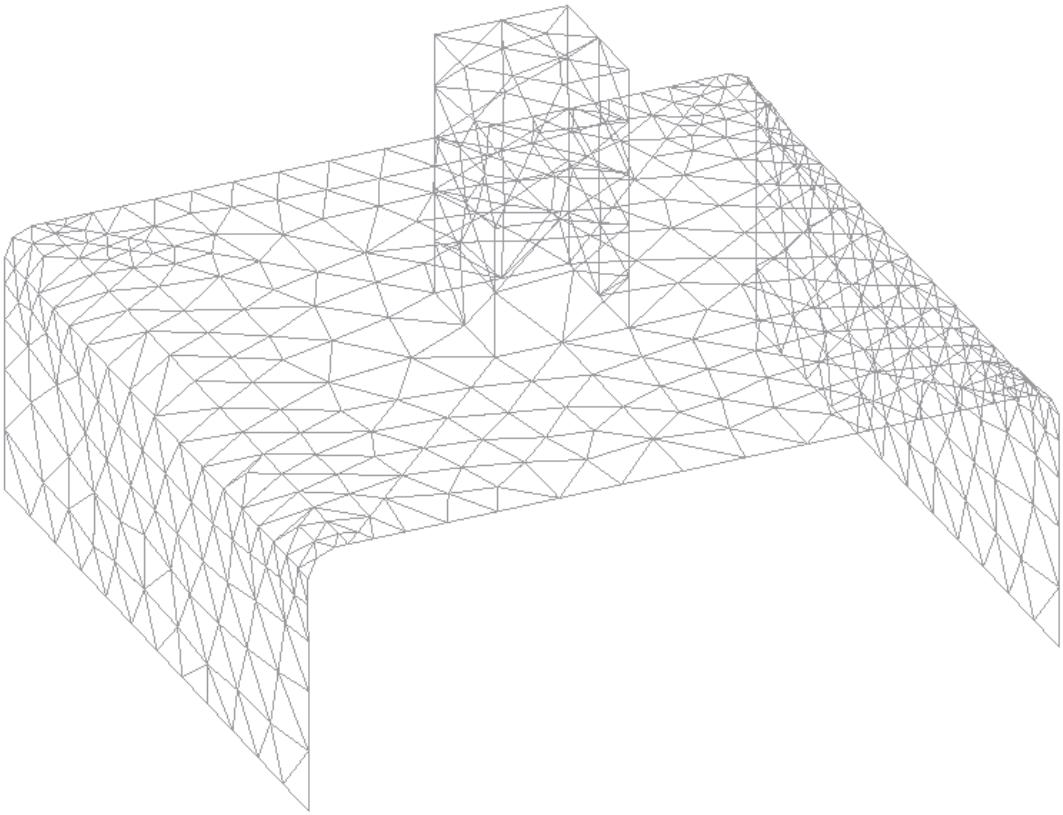


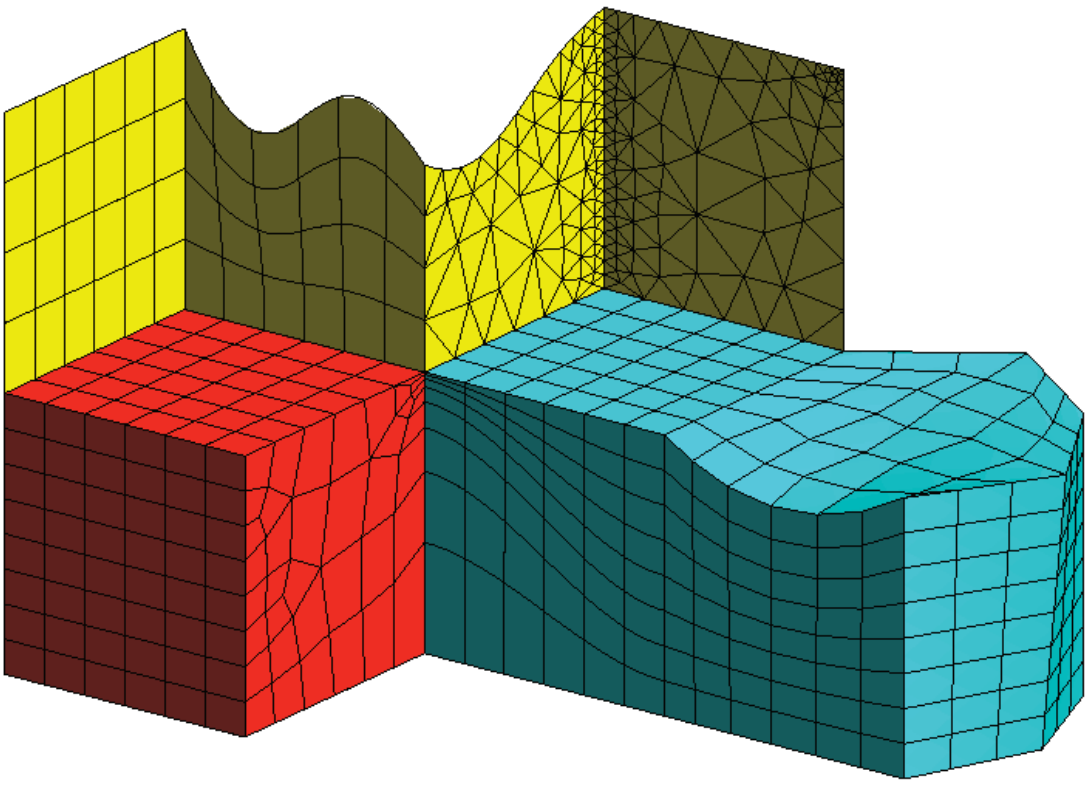
Figure 15. Mesh using the RSurf mesher, with some lines skipped.

7 METHODS FOR MESH GENERATION

The objective of this example is to mesh a model using the various options available in GiD for controlling the element type in structured, semi-structured and unstructured meshes. It also presents how to concentrate elements and control the distribution of mesh sizes.

The six methods covered are:

- Generating a mesh using tetrahedral
- Generating a volume mesh using spheres
- Generate a mesh using circles
- Generating a volume mesh using points
- Generating a mesh using quadrilaterals
- Generating a structured mesh on surfaces and volumes
- Generating a semi-structured volume mesh
- Generating a mesh using quadratic elements



7.1 Introduction

In order to carry out this example, start from the project "ToMesh3.gid". This project contains a geometry that will be meshed using different types of elements.

7.1.1 Reading the initial project

1 . In the **Files** menu, select **Read**. Select the project "ToMesh3.gid" and click **Open**.

2 . The geometry appears on the screen. It is a set of surfaces and three volumes. Select **Render->Flat** from the mouse menu or from the **View** menu. In Figure 1 shows the

geometrical model loaded.

3 . Rotate and make several changes in the perspective so as to get a good idea of the geometry involved.

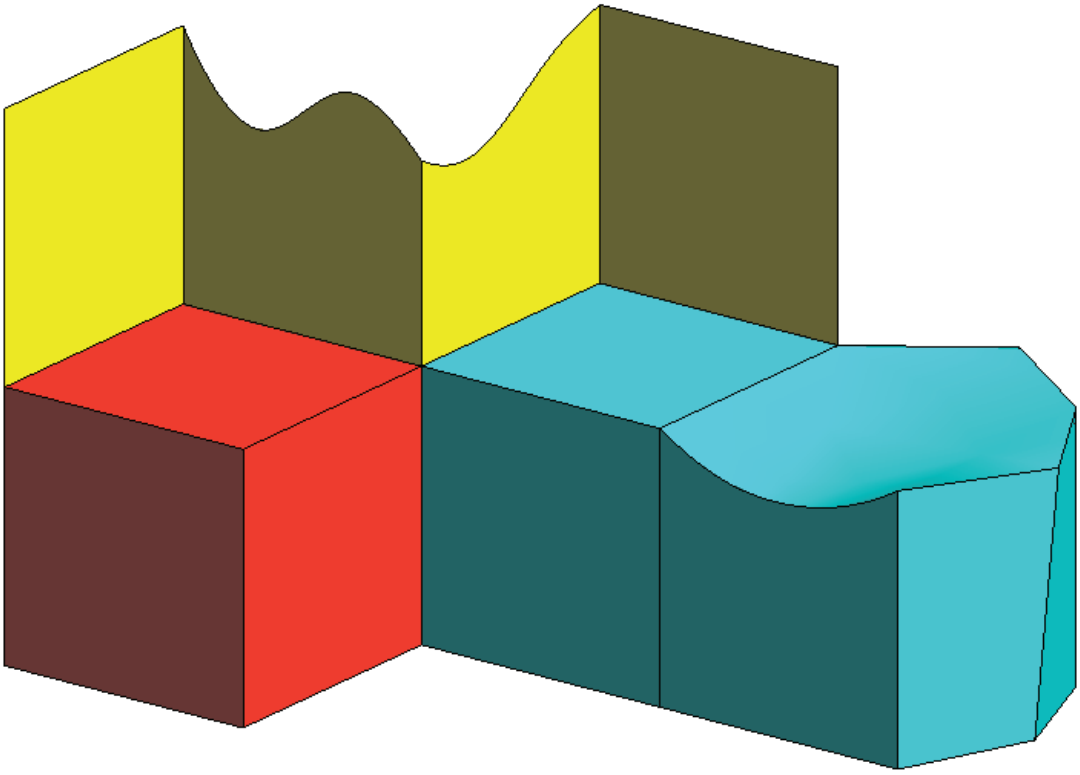


Figure 1. Contents of the project "ToMesh3.gid"

Finally, return to the normal visualization **Render->Normal**. This mode is more user-friendly.

7.2 Types of mesh

Using GiD the mesh may be generated in different ways, depending on the needs of each project. The two basic types of meshes are the structured[2] mesh and the unstructured mesh. For volumes only there is one additional type, the semi-structured[3] mesh.

For all these types of mesh a variety of elements may be used (linear ones, triangles, quadrilaterals, circles,tetrahedra, hexahedra, prisms, spheres or points). In this tutorial you will become familiarized with the mesh-generating combinations available in GiD.

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[2] A structured mesh is one in which each node is connected to a constant number of elements.

[3] A semi-structured volume mesh is one in which you can distinguish a fixed structure in one direction, i.e. there is a fixed number of divisions. However, within each division the mesh need not be structured. This kind of mesh is only practical for topologically prismatic volumes.

7.2.1 Generating the mesh by default

In order to get the same results we will reset the mesh options.

1 . Open the preferences window selecting **Utilities->Preferences.**
2 . Select the **Meshing** card, click on **Reset** and then **Accept**.
3 . Select **Mesh->Generate mesh**.
4 . A window comes up in which to enter the maximum element size for the mesh to be generated. As default value could change from one version of GiD to another, insert **2** to get the same results as shown in images **OK**.
5 . A meshing process window comes up. Then another window appears with information about the mesh generated. Click **View mesh** to visualize the mesh.
6 . The result is the mesh in Figure 2. There are various surfaces and volumes. By default, mesh generation in GiD obtains unstructured meshes of triangles on surfaces and tetrahedra on volumes.
7 . Select **Render->Flat** in mouse menuto see the mesh in render mode. As is shown in Figure 3, volume meshes are represented a little bit differently from surface meshes, although in both cases triangles are shown. If the triangles you see are the boundary of a volume mesh, they are shown with black edges that are thicker than surface meshes triangles. If the triangles form a boundary volume mesh and, at the same time, a triangle surface mesh (this can be obtained if surfaces are selected with the option **Mesh->Mesh criteria->Mesh->Surfaces**), the wider edges are colored with the color of the surface layer. Examples of these different kinds of render are shown in Figure 3.

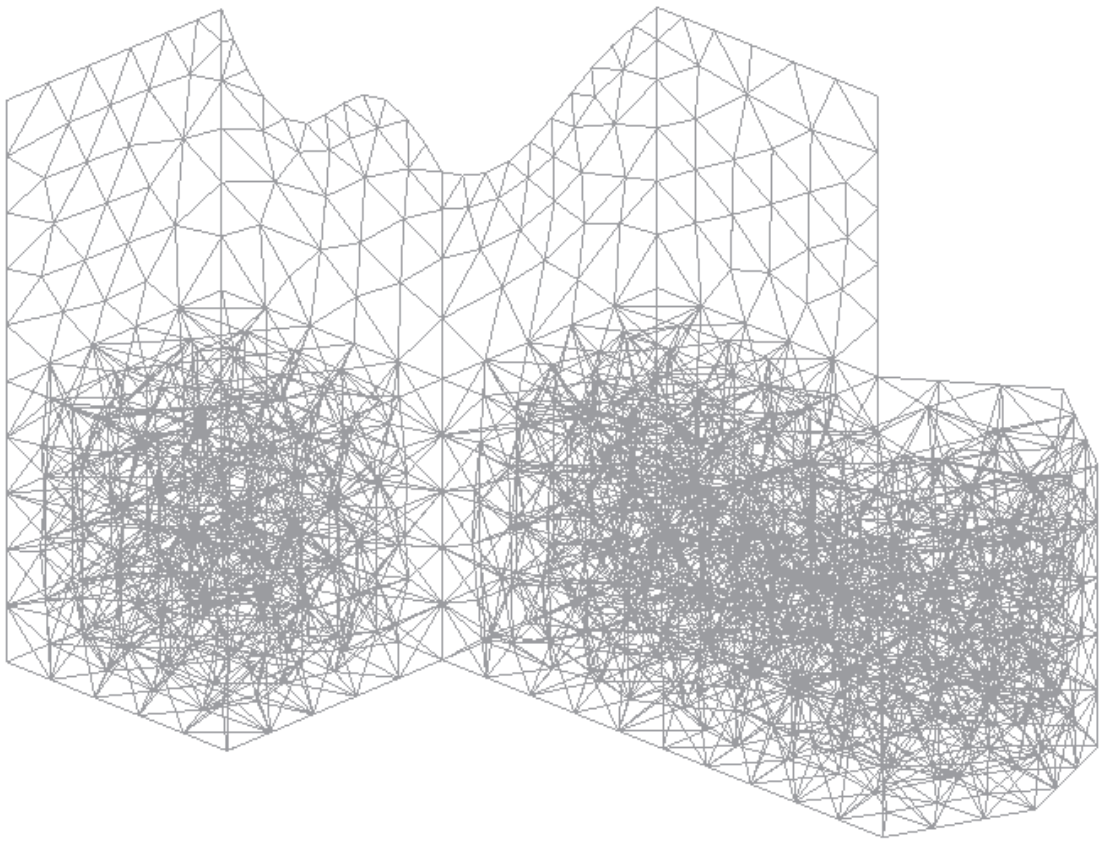

Figure 2. Generating the mesh by default.

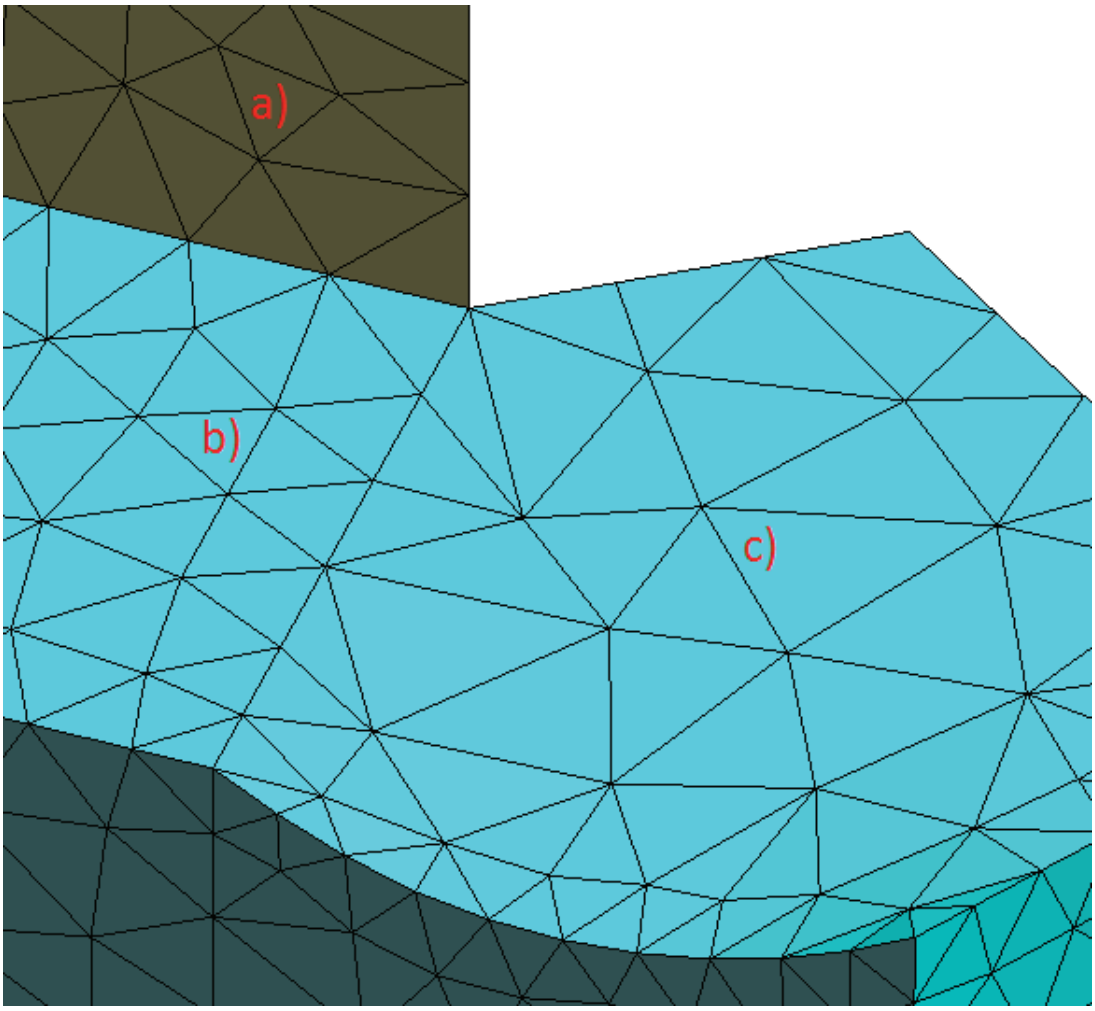

Figure 3. Different render styles: a) surface mesh, b) volume mesh, c) surface mesh and volume mesh together (surface layer is red and volume layer is blue)

7.2.2 Generating the mesh using circles and spheres

1 . Select **Mesh->Element type->Sphere**. Select volume number 1 and press **ESC.** To see entity numbers select **Label** from the mouse menu or from the **View** menu. If you wish the geometrical entity labels to be displayed, the view mode needs to be changed to Geometry using **View->Mode->Geometry** (this option may also be found in the GiD Toolbar). Select **Render->Normal** in the mouse menu to see the labels.

2 . Select **Mesh->Element type->Circle**. Select surface number 24 and press **ESC**.

3 . Select **Mesh->Generate mesh**.

4 . A window comes up asking whether the previous mesh should be eliminated. Click **Yes**.

5 . Another window appears in which to enter the maximum element size. Leave the default value unaltered and click **OK**. The result is a mesh as illustrated in Figure 4.

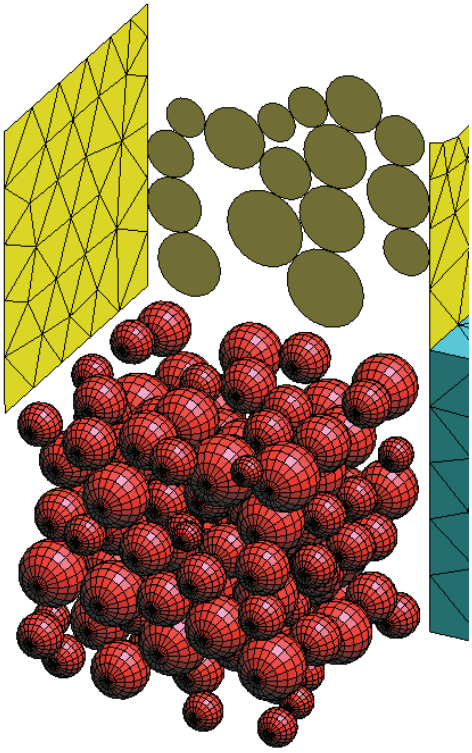

Figure 4.(Render Flat) Generating a mesh on a volume using points.

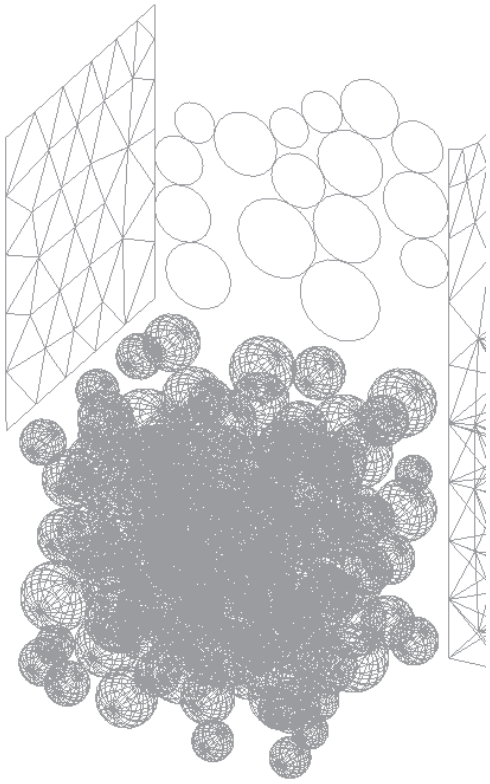

Figure 4.(Render Normal) Generating a mesh on a volume using points.

7.2.3 Generating the mesh using points

1 . Select **Mesh->Element type->Only points**. Select volume number 1 and press **ESC.**

2 . Select **Mesh->Generate mesh**.

3 . A window comes up asking whether the previous mesh should be eliminated. Click **Yes**.

4 . Another window appears in which to enter the maximum element size. Leave the default value unaltered and click **OK**. The result is a mesh as illustrated in Figure 5.

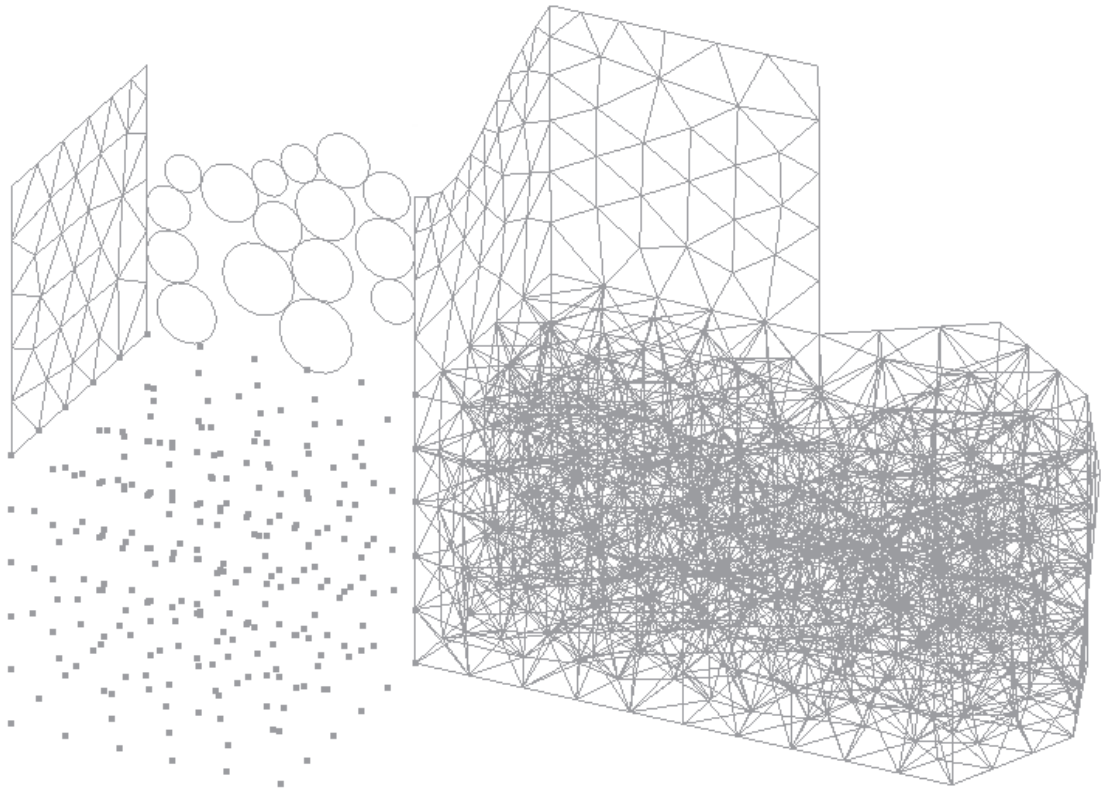

Figure 5. Generating a mesh on a volume using points.

5 . Now volume number 1 is meshed using only the generated nodes.

7.2.4 Generating the mesh using quadrilaterals

1 . Select **Mesh->Element type->Quadrilateral**. Select surfaces number 24 and 12 and press **ESC**.
2 . Select **Mesh->Generate mesh**.
3 . A window comes up asking whether the previous mesh should be eliminated. Click **Yes**.
4 . Another window appears in which the maximum element size can be entered. Leave the default value unaltered and click **OK**. The result will be the mesh illustrated in Figure 6.

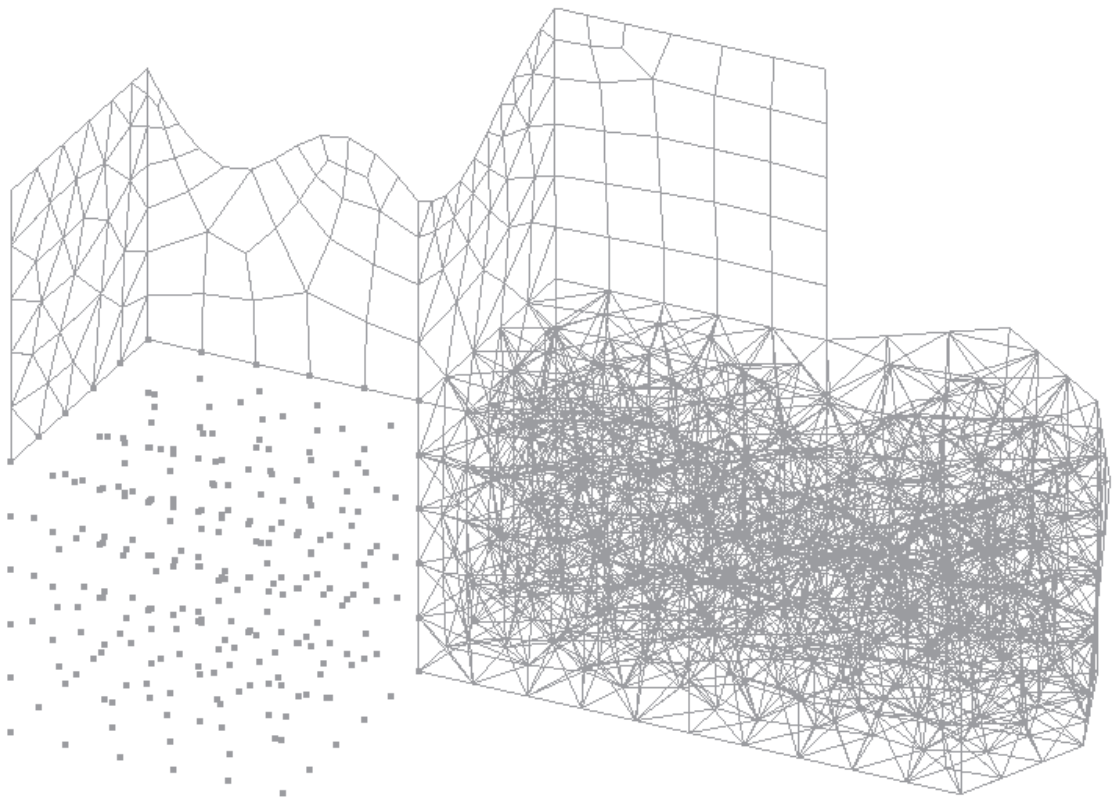

Figure 6. An unstructured mesh generated using quadrilaterals.

5 . The surface is meshed with quadrilaterals, forming an unstructured mesh, surface 12 seems structured but if you zoom in, you will see that it is not.

7.2.5 Generating a structured mesh (surfaces)

1 . To mesh surfaces with a structured mesh, select the option **Mesh->Structured->Surfaces->Assign number of cells**.
2 . Select all top surfaces 9, 24, 26 and 12 and press **ESC**.
3 . A window appears in which to enter the number of divisions that the lines to be selected will have. Enter 4.
4 . Click **Assign** and select one vertical line[5] (parallel to the **Y** axis). Press **ESC**.
5 . Another window appears in which to enter the number of divisions on the lines. Enter 6.
6 . Click **Assign** and select the 4 bottom lines[5]. Press **ESC**.
7 . Another window appears in which to enter the number of divisions on the lines. In this case, all the boundary lines have already been defined. Therefore, click **Close**.
8 . Select **Mesh->Element type->Triangle**. Select surfaces 26 and 12. Press **ESC**.

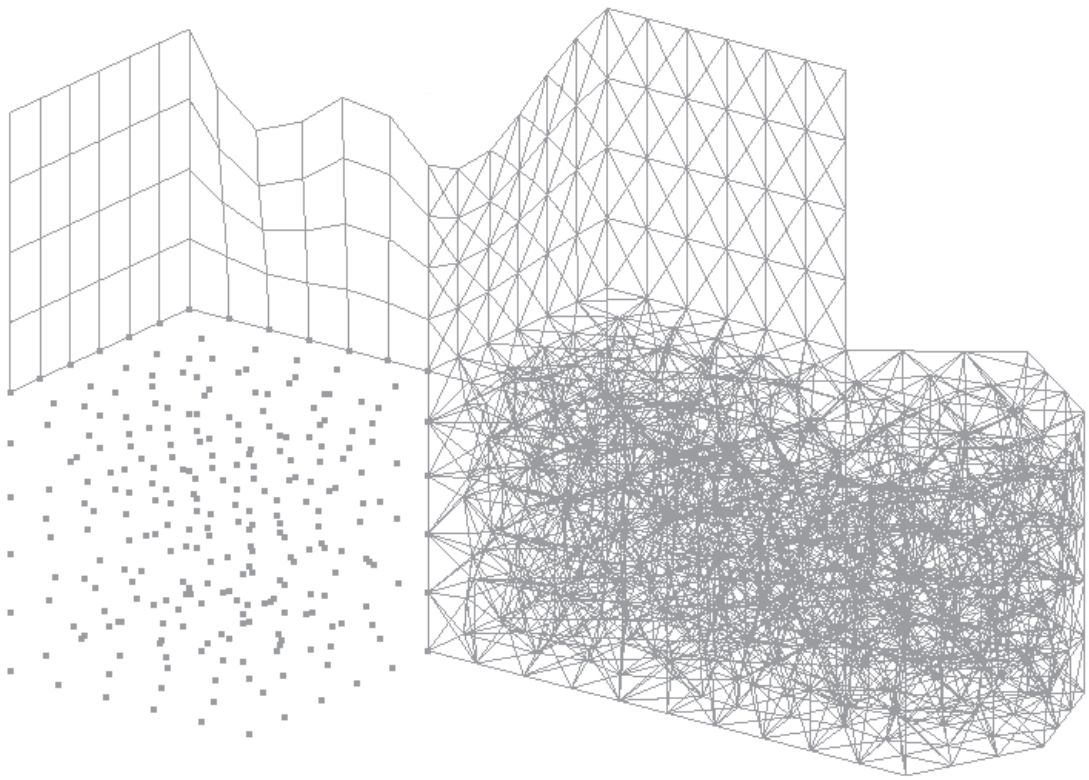

Figure 7. Structured mesh of quadrilateral and triangular elements on surfaces.

9 . Select **Mesh->Generate mesh**.

10 . A window comes up asking whether the previous mesh sould be eliminated. Click **Yes**.

11 . Another window appears in wihich to enter the maximum element size. Leave the default value unaltered an click **OK**. The result is the mesh shown in Figure 8.

12 . As seen in Figures 7 and 8, GID can obtain surface structured meshes made of quadrilaterals or triangles. There are tow kinds of structured mesh that use triangles: the one shown in Figure 7 is obtained when the **Utilities->Preferences->Meshing->Main->Structured Mesher->Symmetrical structured->triangles** option is set. If this option is not set, the mesh presented in Figure 8 is produced (with fewer nodes than if using the previous option).

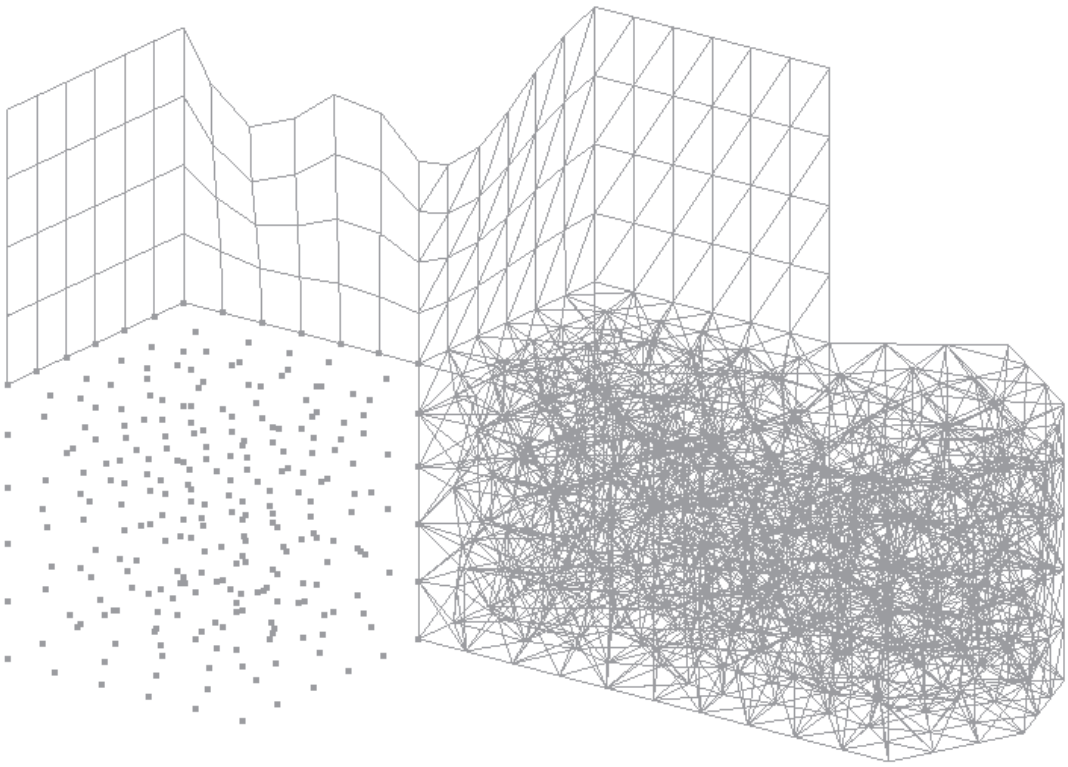

Figure 8. Structured mesh of quadrilateral and triangular elements on surfaces, with the option Symmetrical structured triangles not set.

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[5] When selecting a line, GID automatically selects all lines parallel to it.

7.2.6 Generating structured meshes (volumes)

1 . To mesh volumes with a structured mesh, select the option **Mesh->Structured->Volumes->Assign number of cells**.
2 . Select volumes 1 and 2 and press **ESC**.
3 . A window appears in which to enter the number of divisions that the lines to be selected will have. Enter 6 and click **Assign**.
4 . Select lines of both volumes parallel to the **X** and **Z** axes. GiD automatically selects all the lines in each volume parallel to these in order to create the structured mesh. Press **ESC**.
5 . Another window appears in which to enter the number of divisions on the lines. Divide the lines parallel to the **Y** axis into 8 segments. Enter 8 and click **Assign**.
6 . Select an edge of volume 1 or 2 parallel to the **Y** axis and press **ESC** . Again, the line-division window comes up. Since we have already finished the assignments, click **Close**.

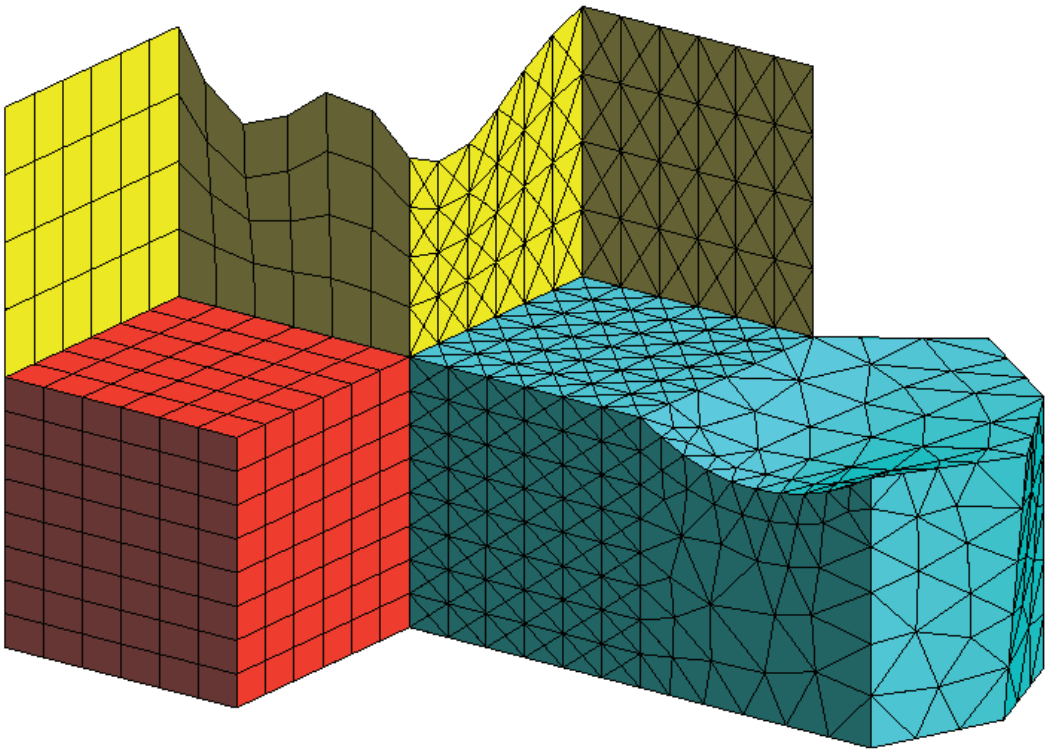


Figure 9. Structured volume mesh of hexahedra an tetrahedra.

7 . For structured volumes, GiD generates tetrahedron meshes by default, but hexahedron structured meshes can also be assigned. Let's assign the element type that we wish to volume 1 and 2. Select **Mesh->Element type->Tetrahedra**,then select volume number 2 and press **ESC**. Select **Mesh->Element type->Hexahedra**, then select volume number 1 and press **ESC**.

8 . Select **Mesh->Generate mesh**.

9 . A window appears asking whether the previous mesh should be eliminated. Click **Yes**.

10 . Another window comes up in which to enter the maximum element size. Leave the default value unaltered and click **OK** . The result is the mesh shown in Figure 10.

11 . GiD can obtain volume structured meshes made of hexahedra, tetrahedra or prisms. As can be seen in Figures 9 and 10, there are two kinds of tetrahedron structured mesh: the one shown in Figure 9 is obtained when the option **Utilities->Preferences->Meshing->Symmetrical structured->tetrahedra** is set. If this option is not set, the mesh presented in Figure 10 is produced (with fewer nodes than if using the previous option;also, it is not topologically symmetrical).

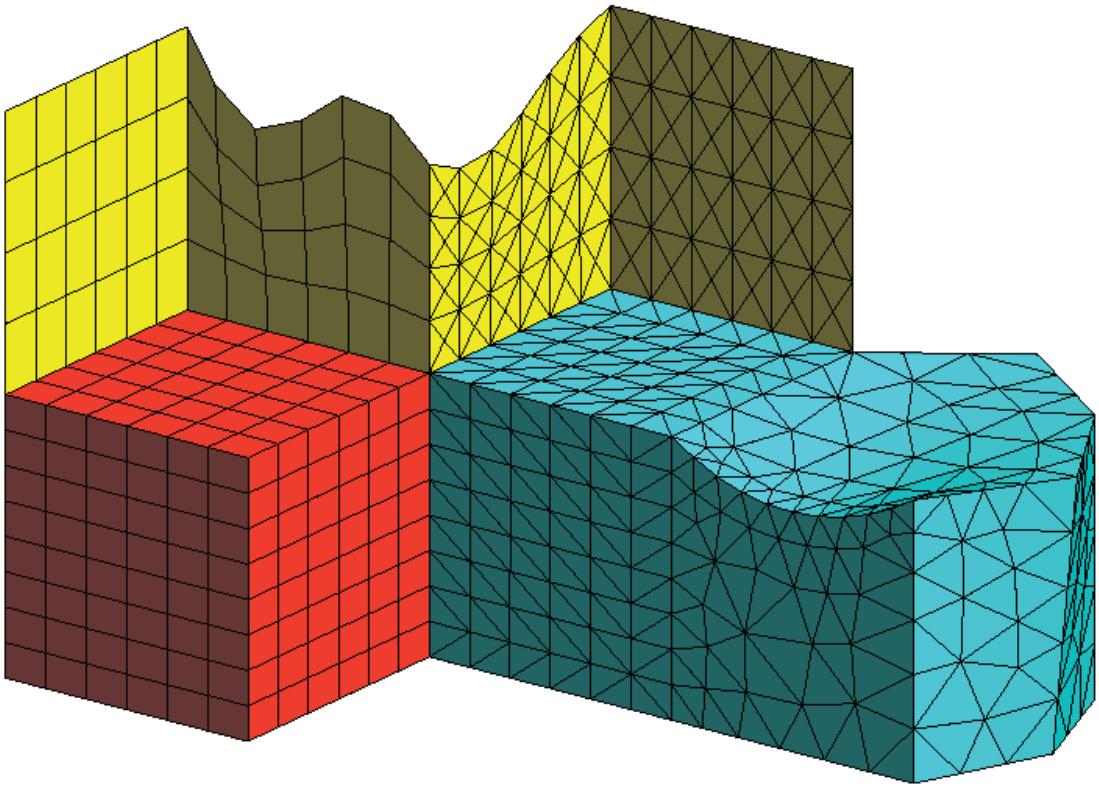


Figure 10. Structured volume mesh of tetrahedra with the option Symmetrical structured tetrahedra not set.

7.2.7 Generating semi-structured meshes (volumes)

1 . To mesh volumes with a semi-structured mesh, select the option **Mesh->SemiStructured->Volumes**.
2 . A window appears in which to enter the number of divisions for the direction in which it is structured (the prismatic one). Enter 8 and click **Assign**.
3 . Select volume 3 and press **ESC**. As volume 3 is prismatic in one direction only (i.e. parallel to **Y** axis) GiD will automatically detect this fact and will select it to be the direction in which the semi-structured volume mesh is structured.
4 . Another window appears in which to enter the number of divisions in the direction of the structure. In this case we do not want to select any more volumes, so click **Close**.
5 . Select **Mesh->Generate mesh**.
6 . A window appears asking whether the previous mesh should be eliminated. Click **Yes**.
7 . Another window appears in which to enter the maximum element size. Leave the default value unaltered and click **OK**. The result is the mesh shown in Figure 11.

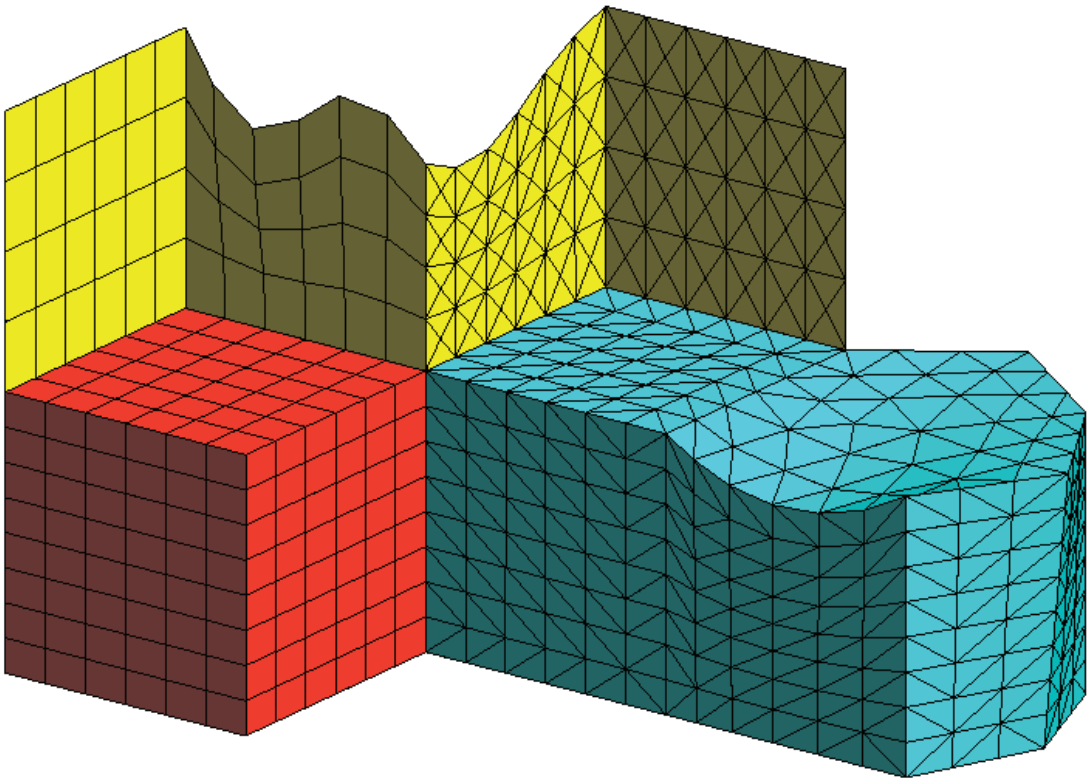


Figure 11. Semi-structured volume mesh of tetrahedra.

As can be seen, volume 3 has been meshed with tetrahedra. Semi-structured volumes are meshed with prisms, by default. However, in this case it was not possible because of volume 2, which has tetrahedra assigned and shares one surface with volume 3. In the following steps a hexahedron mesh is produced.

8 . Select **Mesh->Element type->Hexahedra.**

9 . Select volumes 2 and 3 and press **ESC**.

10 . Select **Mesh->Generate mesh**.

11 . A window opens asking whether the previous mesh should be eliminated. Click **Yes**.

12 . Another window appears in which to enter the maximum element size. Leave the default value unaltered and click **OK**. The result is the mesh shown in Figure 12.

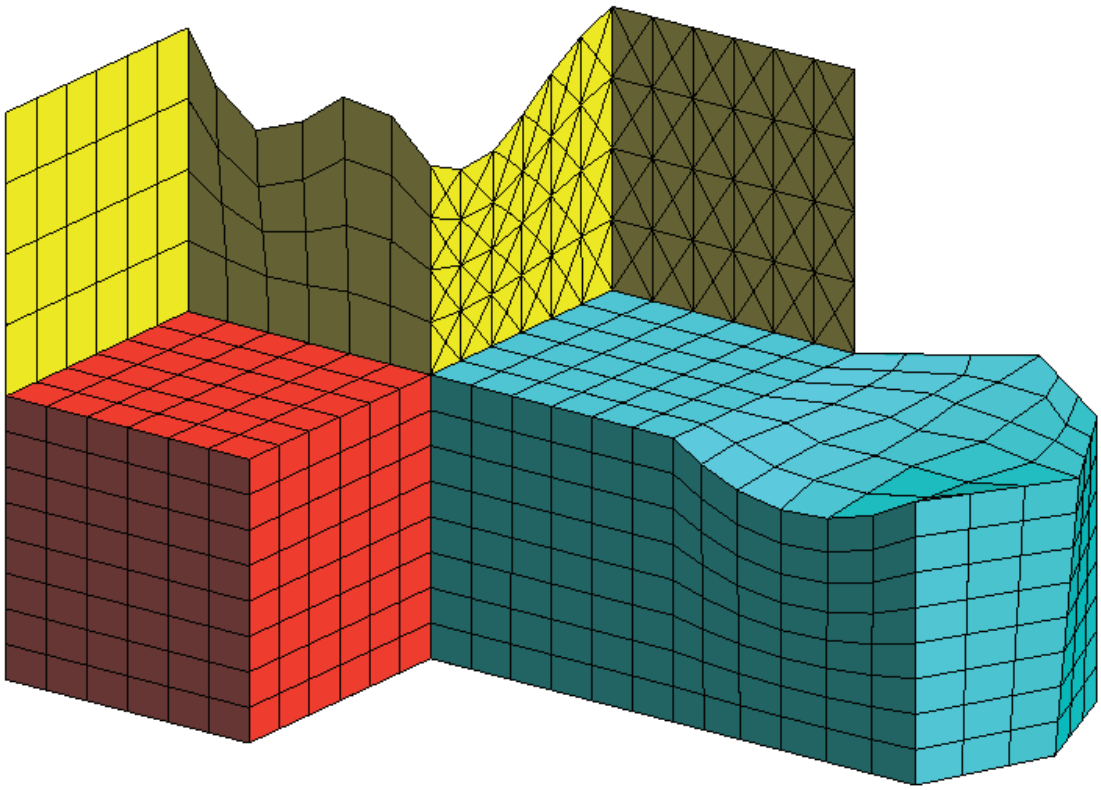


Figure 12. Semi-structured volume mesh of hexahedra.

In case of volume number 3 there is only one direction in which it can possibly be structured (i.e. in the direction of the prism). If the volume is prismatic in more than one direction, there are two ways to choose between them: selecting one top surface (**Mesh->SemiStructured->Set->Master surface**) or the direction of the structure (**Mesh->SemiStructured->Set->Structured direction**). The following example explains this procedure.

13 . Select the option **Mesh->SemiStructured->Volumes**.
14 . A window opens in which to enter the number of divisions in the structured direction (prismatic). Enter 6.
15 . Select volume 1 and press **ESC**.
16 . Another window appears, click **Close**.
17 . Select **Mesh->SemiStructured->Set->Structured direction**.
18 . Select one line parallel to the **X** axis of volume number 1 (for example line number 11) and press **ESC**.
19 . Select **Mesh->Unstructured->Assign entities->Surfaces.**
20 . Select surfaces 1 and 6 and press **ESC**.
21 . Select **Mesh->Generate mesh**.
22 . A window opens asking whether the previous mesh should be eliminated. Click **Yes**.
23 . Another window appears in which to enter the maximum element size. Leave the default value unaltered and click **OK**.

7.2.8 Concentrating elements and assigning sizes

1 . Select **Mesh->Structured->Lines->Concentrate elements**.

2 . Select some structured lines, for example line 43. Press **ESC**.
3 . A window comes up in which to enter two values for the concentration of elements. Positive values concentrate the elements and negative values spread them. Enter 0.5 as **Start Weight** and –0.5 as **End Weight**[10]. Click **Ok** and press **ESC**.
4 . Select **Mesh->Generate mesh**.
5 . A window opens asking whether the previous mesh should be eliminated. Click **Yes**.
6 . Another window appears in which to enter the maximum element size. Leave the default value unaltered. The result is the mesh shown in Figure 13.

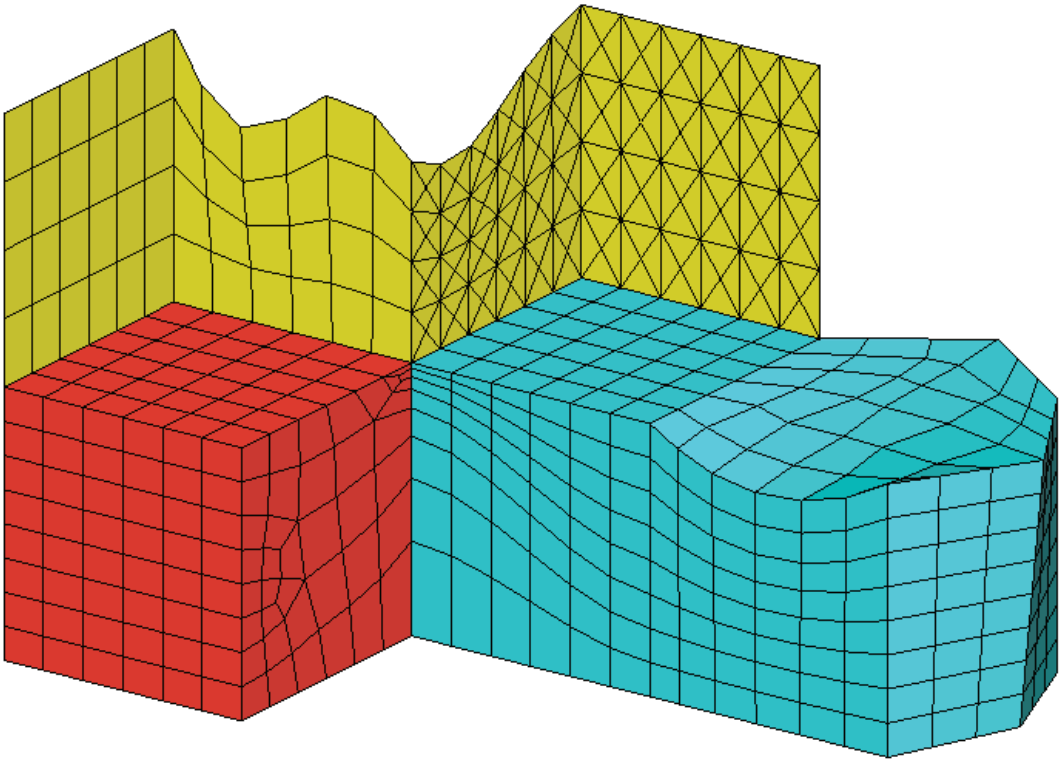


Figure 13. Concentration of elements on line 43.

It is also possible to assign sizes to geometrical entities, so that mesh elements can be concentrated in certain zones. In the following steps some examples are given.

7 . Select **Mesh->Unstructured->Assign sizes on points.**
8 . A window appears in which to enter the size to be assigned to points. Enter 0.1 and click **Assign**.
9 . Select point number 15 and press **ESC**.
10 . Another window appears in which to enter the size to be assigned to points. In this case, we donot want to assign sizes to any other points, so click **Close**.
11 . Select **Mesh->Unstructured->Assign sizes on lines.**
12 . A window appears in which to enter the size to be assigned to lines. Enter 0.5 and click **Assign**.
13 . Select line number 25 and press **ESC**.
14 . Another window appears in which to enter the size to be assigned to lines. In this case, we do not want to assign sizes to any more lines, so click **Close**.
15 . Select **Mesh->Generate mesh**.

16 . A window appears asking whether the previous mesh should be eliminated. Click **Yes**.
17 . Another window appears in which the maximum element size should be entered. Leave the default value unaltered and click **OK**. The result is not the desired, we just get the previous mesh. This is because surrounding surfaces and lines are structured, so they do not have enough freedom to achive the given sizes.
18 . Select **Mesh->Unstructured->Assign entities->Surfaces.**
19 . Select Surfaces 26 and 12. Press **ESC**.
20 . Select **Mesh->Unstructured->Assign entities->Lines.**
21 . Select lines 48, 26 and 27. Press **ESC**.
22 . Select **Mesh->Generate mesh**.
23 . A window appears asking whether the previous mesh should be eliminated. Click **Yes**.
24 . Another window appears in which the maximum element size should be entered. Leave the default value unaltered and click **OK**. The result is the mesh shown in Figure 14.

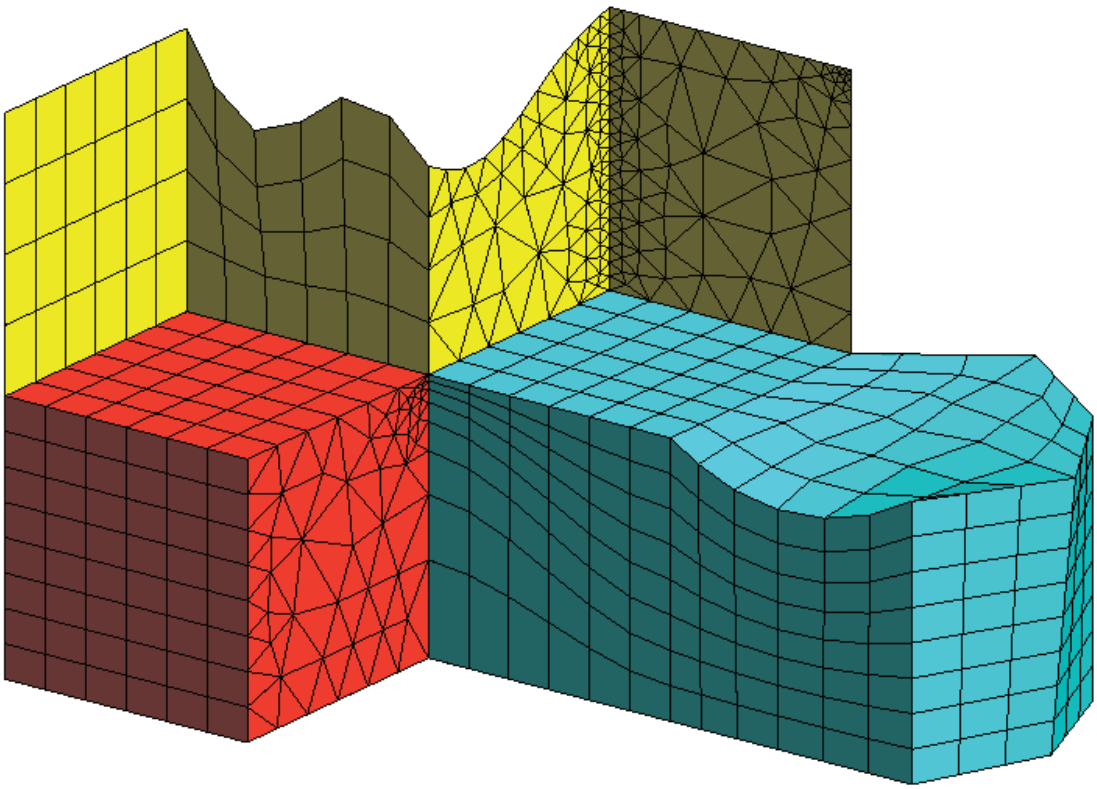


Figure 14. Unstructured size assigned in a point and a line.

---

[10] Start Weight and End Weight refer to the start point and end point of the line, oriented as it is drawn when you select it.

7.2.9 Generating the mesh using quadratic elements

Enlarge one area of the mesh with the zoom.

1 . Select **Label->All in->Points** . The result is shown in Figure 15.

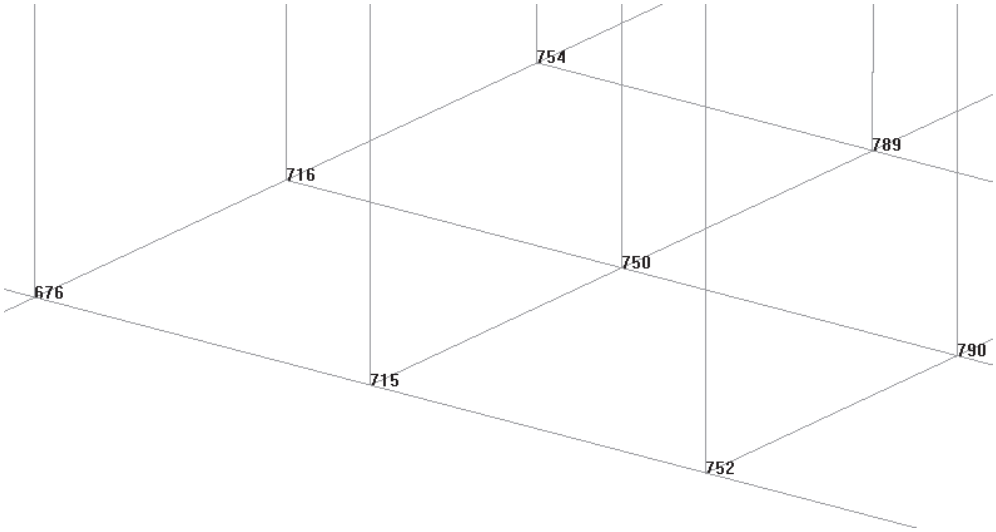


Figure 15. Each number identifies a node. There is a node for each element vertex.

2 . The node identifiers created by generating the mesh appear on the screen. There is one identifier for each vertex of each element.

3 . Select **Mesh->Quadratic type->Quadratic.**

NOTE : By default GiD meshes with first degree (linear) elements. To find out which mode GiD is working in, go to **Mesh->Quadratic type**.

4 . Select **Mesh->Generate mesh**.

5 . A window opens asking whether the previous mesh should be eliminated. Click **Yes**.

6 . Another window appears in which the maximum element size should be entered. Leave the default value unaltered and click **OK**.

7 . Once the mesh has been generated, select **Label->All in->Points** . The result is shown in Figure 16. Now, there are not only nodes at the vertices, but also at the midpoints of the edges of the elements.

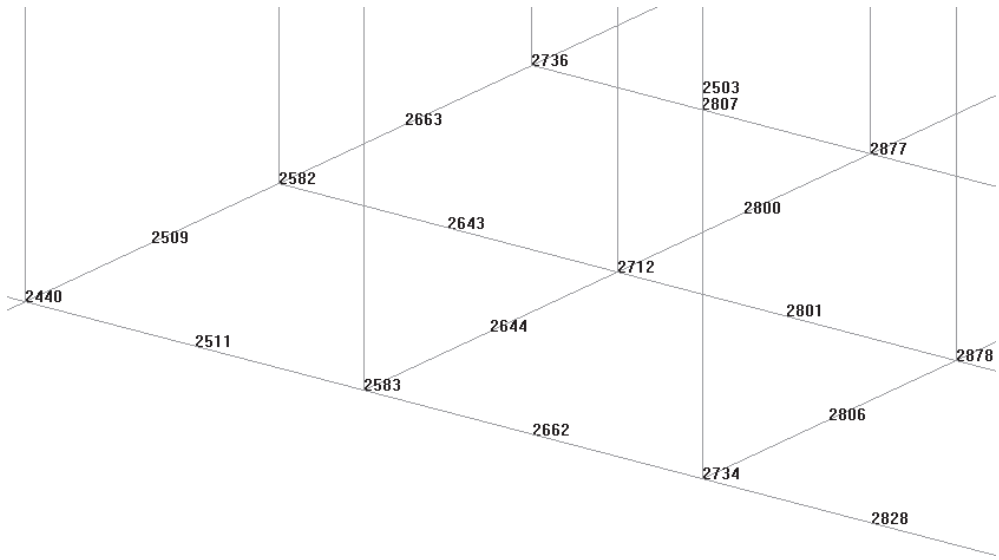


Figure 16. Each number identifies a node. There is a node at each element vertex and at the midpoint of each edge.

8 . Select **Mesh->Quadratic type->Quadratic9**.

9 . Select **Mesh->Generate mesh**.

10 . A window opens asking whether the previous mesh should be eliminated. Click **Yes**.

11 . Another window appears in which the maximum element size should be entered. Leave the default value unaltered and click **OK**.

12 . Select **Label->All in->Points** (see Figure 17).

13 . Notice that the four-sided elements (quadrilaterals) also have a node in the center, in addition to the nodes at the vertices and midpoints of the edges. Similarly, hexahedra also have a node at their center point.

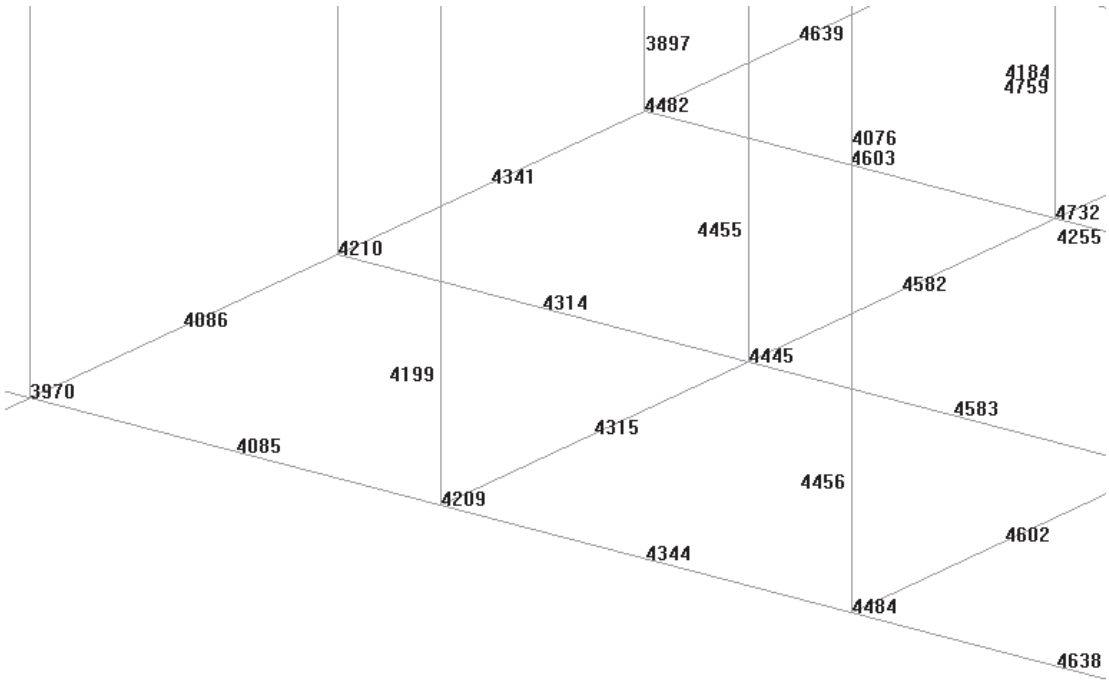


Figure 17. Each number identifies a node. There is a node at each vertex, at the midpoint of each edge and in the center of quadrilaterals and hexahedra.

8 POSTPROCESSING

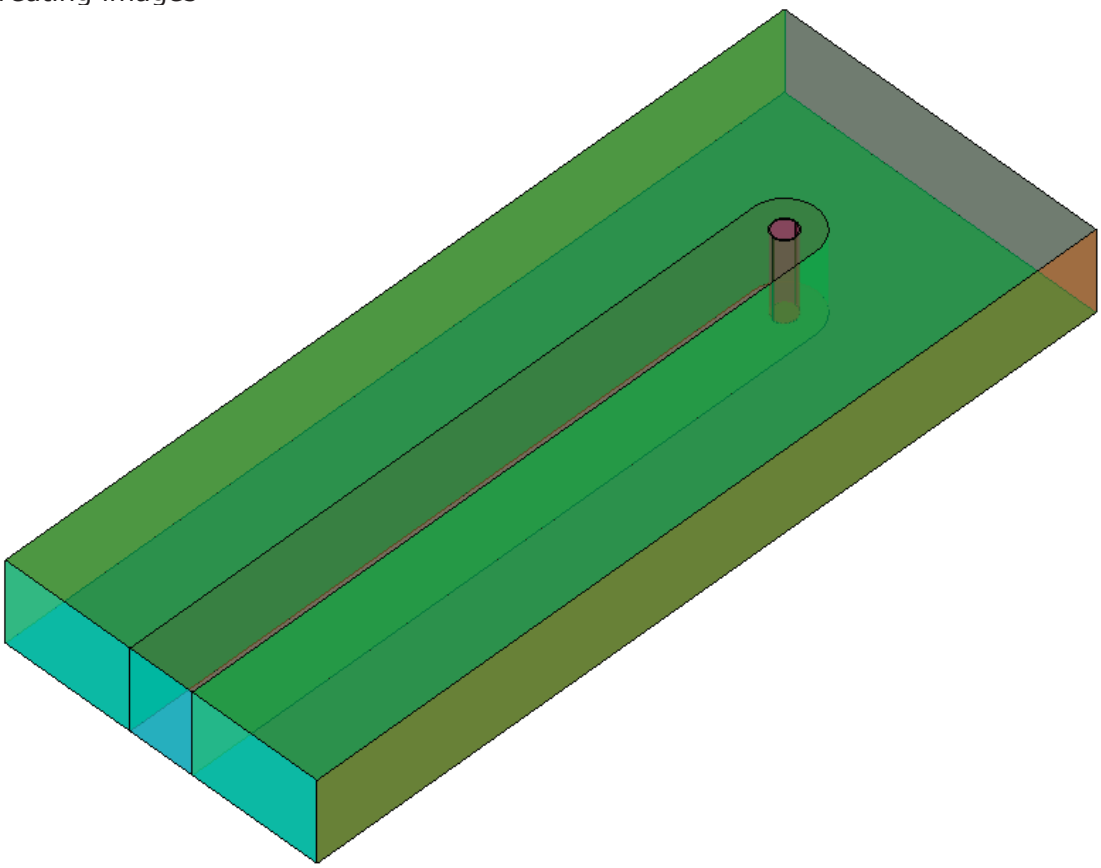
The objective of this tutorial is to do a postprocess analysis of an already calculated fluid simulations, no preprocess option is used.

Not only the model is already meshed and the constraints are assigned, but also the results have been calculated. For more information about the preprocess part of GiD, please check the preprocess tutorials.

In this tutorial, the model *Cylinder.bin* has been used. The problem type used to do this simulations is Tdyn, particularly the Ransol model. Tdyn is a fluid dynamic (CFD) simulation environment based on the stabilized Finite Element Method.

Steps followed in this tutorial:

- Loading the model
- Changing mesh styles
- Visualization of results
- Creating images



8.1 Loading the model

There are two ways to load the results simulation information into GiD:

- If the model has been calculated inside GiD, the results are also inside the GiD model, then just load the GiD project and change to postprocess mode. This can be achieved clicking on this icon:

, or selecting the **Files->Postprocess** menu entry.

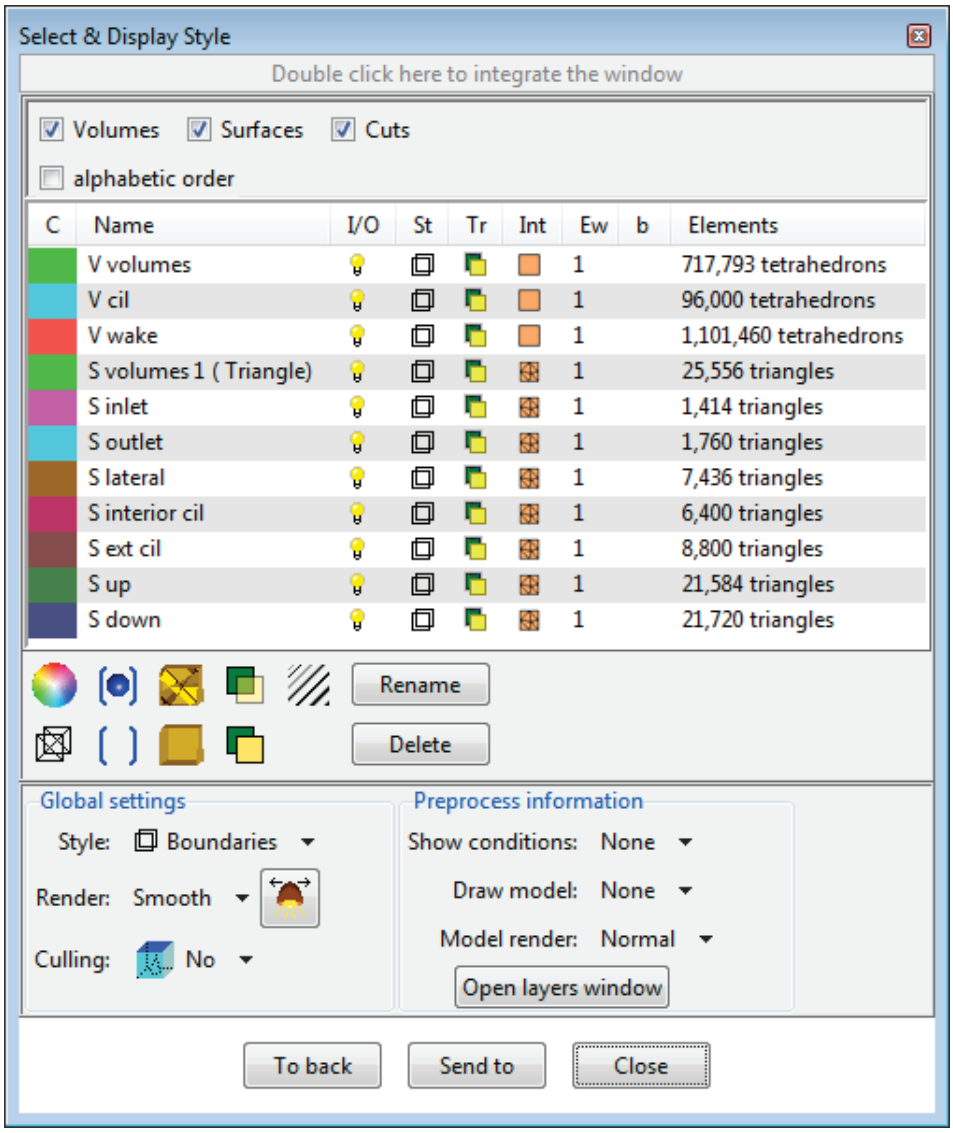
- If only a mesh and results file(s) are present then GiD should be started, and switched to postprocess mode ( ) before loading the file(s).

For this tutorial we will use the file called "Cylinder.bin" that contains the postprocess information, so the steps to follow are:

1 . Start GiD
2 . Switch to postprocess mode: or **Files->Postprocess**
3 . Open the model with: **Files->Open**, **Ctrl-o** or clicking on

8.2 Changing mesh styles

1 . Select **Window->View style...**
2 . Select all the layers
3 . change the style to **Boundaries**
4 . Play a little with the options of these windows, but to continue the tutorial, let a **Boundaries** style selected for all meshes
5 . Change render mode to **Normal**

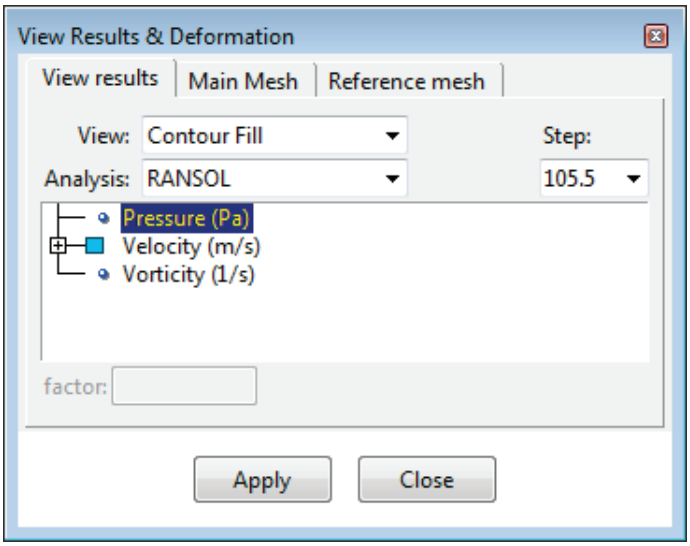


8.3 Viewing the results

In the example, several results have been calculated for several time steps. You can check these results through the **Results** menu, opening the **View Results** window or through the results view icon bar.

Menu: View Results

Window->View Results...



Results view icon bar:

8.3.1 Iso surfaces

Menu: View results->Iso Surfaces

With this result visualization a surface, or line, is drawn passing through all the points which have the same result's value inside a volume mesh, or surface mesh. To create isosurfaces there are several options.

1 . Select **View results->Iso Surfaces->Automatic Width->Velocity(m/s)->|V|**throught the menu bar or clicking on on the results view icon bar.

After choosing the result, you are asked for a width. This width is used to create as many isosurfaces as are needed between the Minimum and Maximum defined values (these are included).

2 . enter the value 0.25727 to get the picture below.
3 . Select **View->Render->Smooth** in order to get a better view.

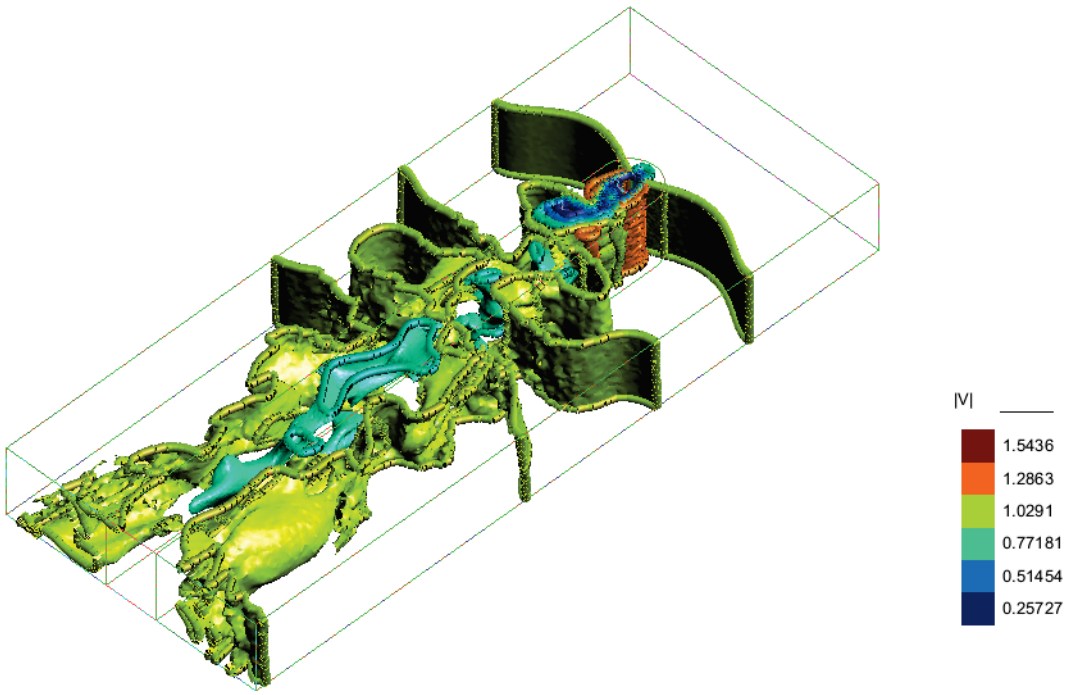
Several configuration options can be set via the Options menu.

Menu: Options->Iso surfaces

Using **Options -> Iso surfaces -> Display Style** the style of the iso-surface can also be changed as with the volume and surface meshes.

In order to see the inner zones we will set the transpacency on the iso surfaces.

4 . Select **Options->Iso Surfaces->Transparency->Transparent**
5 . Move the model to see the inner zones
6 . Select **Options->Iso Surfaces->Transparency->Opaque**



Other interesting options are:

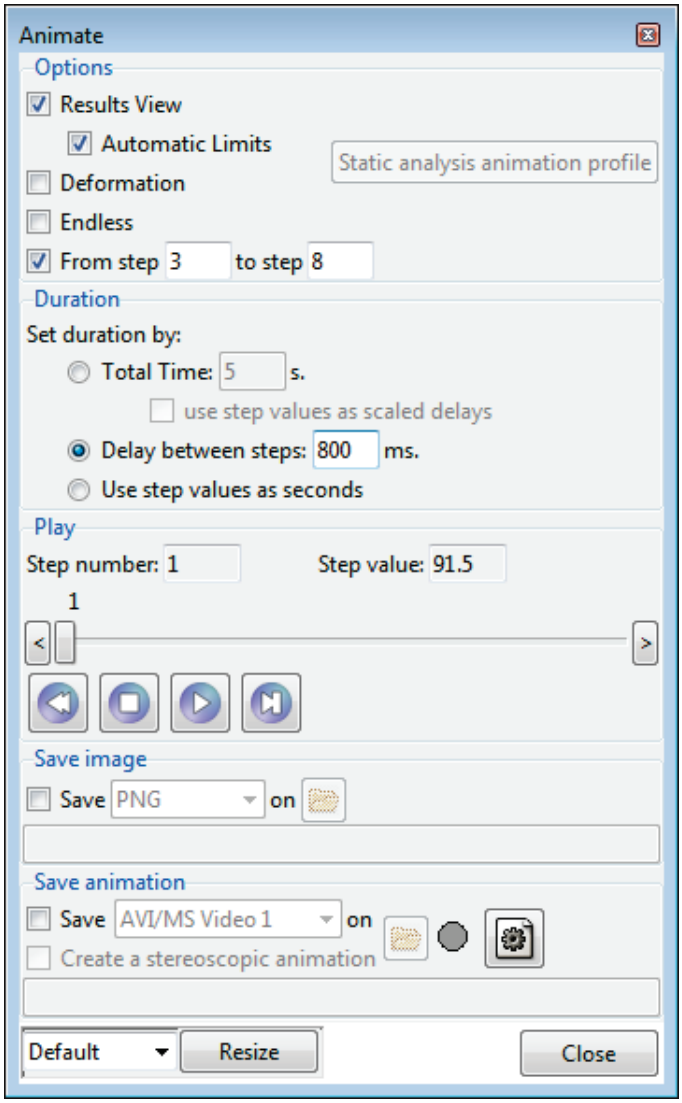
- **Options->Iso surfaces->Convert to cuts** which consolidates the isosurface as mesh which can be exported to a file.
- **Options->Iso surfaces->Color Mode** allows to draw the iso-surfaces with a single colour (**Monochrome**), according to the results used to create the iso-surface (**Result color**) or using the color map of the visualized contour fill result (**Contour fill color**).
- **Options->Iso surfaces->Show isolines** this option allows the user to switch isolines of surafaces on or off.
- **Options->Iso surfaces->Draw always** if this option is selected the iso-surfaces are always drawn even though all the meshes are switched off.

8.3.2 Animate

Menu:Window->Animate...

This window allows the user to animate the current visualized results.

If only one step is present, then the **Static analysis animation profile** button is enabled so that a custom animation profile can be step to animate that one step.



If one result has several steps you can visualize them in an animation. In this case we will

use the iso surfaces result.

1 . Select **View->Render->Smooth**
2 . Select **Window->Animate...**to open the animation window

Please notice that we have from step 1 to 13. We will do the animation only of some of these steps.

3 . Check the **From step** option and set 3 **to step** 8
4 . Select the **Delay between steps** option and set it to 800 ms. The animation should take 4 seconds
5 . Try it clicking on the **play** icon

We will record a video during the animation.

6 . Once the animation is finished check the **Save** option on the **Save animation** part

You can choose from several video formats.

7 . Select AVI/mjpeg
(to include this animation in a MS PowertPoint an apropiate codec is needed like the one supplied with Combined Community Codec Pack, CCCP)

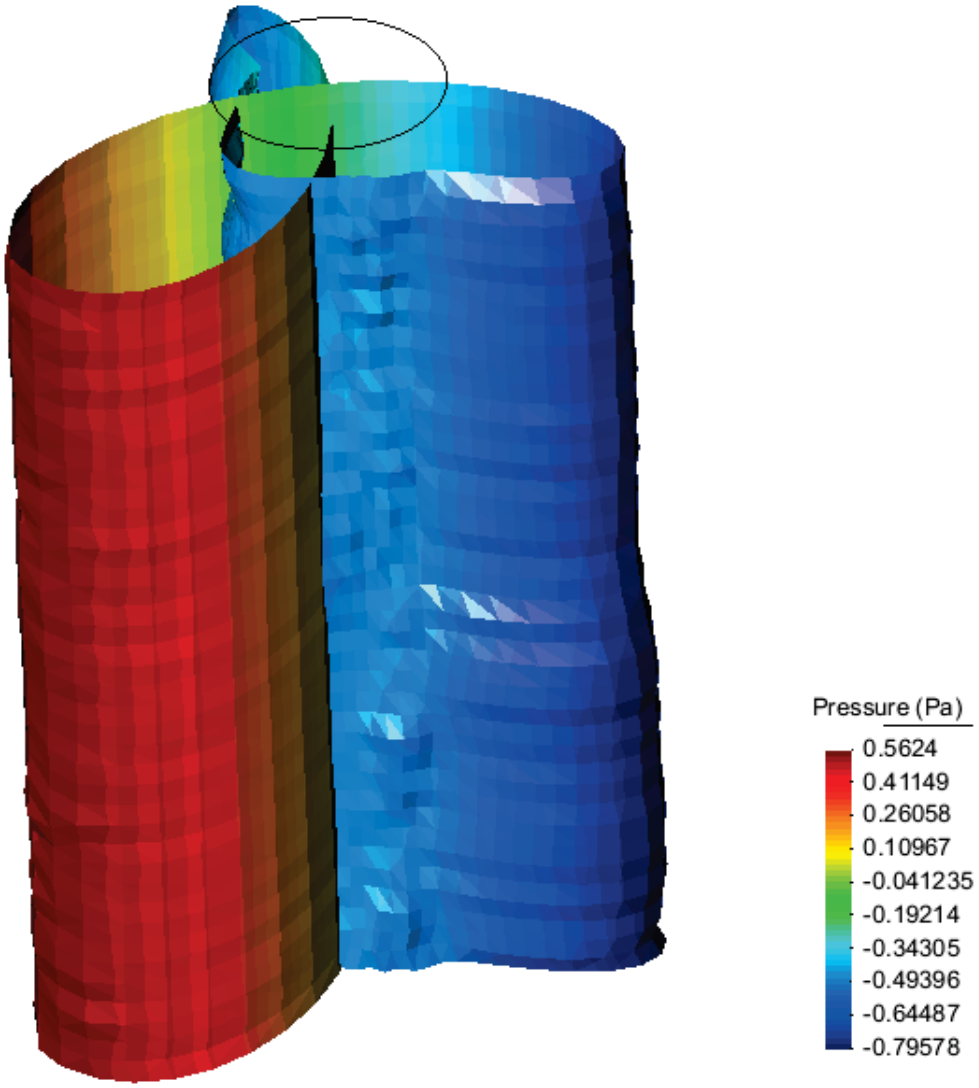
8 . Select a folder where the video will be saved clicking on the **folder** icon or writing the path in the text entry
9 . Click on the **play** button and the recording will begin. This step could take a little bit long. Wait until the red circle turns to green
10 . **Close** the Animate window

Now we will visualize another result but before we will clear all the results.

11 . Select **View results->No results** through the menu bar or using the icon 

8.3.3 Result surface

Another result visualization of interest is this one:



To get this visualization follow these steps:

1 . Switch off all the sets except **S interior cil**. To do this:
   - Select **Window->View style...** in the menu bar.
   - Select all the sets except **S interior cil** pressing Ctrl while selecting with mouse.
   - Click on the **bulb light** icon on the **I/O** column or click on the icon .
2 . Through the "View style" window change the Style to **Body Bound.**
3 . Select **View results->Result surface-> Pressure (Pa)**. A surface will be drawn which results from moving the nodes along its smoothed normal according to the results value for this node.
4 . Enter **5** as factor in the bottom command line.
5 . Select **Options->Result surface->Show elevations->None .**
6 . Select **Options->Result surface->Show elevations->Contour fill**. With this last option the surface is colored according to the pressure value.

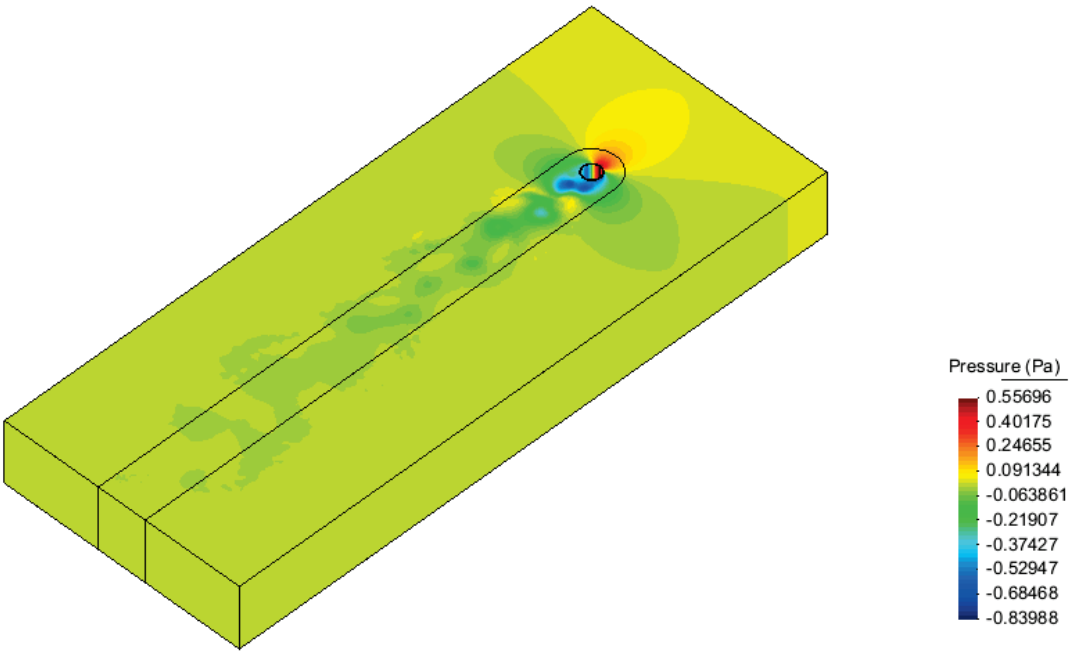
Play with the other options as you will.

7 . Select **View results->No results** through the menu bar or using the icon

8 . Switch on all the sets again through the "View style" window by selecting all sets and clicking on the icon.

8.3.4 Contour fill, cuts and limits

Contour fill



Menu: View results->Contour Fill

1 . Please select **View results->Contour Fill->Pressure (Pa)** through the menu bar, or clicking on or using the **Window->View results...** window.

2 If not all sets show the contour fill like the picture above, remember to select **BodyBoundary** mesh style for all the sets.

This option allows the visualization of coloured zones, in which a scalar variable or a component of a vector varies between two defined values. GiD can use as many colours as permitted by the graphical capabilities of the computer The number of colours can be set through **Options->Contour->Number of colours**. A menu of the variables to be represented will be shown, and the one that is chosen will be displayed using the default analysis and step selected.

In the model the pressure has been calculated. We can visualize the result for each step in a contour fill.

You can choose the step that you want to view through the **View results** window or clicking on

3 . Select the **step 103**

Several configuration options can be set via the Options menu.

Menu: Options->Contour

You can change the color scale in orther to get a more comfortable view. You can select several predefined color scales. The default scale is *standard,* which is a rainbow colour map starting from blue (minimum) through green and yellow, to red (maximum).

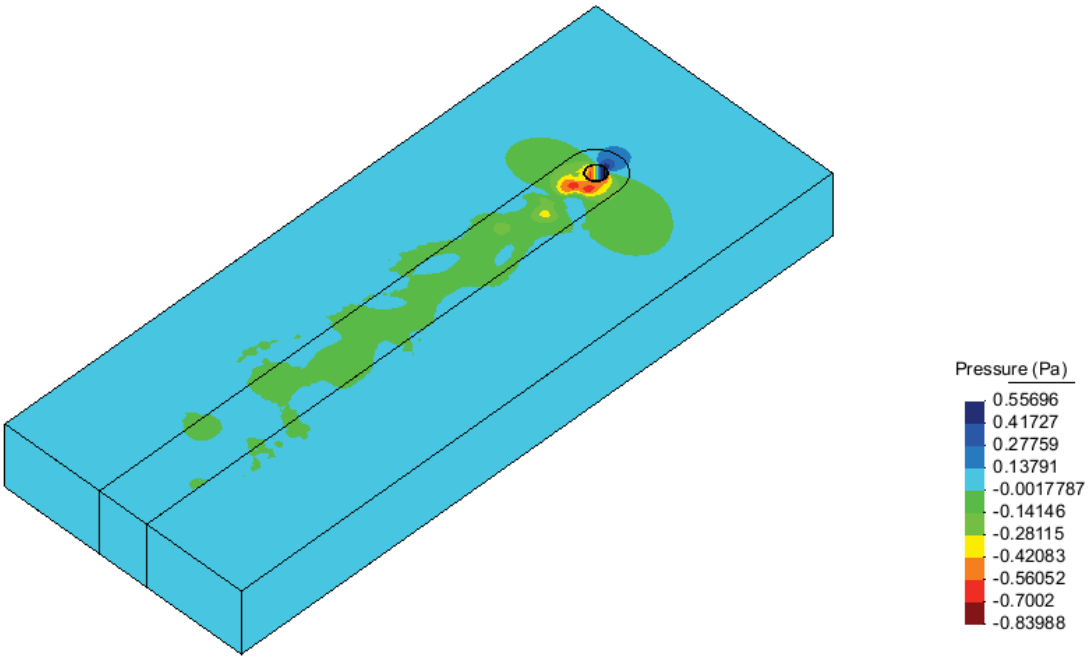
1 . Select **Options->Contour->Color Scale->Inverse Standard**

You can also define your own scale.

2 . Select **Options->Contour->Color scale->User defined...** or **Options->Contour->Color Window...**

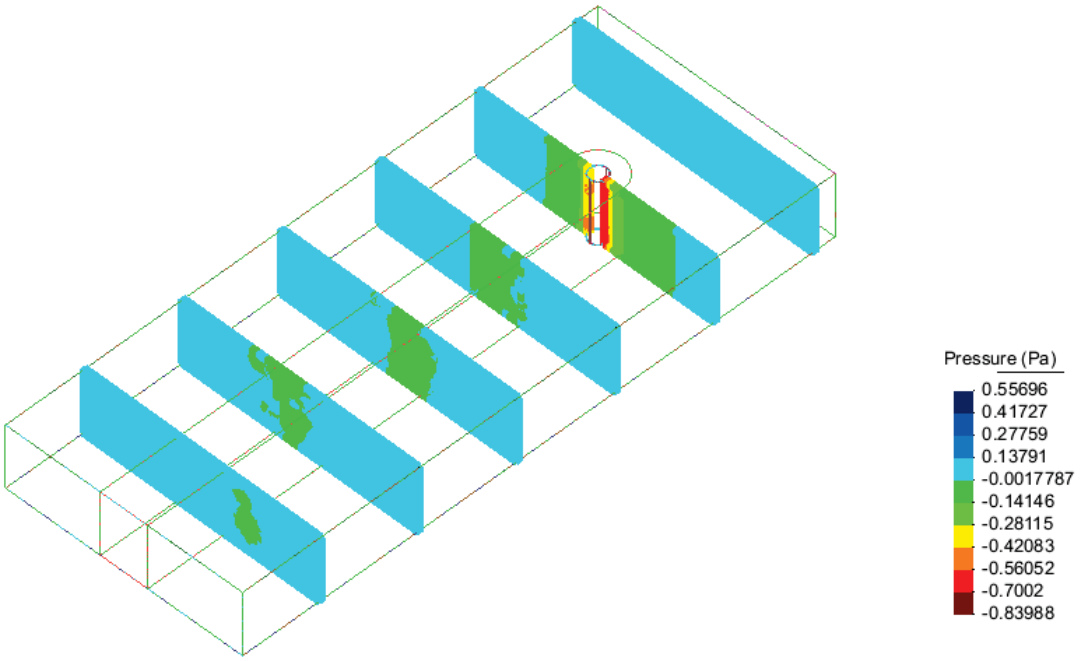
In this window you can change the number of diferent colors used in the scale. If you need more accuracy you can increase this number, or decrease it for a higher contrast.

3 . Change the number of colors to **10**
4 . Click on **Apply** button
5 . Click on **Close** button



Cuts

In order to view the inner zone we will do several cuts along the model.



Menu: Do cuts

In order to make it easier first we will change the plane visualization.

1 . Please select **View->Rotate->Plane XY(Original)** through the menu bar, **Rotate->Plane XY(Original)** throught the mouse menu or clicking on and . Now you have a top view of the model.

2 . Select **Do cuts->Cut plane->Succession** through the menu bar or clicking on and then

With the **succession** option you specify an axis that will be used to create cut planes orthogonal to this axis. The number of planes is also asked for.

3 . Draw a line through the X axis in the middle of the model and ask for 7 cuts. You should obtain 7 parallel planes to Y axis.

Note: after clicking the first point, pressing the Alt key while moving the mouse the dynamic line will be axis aligned or at 45 degrees.

4 . Now change the display style (**Utillities->View style**) in order to see only the cuts. You can see that several layers have appeared a prefix like **CCutSetX** indicating which mesh or set has been cut. These names can always be changed through the **Window->View Style**. Select all the layers except the cuts and change their style to **Boundaries**. You can rotate the model in order to see the contour fill result on the cut planes.

5 . In the same window select all the **CCutSetX** and click on **Delete** button in order to delete all the cuts.

6 . Select **BodyBoundary** as mesh style to visualize the **contour fill** of **pressure** again.

7 . Select **Options->Contour->Reset all** in order to set all the defaults options.

Define limits

You can set the limit values for the contour fill. In our case we only want to see the positive values. In order to do this we will set the minimum value to 0.

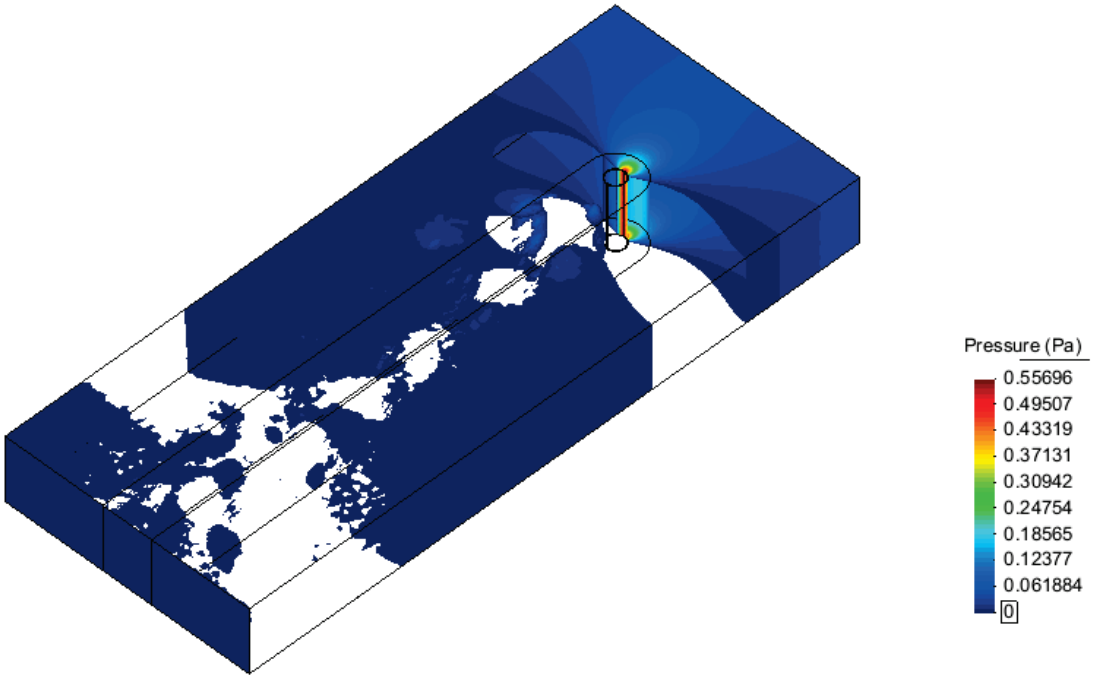
1 . Select **Options->Contour->Define Limits...** through the menu bar or clicking on 

Choosing the first option the Contour Limits window appears. With this window you can set the minimum/maximum value that Contour Fill should use.

2 . Check the Min checkbox
3 . Change the value to 0
4 . Click on the **Apply** button
5 . Click on the **Close** button

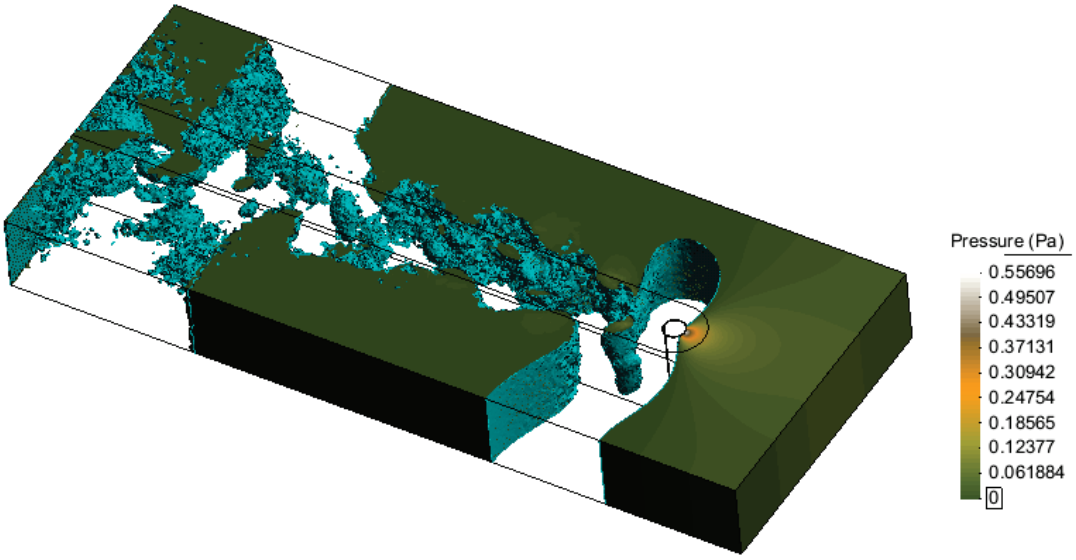
Outliers will be drawn in the colour defined in the Out Min Colour option. In order to view it better we will change this color to transparent.

6 . Select **Options->Contour->Min Options->Out Min Color->Transparent**



8.3.5 Combined results

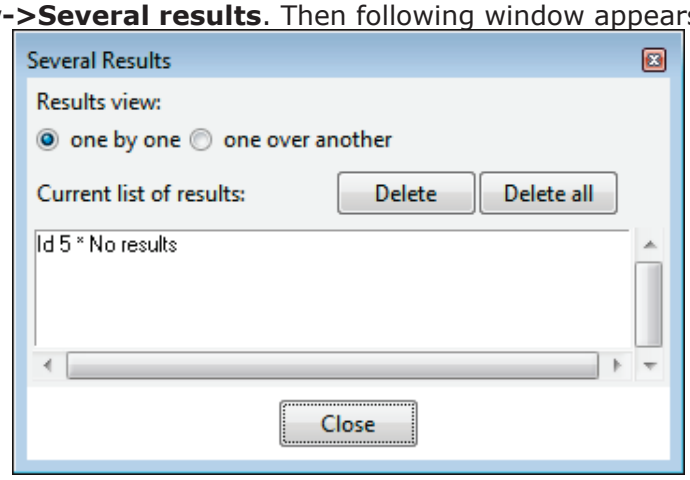
An interesting postprocess options is to combine several result visualizations, like this one:



To get this view follow these steps:

1 . Clear all results visualizations with **View Results->No results** or the icon 

2 . Select **Window->Several results**. Then following window appears:



3 . In this window select **one over another**. With this option GiD is told to visualize one result over another

4 . Select **View Results->Default Analysis/Step->Ransol->103**

5 . Select **View Results->Iso surfaces->Exact->Pressure** through the menu bar or clicking on the 

6 . In the following questions: How many **isosurfaces**? Enter 1

7 . Enter the 1 value ...? Enter 0

8 . Select **View Results->Contour Fill->Pressure**

9 . Set the **minimum** value to 0

10 . Select **Options->Contour->Min options->Out min color->Transparent**

11 . Select **Options->Contour->Color scale->Terrain Map**

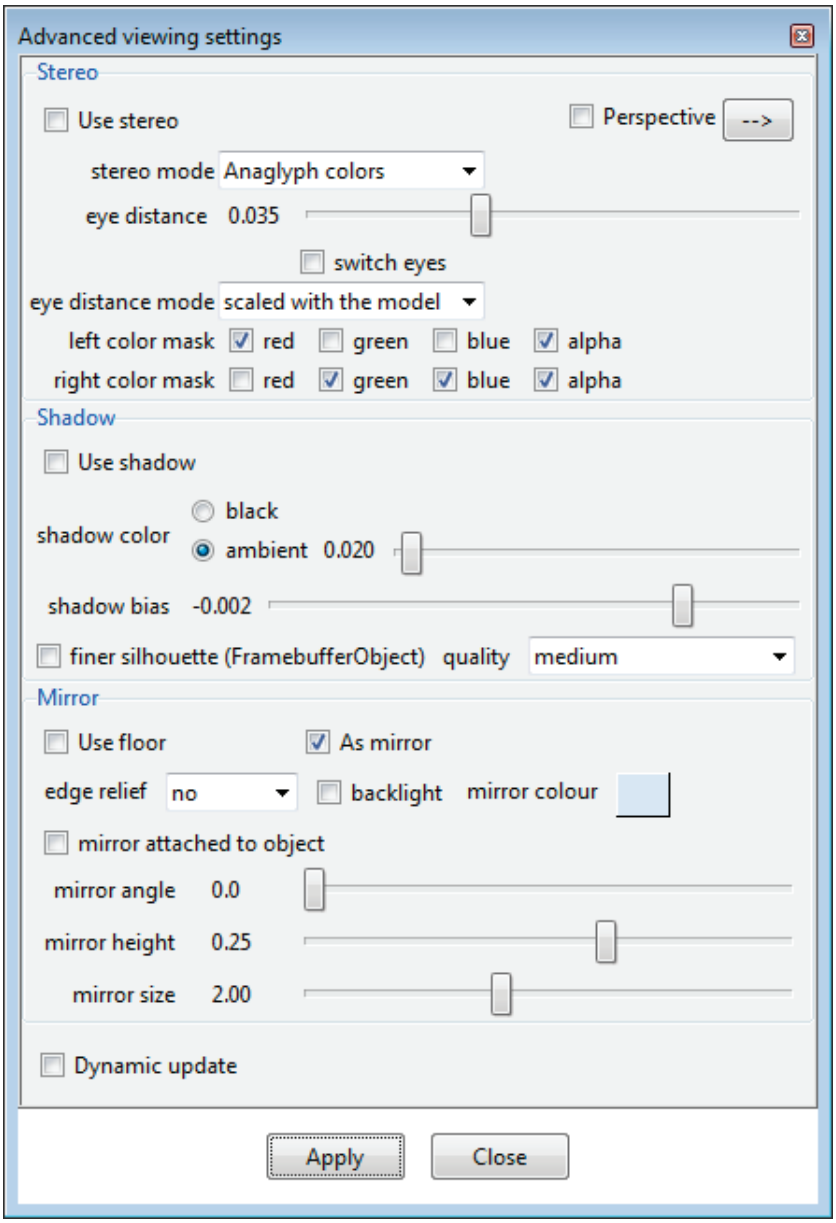
12 . Select **Options->Iso surface -> Color mode -> Monochrome**

13 . Select **Options->Iso surface -> Change color** to change the color of the iso

surface.

Note: On newer version of GiD, step 2 and step 3 is not needed.

8.3.6 Stereo mode (3D)



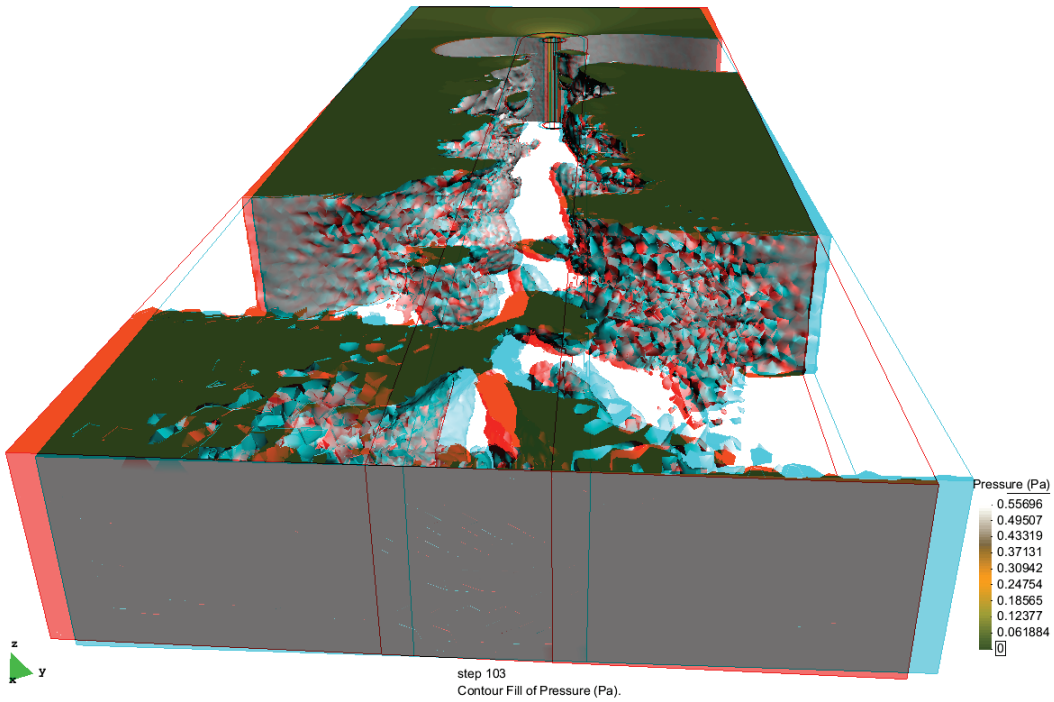
Menu: View->Advanced viewing settings...

If you have an **anaglyphic** glasses you can try this option. The model can be set as an anaglyphic image in order to provide a stereoscopic 3D effect, when viewed with 2 color glasses (each lens a chromatically opposite color, usually red and cyan).

Anaglyphic images are made up of two color layers, superimposed. Since the glasses act as red and cyan filters we should be careful with the model's colors. To avoid problmes we will change the contour fill color scale.

1 . Select **Options->Contour->Color Scale->3D Anaglyphs**
2 . Select **View->Advanced viewing settings...**
3 . Check the **Use stereo** option

4 . Check the **Dynamic update** option in order to change the options without the need to click the Apply button
5 . Set the eye distance to the value where you can see the 3D effect
6 . Unheck the **Use stereo** option
7 . **Close** the window
8 . Select **View results->No Results**
9 . Change the **view style** to boundaries for all the layers, like in **Changing style** chapter

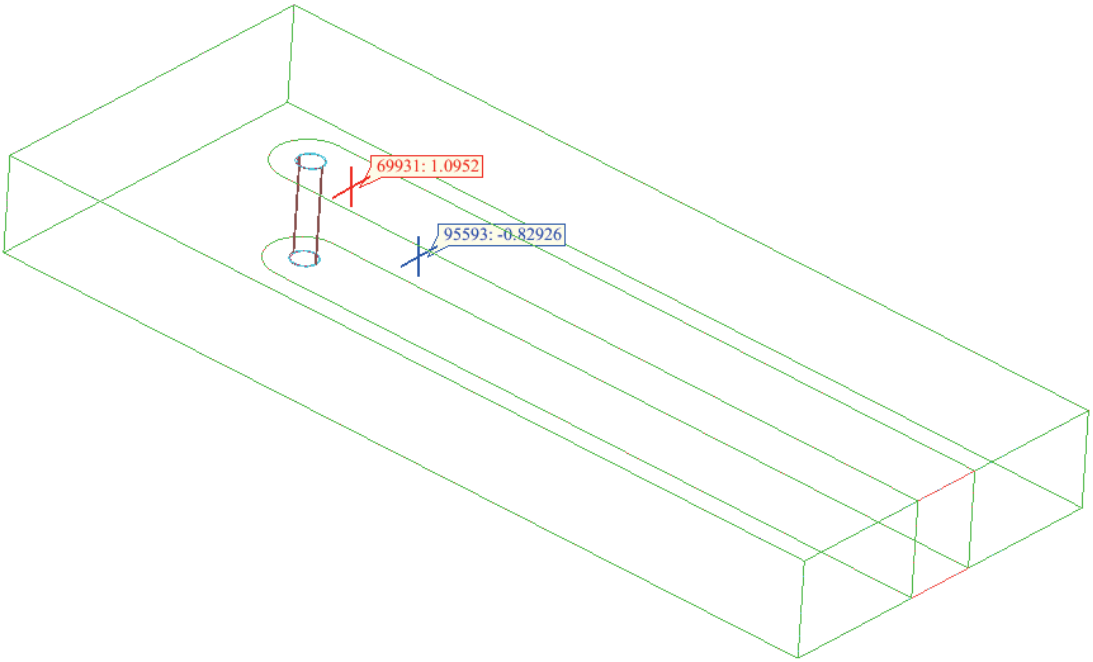


8.3.7 Show Min Max

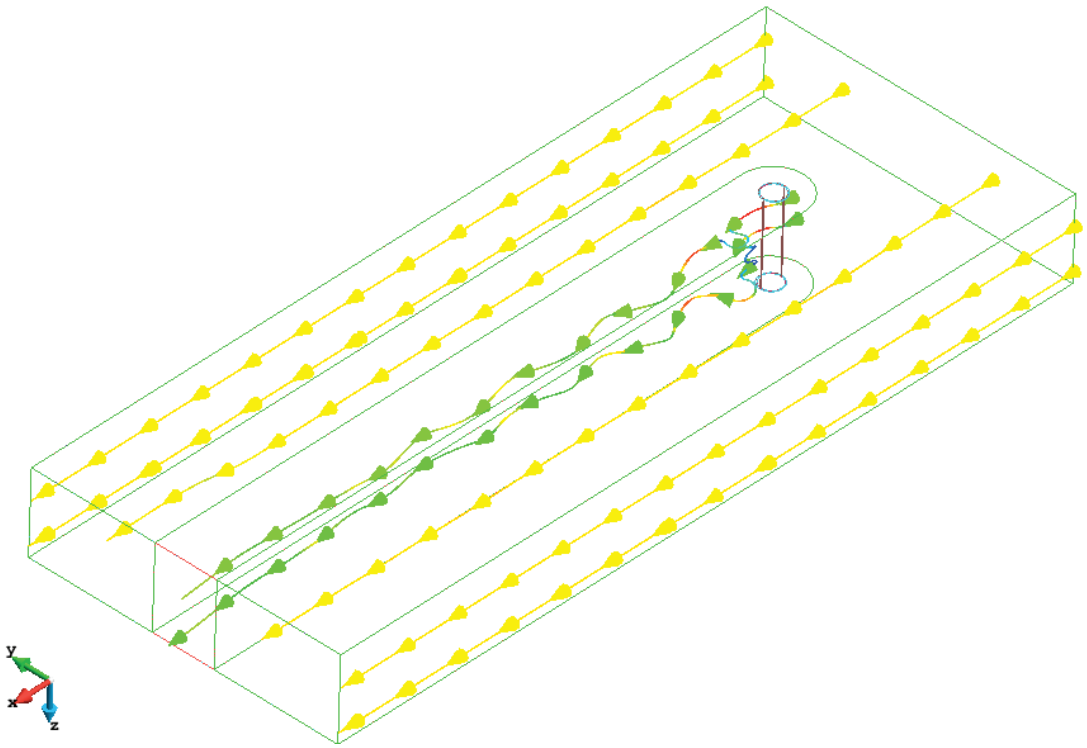
Menu: View results->Show Min Max

With this option you can see the minimum and maximum value of the chosen result in the chosen analysis step. In our case we will choose the Vy component of velocity result for the first analysis step.

1 . Select **View results->Default Analysis/Step->RANSOL->91.5** throught the menu bar or clicking on
2 . Select **View results->Show both->Velocity (m/s)->Vy** throught the menu bar or clicking on . The label shows the node number and the value of the result.
3 . Select **View results->No Results**



8.3.8 Stream lines



Menu: View results->Stream Lines

With this option you can display a stream line, or in fluid dynamics, a particle tracing, in a vector field.

Note: stream lines are confined in a single volume mesh, i.e. they do not jump from one

volume mesh to the next volume mesh, even if they are close neighbours. In the provided example there are three volume meshes and stream lines will not cross the volume boundaries. You can join the volume meshes into a single volume mesh using **Utilities --> Join --> Volume sets** . Then you can delete the three separate volumes and switch the single joined volume mesh on.

The above image results from doing this tutorial with the three separated volumes.

The image at the end of this *stream lines* tutorial is achieved if following step is done before the enumerated *stream lines* tutorial steps.

- Select **Utilities --> Join --> Volume sets** to create a single volume mesh, and delete the three other volume meshes: *V volumes*, *V cil* and *V wake*. (The above image results from

1 . Select **View results->Default Analysis/Step->RANSOL->103.0** throught the menu bar or clicking on
2 . Select **View results->Stream Lines->Along line->Velocity (m/s)** throught the menu bar

With this option you can define a segment along which several start points will be chosen. The number of points will also be asked for, including the ends of the segment. In the case of just one start point, this will be the center of the segment.

NOTE: This action could also be done clicking on in the icon bar. In this case we have to select the way to define the start point through the mouse menu. In this case select **Contextual->Along line.**

We want to create several stream lines along the model doing 2 lines.

3 . Write the **initial** point in the command line 10 15 3
4 . Write the **final** point in the command line 10 -15 3
5 . You are asked for the **number of points** along the line. Enter **5** and click **Ok**.

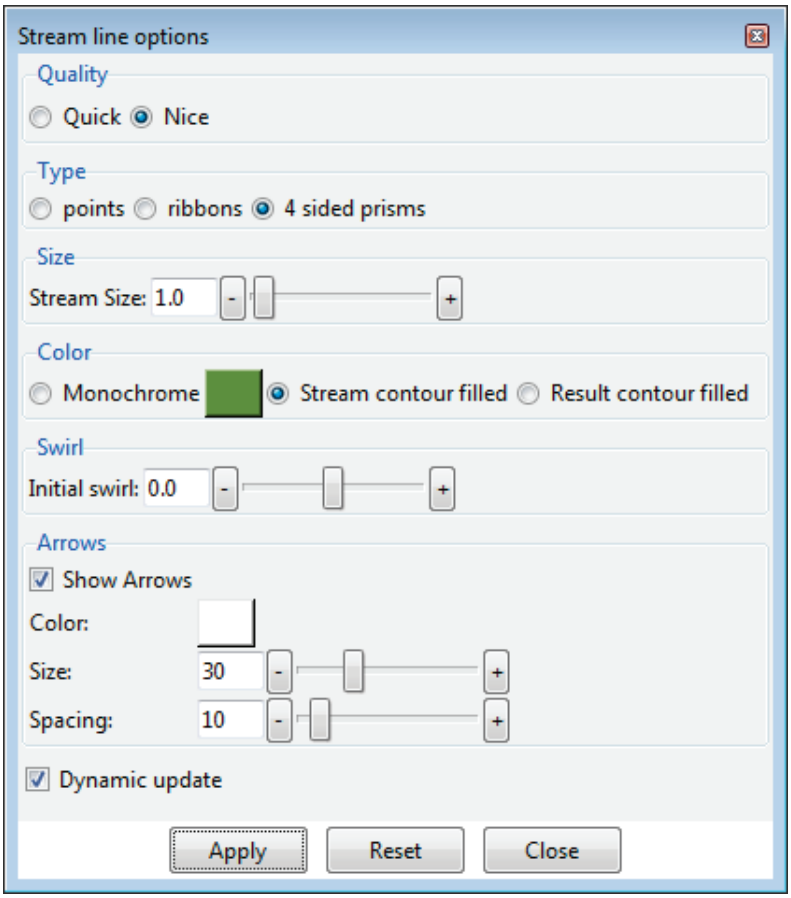
Note: (You can also press Ctrl-t to set the cursor in the command line)

The first line with 5 stream lines is created.

6 . Write the **initial** point in the command line 10 15 7
7 . Write the **final** point in the command line 10 -15 7
8 . You are asked for the **number of points** along the line. Choose 3.

The second line with 3 stream lines is created.

9 . Click the middle mouse button or press the **Esc** key in order to finish the operation.



Several configuration options can be set via the Options menu.

Menu: Options->Stream lines

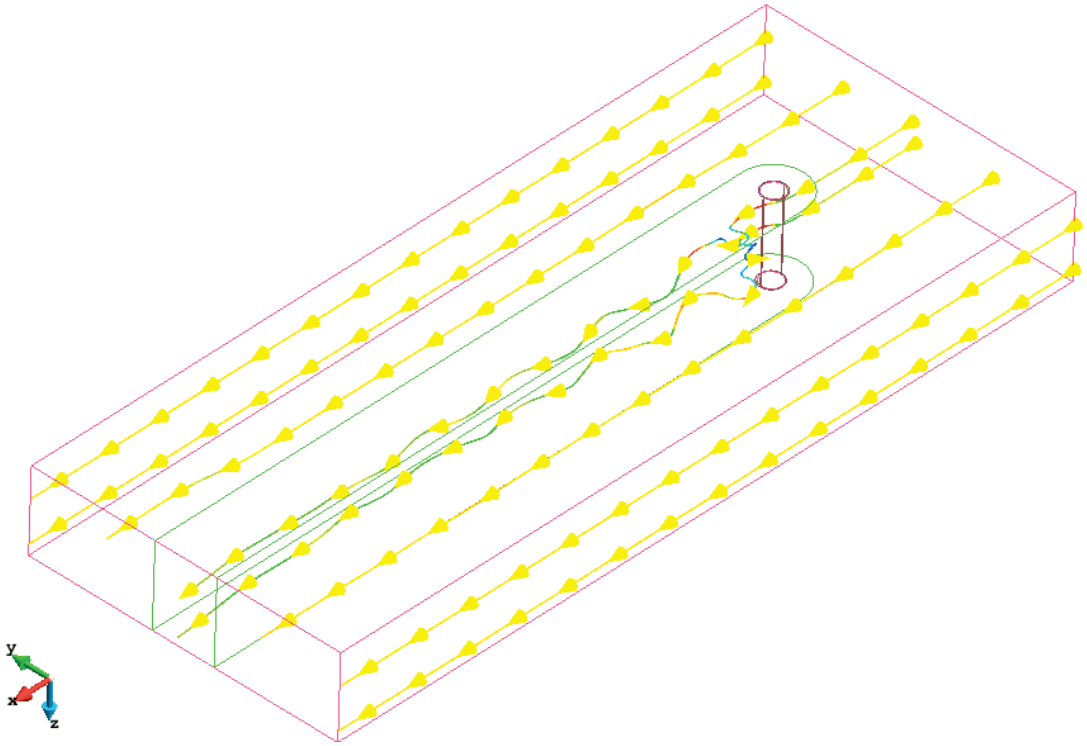
The options can be also managed through the **Size & detail** window.

10 . Select **Options->Contour->Color Scale->Standard**
11 . Select **Options->Stream lines->Size & detail...**
12 . Check the **Dynamic update** option
13 . Select **Stream contour filled**

The stream lines will be drawn with the colors used in the velocity contour fill.

14 . In the **Arrows** options, set 30 for the **Size** option
15 . Set 10 for the **Spacing** option
16 . Check the **Show Arrows** option
17 . You may play with the diferent stream types: points, ribbons or 4 sided prisms. If the ribbons type is selected you may adjust the initial swirl to rotate the ribbon.
18 . Close the window
19 . Select **Options->Stream lines->Delete all**

NOTE: A way to achive the best results is to first create a cut of the volume mesh throught the *region of interest* and then use these nodal information as support to create *stream lines* and its options: *along line, in a quad,* etc.



8.3.9 Graphs

Menu: View results->Graphs

From this menu several graphs types can be created, we will try some of them. Graphs are supported for results defined over nodes.

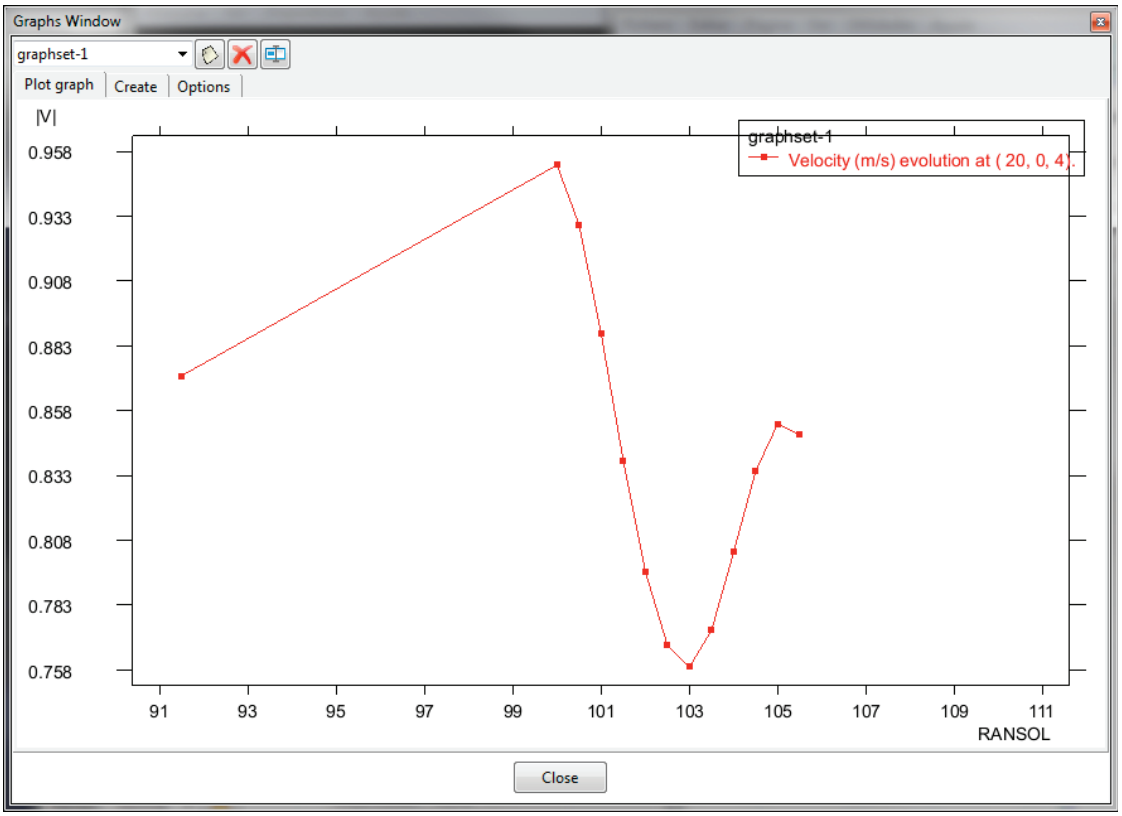
Graphs are organized into **graph sets** in order to ease the management. Each set shares the same units for each axis.

When a graph is created is placed in the current graphset if the units are the same, otherwise a new graphset is created.

In order to work with graphs we will use the 'graphs window'.

The **Point evolution** graph displays a graph of the evolution of the selected result along all the steps, of the default analysis, for the selected nodes.

1 . Select **View results->Graphs->Point evolution->Velocity(m/s)->|V|**
2 . Write 20 0 4 in the command line in order to specify the point.
3 . Affter pressing the **Escape** key, or the middle mouse button, the graph will be shown in a separate window:

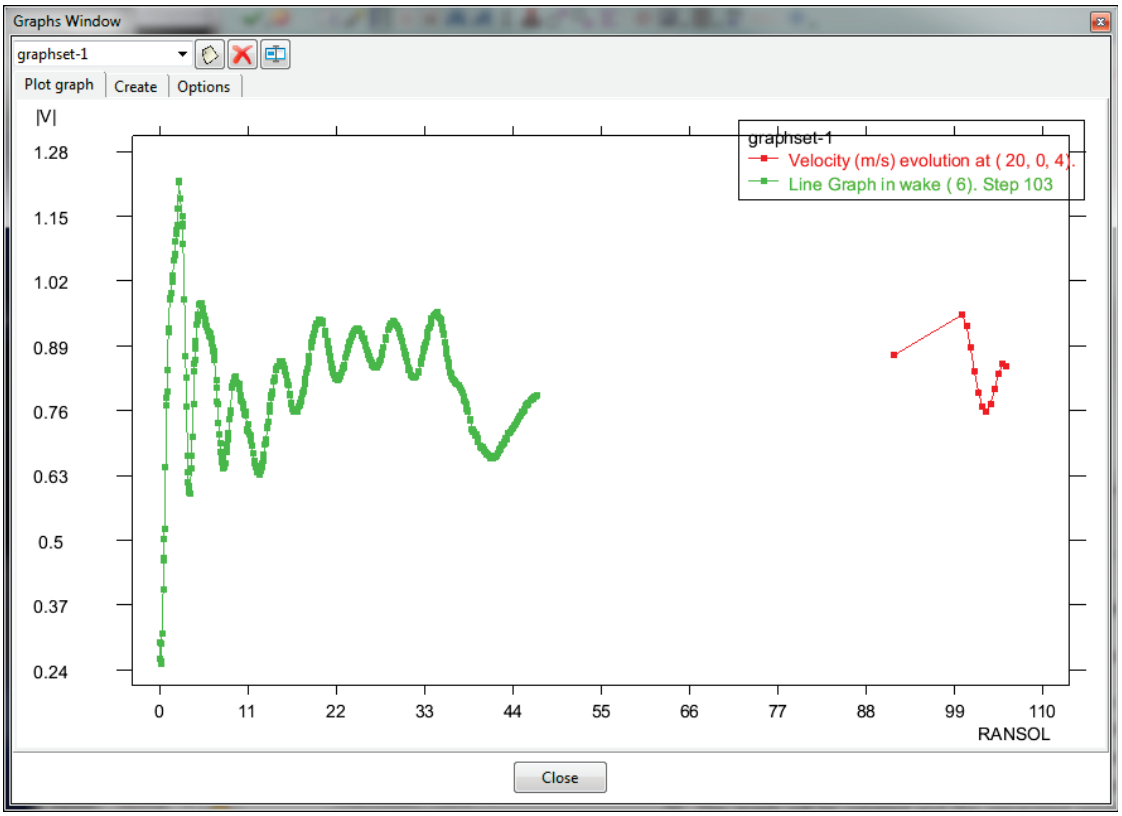


The graph is created in the graphset-1. We will create another graph in the same graph set.

The **Line graph** displays a graph defined by the line conectig two selected nodes of surfaces or volumes, or any arbitrary points on any projectable surface and in any position.

4 . Switch all surface meshes off, and let only the three volume meshes on: V volumes, V cil, V wake.
5 . Select **View results->Graphs->Line graph->Velocity(m/s)->|V|**
6 . Write 3 0 4 in the command line in order to specify the initial point.
7 . Write 50 0 4 in the command line in order to specify the final point.

Now both graphs are showed in the same graph set:



We will rename the graph set.

8 . In the top part of the window click the icon.

9 . A window will appear asking for a new name. Enter 'Velocity', for example.

We will create a new graph set.

10 . In the top part of the window click the icon.

A new graph set is created with default name 'graphset-1'. When a new graph set is created becomes the current one. We can see that there are no graphs on this new graph set.

It's also possible to create graphs from the graph window.

11 . Go to **Create** tab and select **Point evolution** int **View** option.

12 . In **Y Axis** list double click **Pressure (Pa)**.

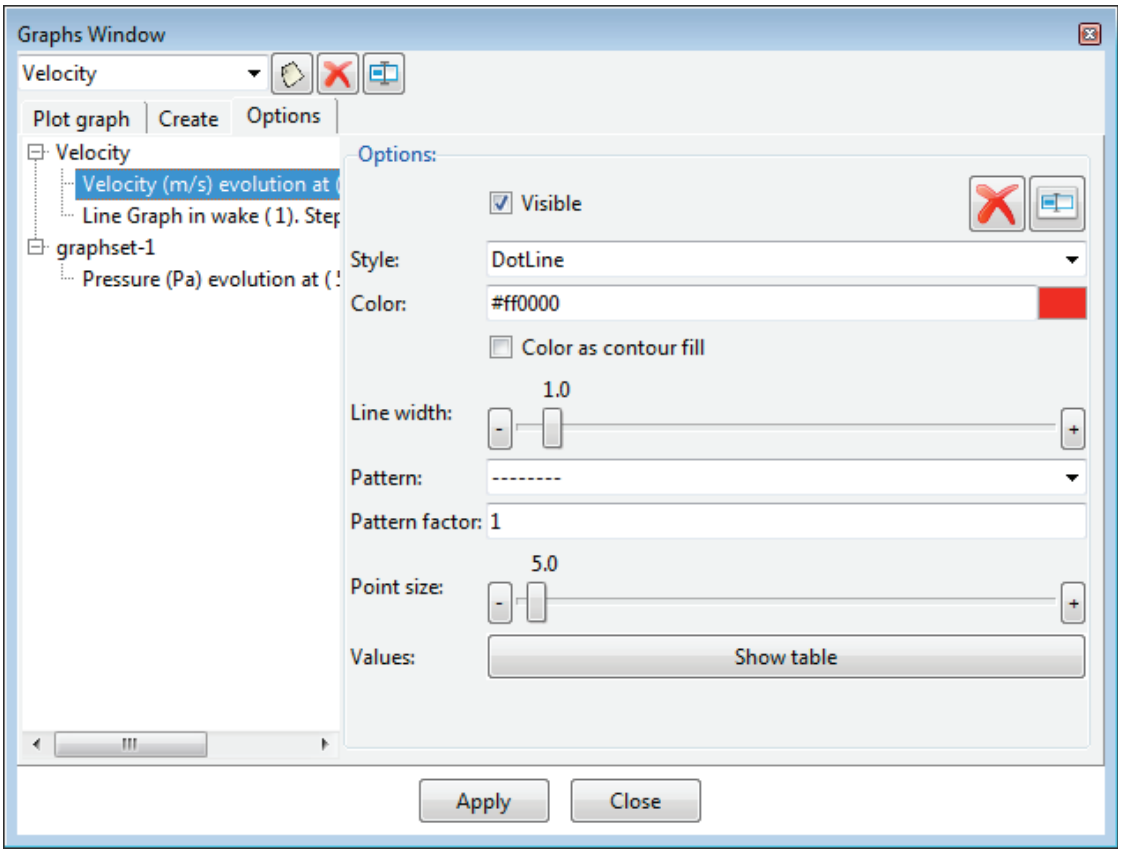
13 . Write 50 0 0 in the command line in order to specify the point.

14 . Press **Escape** to finish the graph.

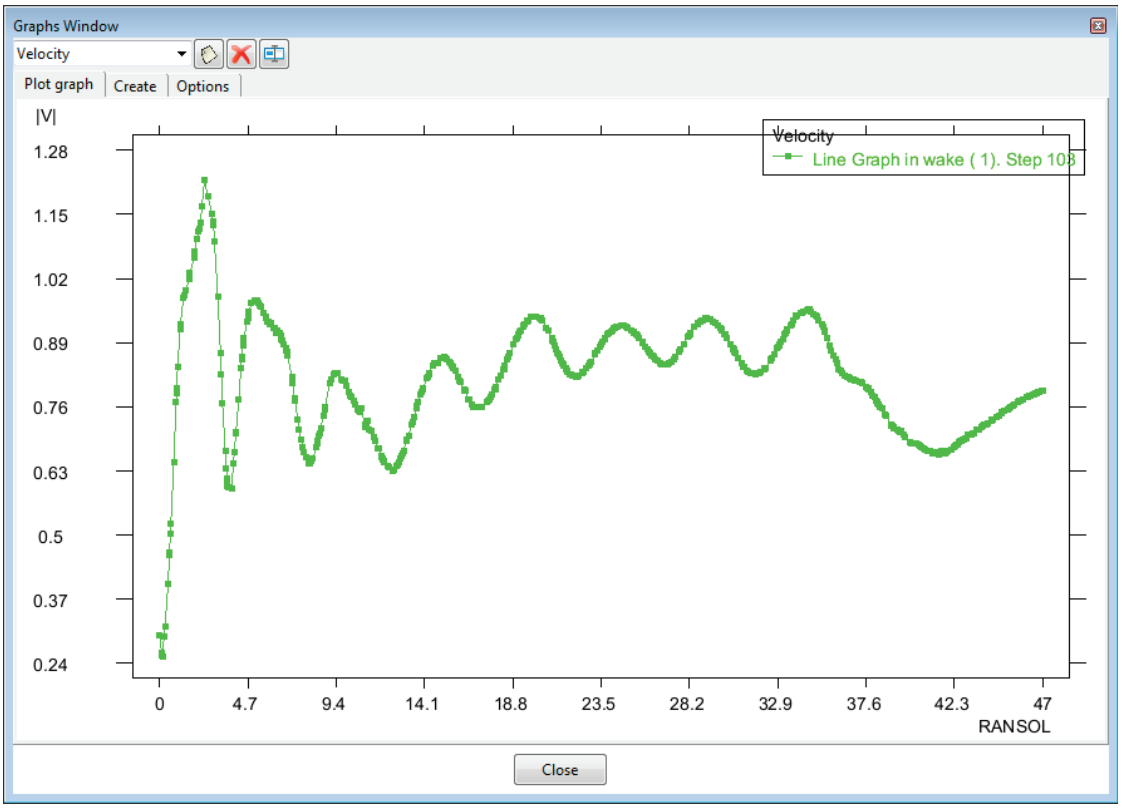
We can manage graphs and graphs sets in the Options panel. Depending if we are selecting a graph set or a graph in the tree we will see different options in the tab.

15 . Go to the **Options** panel, select the 'Velocity (m/s) evolution at (20, 0, 4)' graph and delete it pressing the button with the red cross.

16 . A confirmation window appears. Click **Yes**.



17 . Please notice that the current graph set have been changed to 'Velocity'. Now the Plot graph panel will show only one graph:

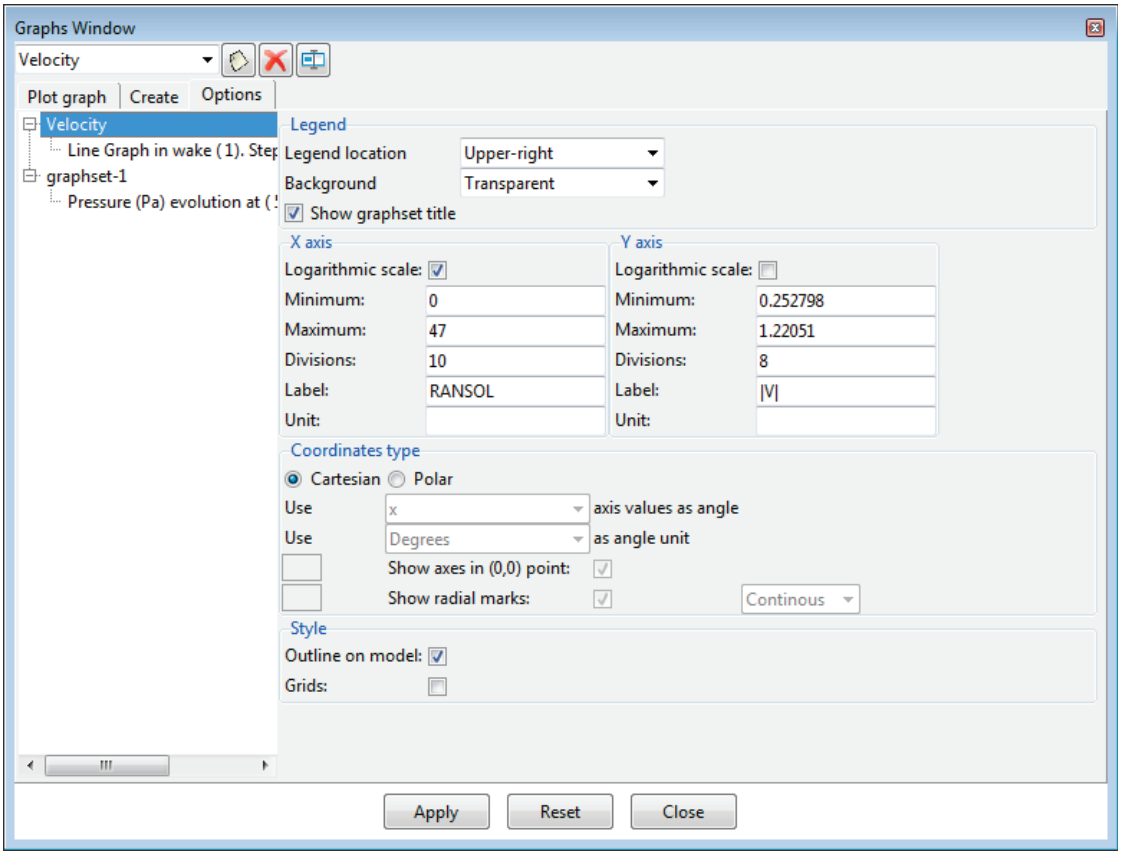


The graph size is readapted. We can will change several style options of a graph.

18 . **Double click** in any point of the graph and we will access to the **Options** tab.
19 . Choose **Line** in the **Style** option
20 . Set to red the **Color** option. You can do it writing #ff0000 or selecting the red clicking on the right color window
21 . Set to 4.0 the **Line width**
22 . Click on **Apply** button

Graph sets options can be managed selecting the set in the tree.

23 . Select 'Velocity' branch. The options will change.
24 . For instance mark 'Logarithmic scale' option in X axis.
25 . Click on **Apply** button



We can export the graph information in order to open it later with GiD.

26 . Select **Files->Export->Graph->All**. You are asked for the location where to save the .grf file.
27 . Choose the location

Now you can import the selecting **Files->Import->Graph**

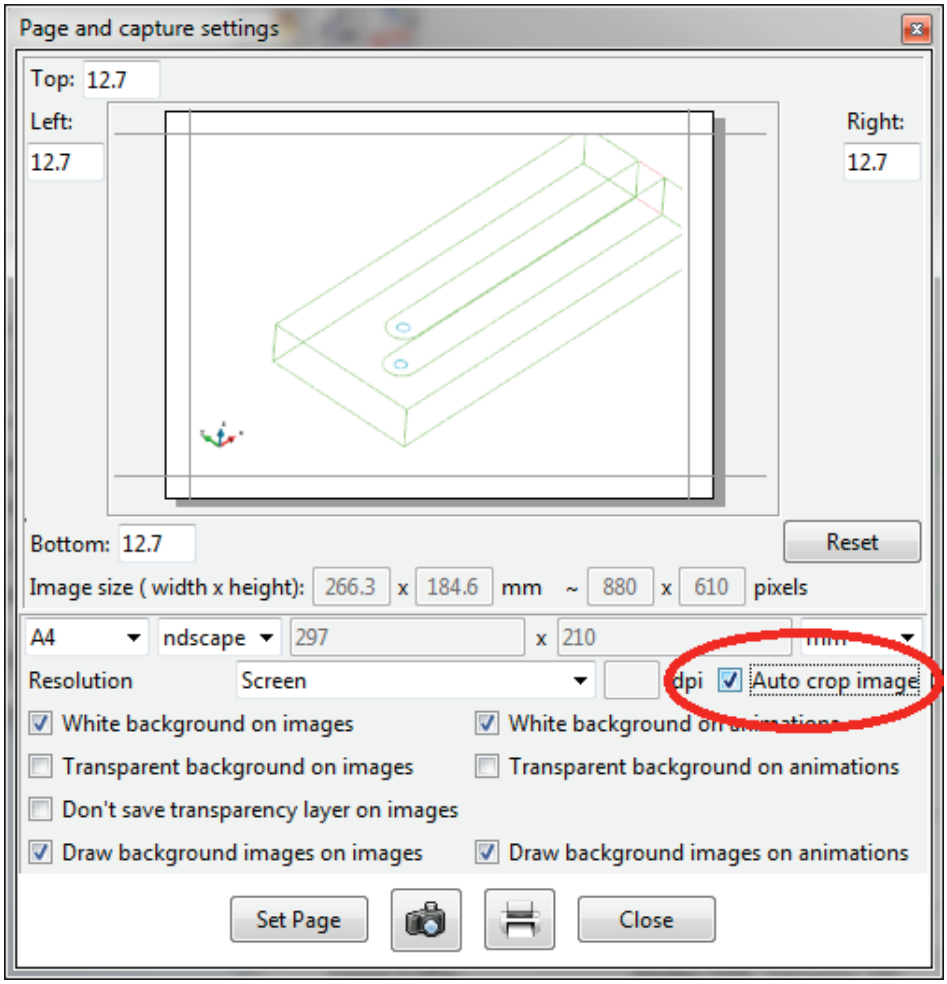
28 . Select **Options->Graphs->Clear graphs** in order to delete all the graphs

8.4 Creating images

Menu:Files->Page and capture settings...

Finally we will take some snapshots of our model. You can save images in several formats. The properties of the image (resolution, size, etc.) can be assigned in Page and capture settings option.

1 . Select **Files->Page and capture settings...**
2 . Check the **Auto crop image** option in order to cut the image in the model limits
3 . Click on **Set Page** button
4 . Click on **Close** button



Menu:Files->Print to file

This option asks you for a file name and saves an image in the required format with the defined properties in **Page and capture settings**.

1 . Select **Files->Print to file->PNG...** throught the menu bar
2 . Choose the location where you want to save the image
3 . Choose a name for the file
4 . Click on **Save** button

NOTE: This action could also be done by clicking on throught the icon bar. This icon can also be found in the "Page and capture settings" window. In this case the image format is choosen while saving the file in the "Files of type" combobox.

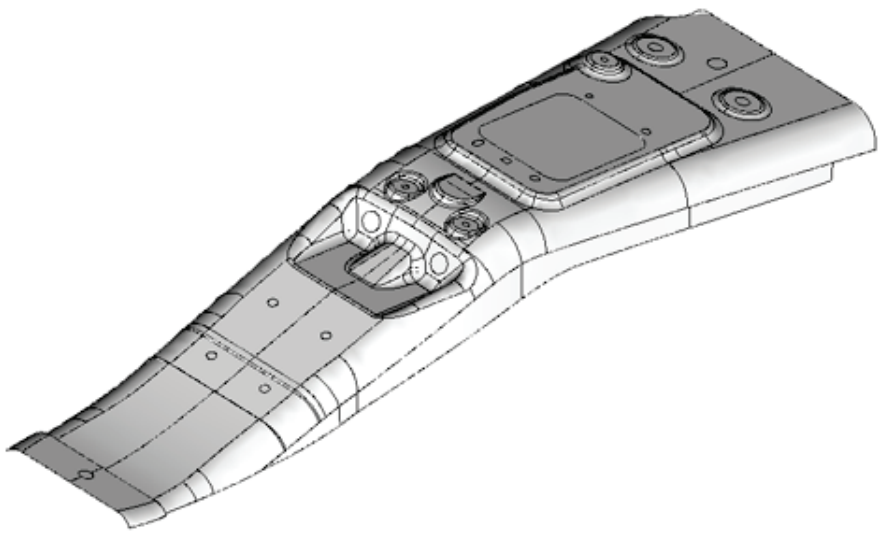
9 CAD CLEANING OPERATIONS

IMPORTING FILES

The objective of this case study is to see how GiD imports files created with other programs. The imported geometry may contain imperfections that must be corrected before generating the mesh.

For this study an IGES formatted geometry representing a stamping die is imported. These steps are followed:

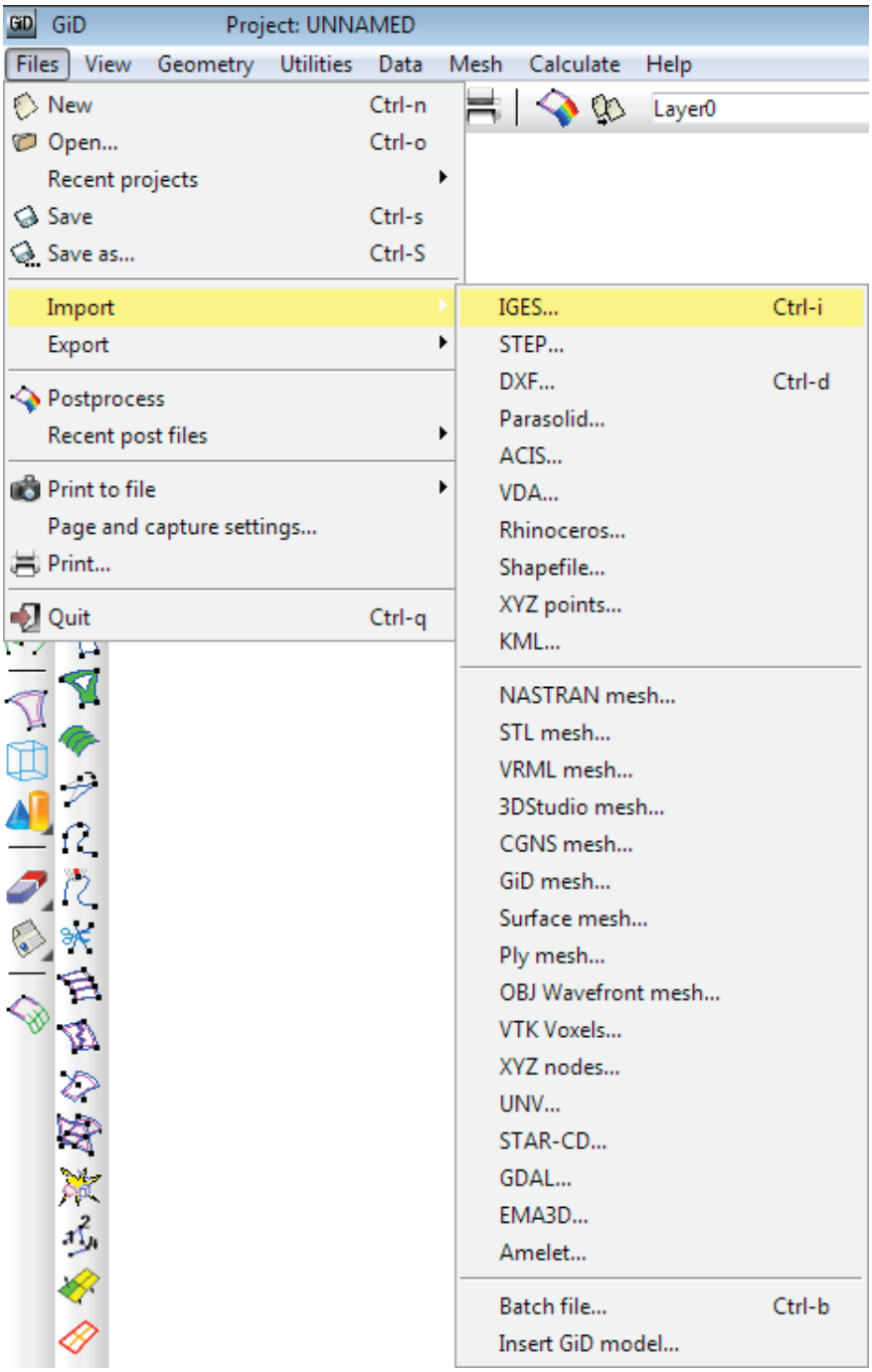
- Importing an IGES-formatted file to GiD
- Correcting errors in the imported geometry and generating the mesh
- Generating a conformal mesh and a non-conformal mesh



Pice provided by courtesy of PSA DEGAD-MAC AIE

9.1 Importing on GiD

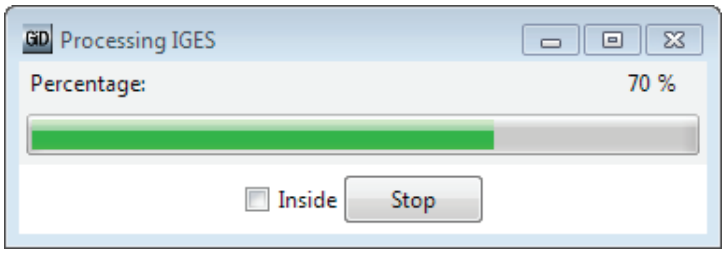
GiD is designed to import a variety of file formats. Among them are standard formats such as IGES, DXF, or VDA, which are generated by most CAD programs. GiD can also import meshes generated by other programs, e.g. in NASTRAN or STL formats.



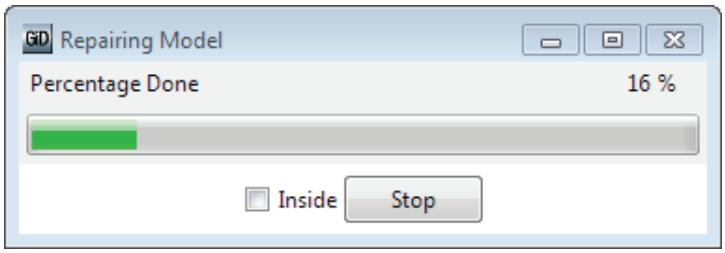
The file importing process is not always error-free. Sometimes the original file has incompatibilities with the format required by GiD. These incompatibilities must be overcome manually. This example deals with various solutions to the difficulties that may arise during the importing process.

9.1.1 Importing an IGES file

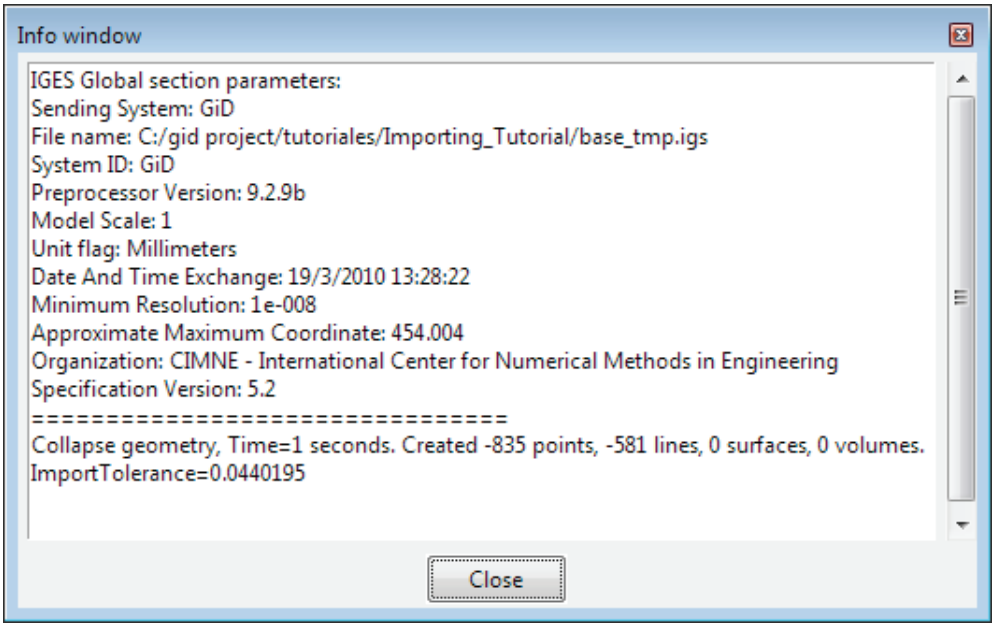
1 . Select **Files->Import->IGES ...**
2 . Select the IGES-formatted file "base.igs" and click **Open**.



Reading the file

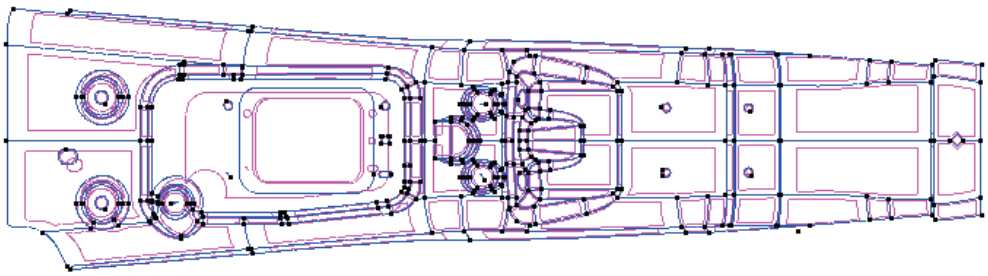


Repairing the model



Importing process information

After the importing process, the IGES file that GiD has imported appears on the screen.

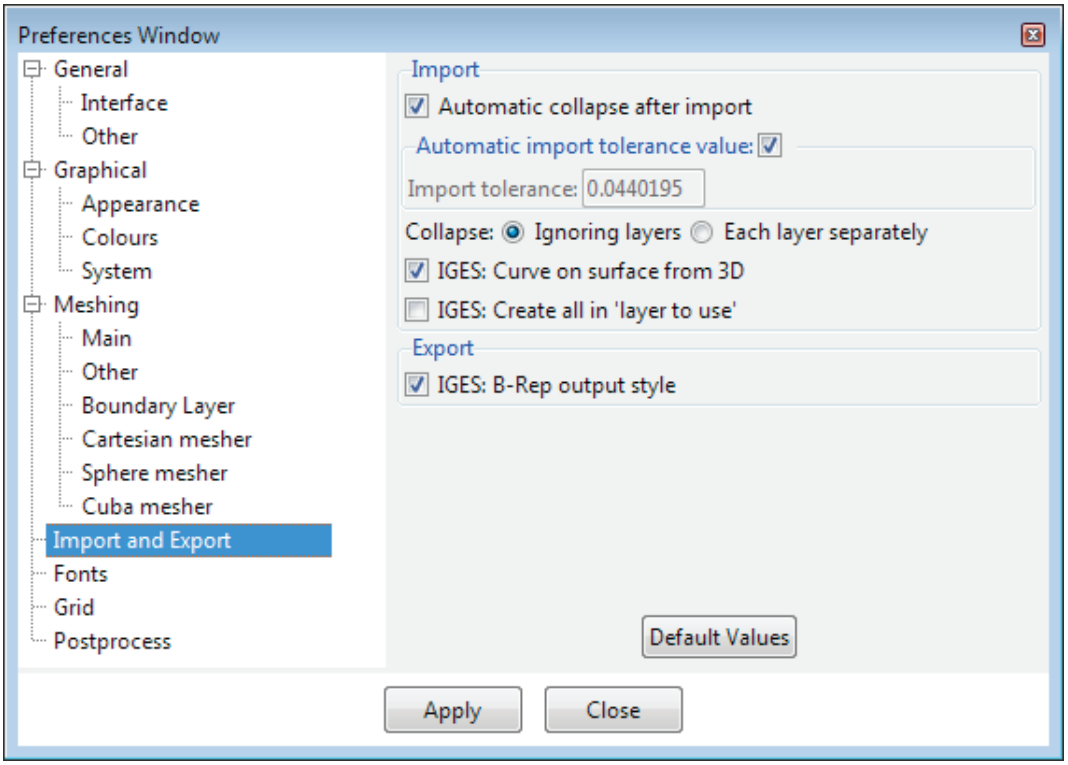


File "base.igs" imported by GiD.

NOTE: One of the operations in the importing process is repairing and collapsing the model. We say that two entities collapse when, the distance between them being less than the **Import Tolerance**, they become one.

The **Import Tolerance** value may be modified by going to the **Utilities** menu, opening **Preferences**, and selecting **Import and Export** from the tree. By default, the **Automatic import tolerance value** is selected. With this option selected, GiD computes an appropriate value for the **Import Tolerance** based on the size of the geometry.

Collapsing the model may also be done manually. This option is found in **Geometry->Edit->Collapse->Model**.



The preferences window

9.2 Correcting errors in the imported geometry

The great diversity of versions, formats, and programs frequently results in differences (errors) between the original and the imported geometry. With GiD these differences might give rise to imperfect meshes or prevent meshing altogether. In this section we will see how to detect errors in the imported geometry and how to correct them.

Importing the same file with different versions of GiD might produce slight variations in the results. For this reason from now we will use a project that contains the original IGES file translated into GiD format.

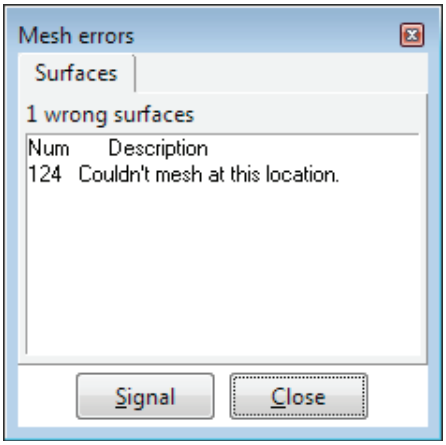
1 . Select **Files->Open...**
2 . If a dialog window appear asking to save changes to the project, click **No**.

9.2.1 Meshing by default

1 . Select **Mesh->Generate Mesh**.

A window comes up in which to enter the maximum element size for the mesh to be generated. Leave the default value provided by GiD unaltered and click **OK**.

When the **GiD** finishes the meshing process, an error message appears. This error is due to a defect in the imported geometry. As the window shows, there have been errors meshing surface number 124.



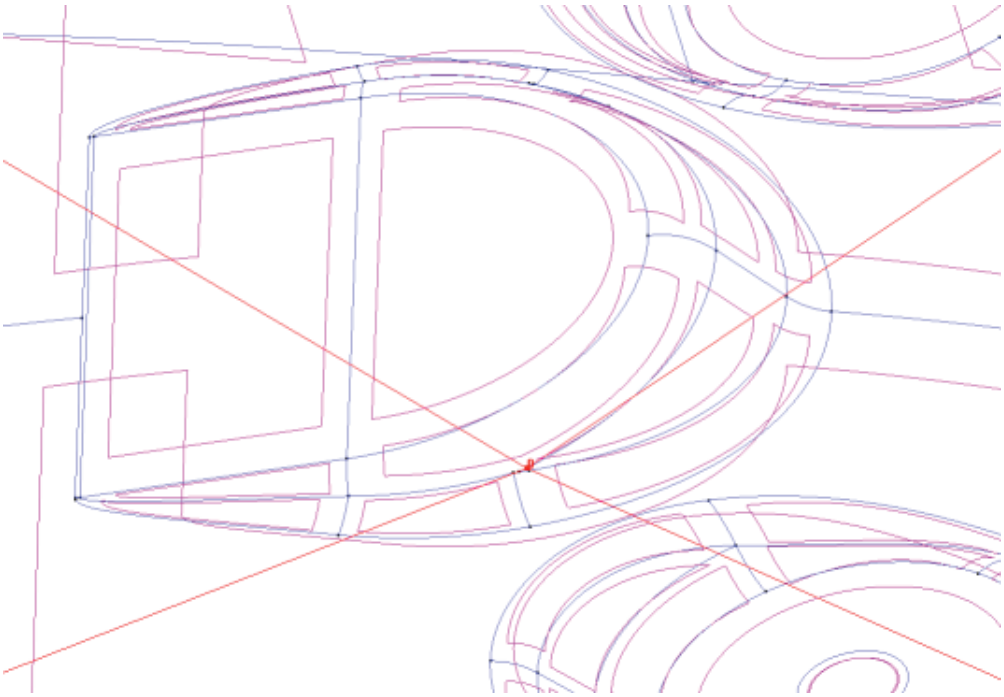
Dialog warning window of meshing errors

In this part of the tutorial we focuson repairing surface number 124.

To locate surface 124, select the line "**124 Couldn't mesh at this location**" in the dialog box and press the **Signal** button (the same effect is obtained by double-clicking over the message with the left mouse button).

NOTE : If user clicks the right button over a message in the Mesh Errors window, three options are displayed: "Signal problematic point", "More help…" or "List…" The first option is the same as the Signal button, while the "List…" option presents a list of the problematic geometrical entities to make selection easier when performing some common procedures (like sending the entities to a separate layer, erasing the entities, etc…). The "More help…" option gives advice about to correct the geometrical model so the mesh can be generated.

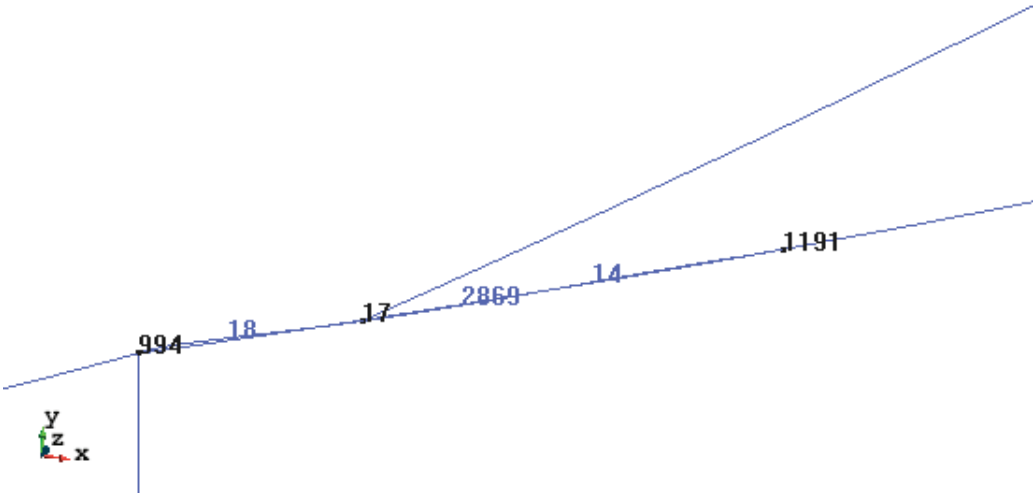
NOTE : *The* **Mesh Errors** *window can be recovered while dealing with the model by selecting the "***Show errors...***" option in the* **Mesh** *menu*.



Signaling surface 124

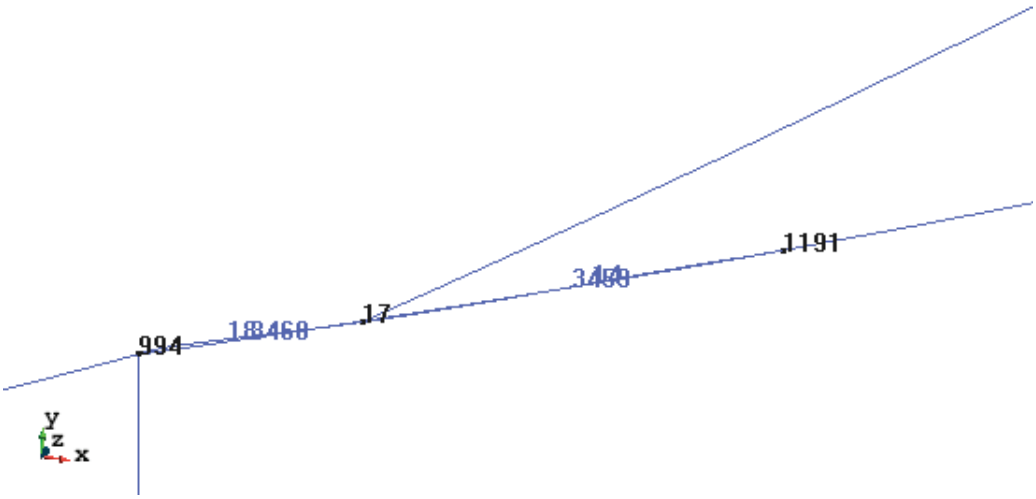
9.2.2 Correcting surfaces

1 . With the **View->Zoom->In** option in the menu or **Zoom->In** on the mouse menu, magnify the zone around surface 124.



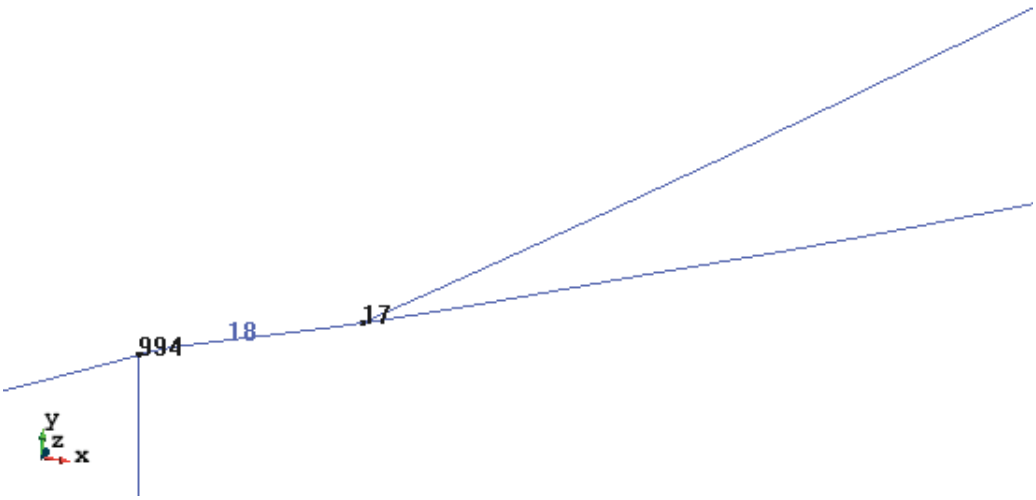
An enlargement of the zone around surface 124

2 . Several line segments are superimposed over each other, thus creating an incorrect surface boundary. Select **Geometry->Edit->Divide->Lines->Near point** and then select point 17 (to select it, go to **Contextual** in the mouse menu, then select the option **Join Ctrl-a**). Point 17 is the point at which to make the cut.



The zone after cutting line 2869 at point 17

3 . Now that the lines are precisely connected, a local collapse may be executed. Select **Geometry->Edit->Collapse->Lines**. Then select the lines that appear on the screen and press **ESC**.



The situation after collapsing the lines

4 . After the collapse, the surface boundary is correct and the surface may be drawn with the new boundary. The labels are no longer needed, so click **Label->Off** in the mouse menu.

5 . Select **Geometry->Create->NURBS surface->Trimmed**. Select surface 124. Then select the lines defining the recently repaired boundary. Press **ESC** twice.

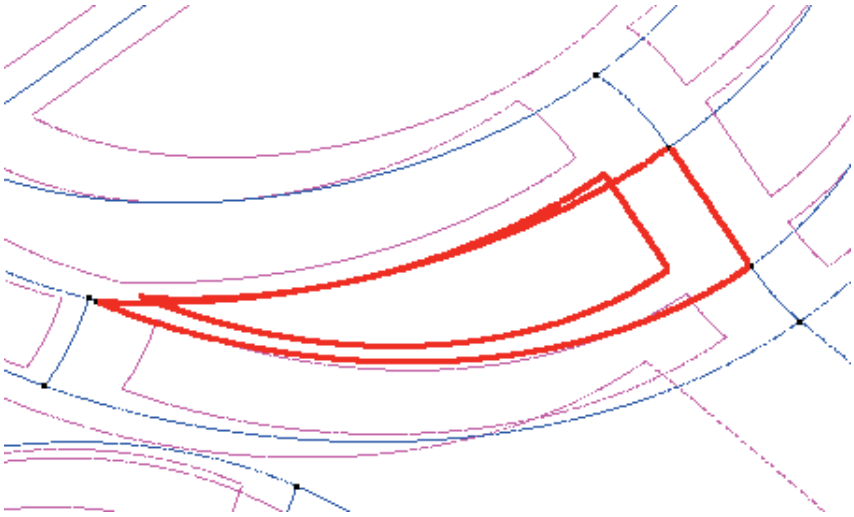


Figure 11. Surface 123 with its new boundary.

6 . Select **Geometry->Delete->Surfaces**. Select surface 124 and press **ESC**.

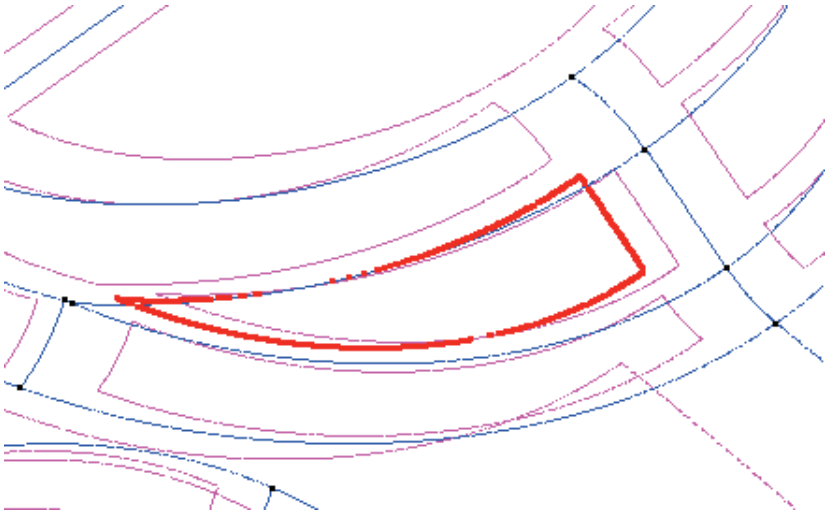
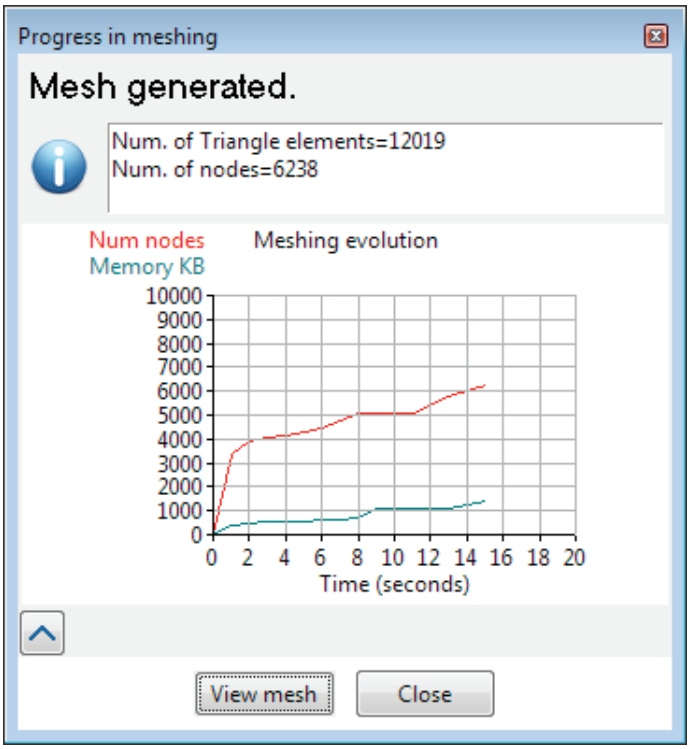


Figure 12. The surface to be eliminated.

7 . To begin the second example in this section, mesh the geometry again with **Mesh->Generate Mesh**.

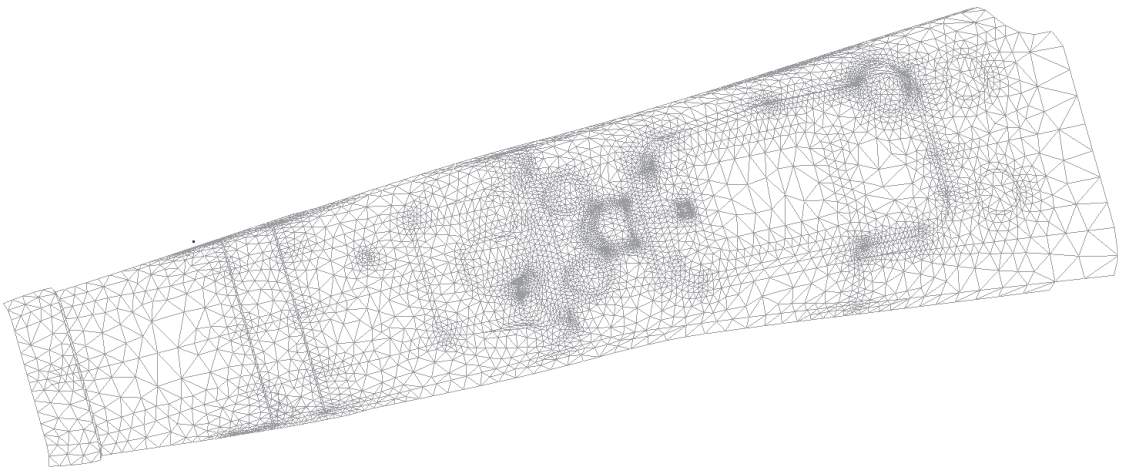
8 . A window comes up in which to enter the maximum element size for the mesh to be generated. Leave the default value provided by GiD and click **OK**.

The mesh generating process may be carried out with no further errors found.



indow with information about the generated mesh

9 . The imported piece is now meshed.



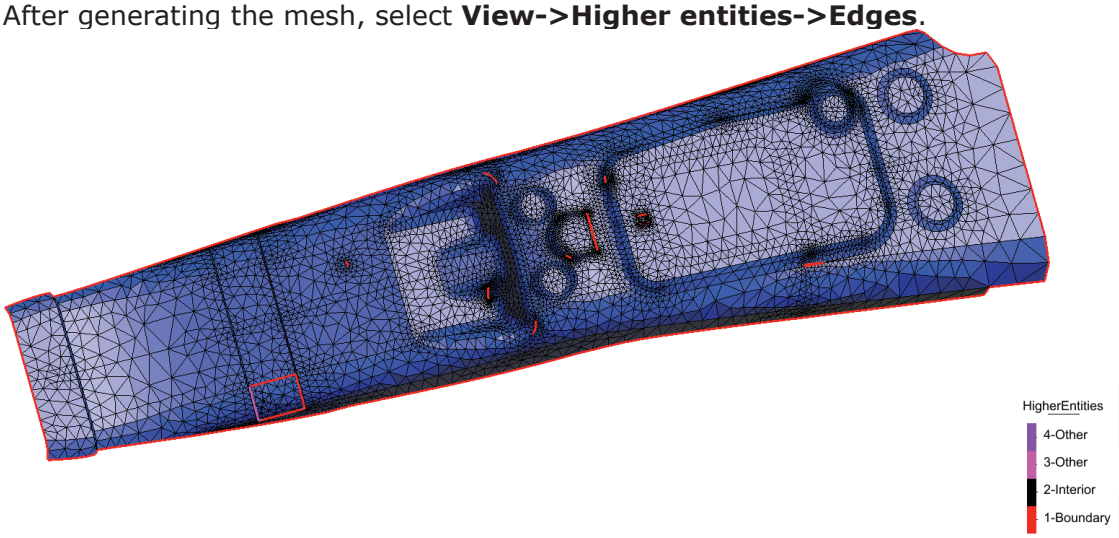
The mesh of the imported geometry

9.3 The conformal mesh and the non-conformal mesh

In the previous section, after correcting some errors, we were able to mesh the imported geometry, thus obtaining a non-conformal mesh. A conformal mesh is one in which the elements share nodes and sides. To achieve this condition, contiguous surfaces (of the piece) must share lines and points of the mesh. Most calculating modules require conformal meshes; however, some modules accept non-conformal meshes. A non-conformal mesh normally requires less computation time since it generates fewer elements.

9.3.1 Global collapse of the model

1 . After generating the mesh, select **View->Higher entities->Edges**.



The higher edges visualization

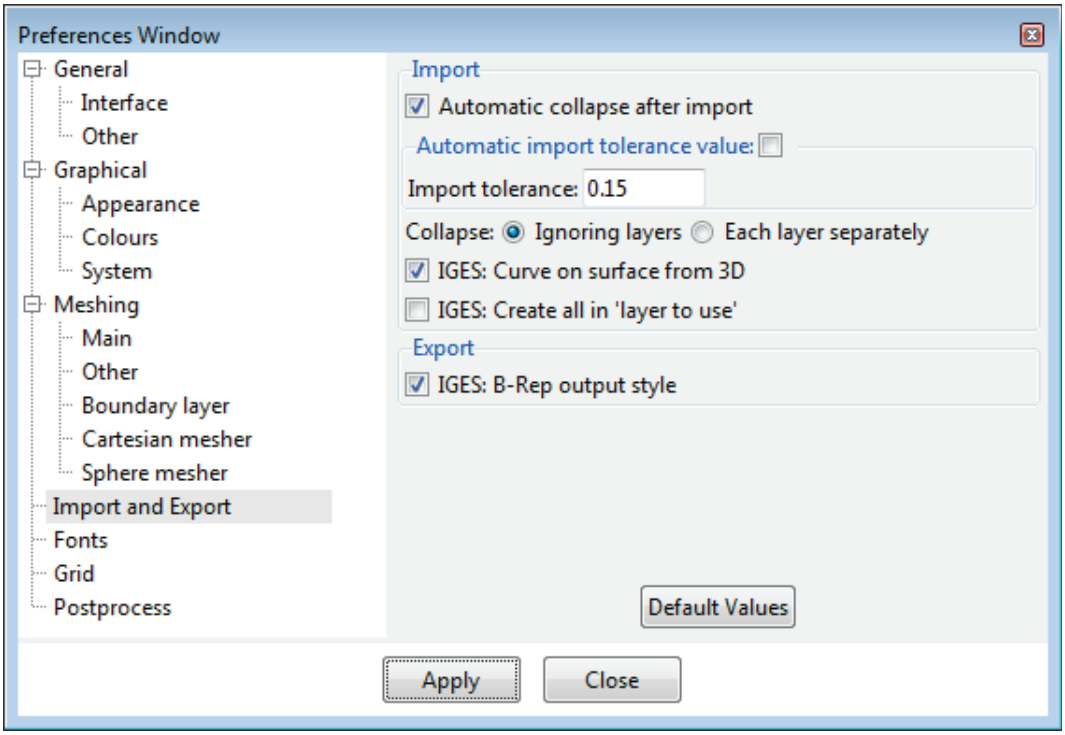
2 . Visualization of higer entities of edges shows that in the interior of the piece some surfaces are isolated.

3 . Press **ESC** to finish higer entities visualization.

4 . To generate a conformal mesh, first execute a global collapse of the model.

5 . The GiD collapse depends upon the **Import tolerance**. Two entities are collapsed (converted into one) when they are separated by a distance less than the **Import tolerance** parameter. To test this, enter a new value for the **Import tolerance** parameter.

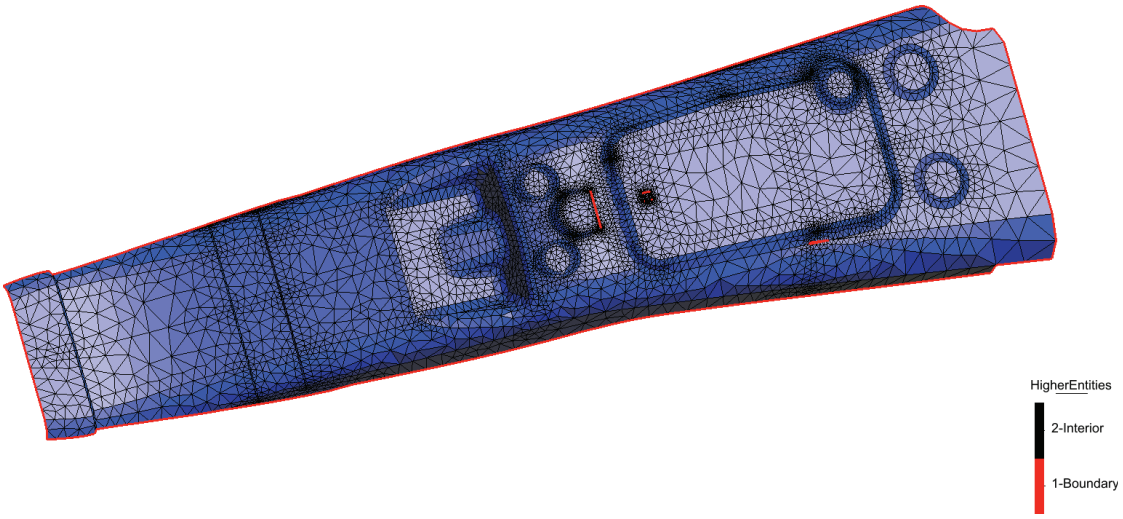
6 . Go to **Utilities->Preferences**, and select **Import and Export** branch. Uncheck the **Automatic import tolerance value** and enter 0.15 for the **Import tolerance value**. Click **Apply**.



The preferences window

7 . Select **Geometry->Edit->Collapse->Model**.
8 . A dialog window appears to confirm the seletion. Click **Ok**.
9 . Select **Mesh->Generate**. Erase the old mesh and use the default element size.
10 . Visualize the results with **View->Higher entities->Edges**.

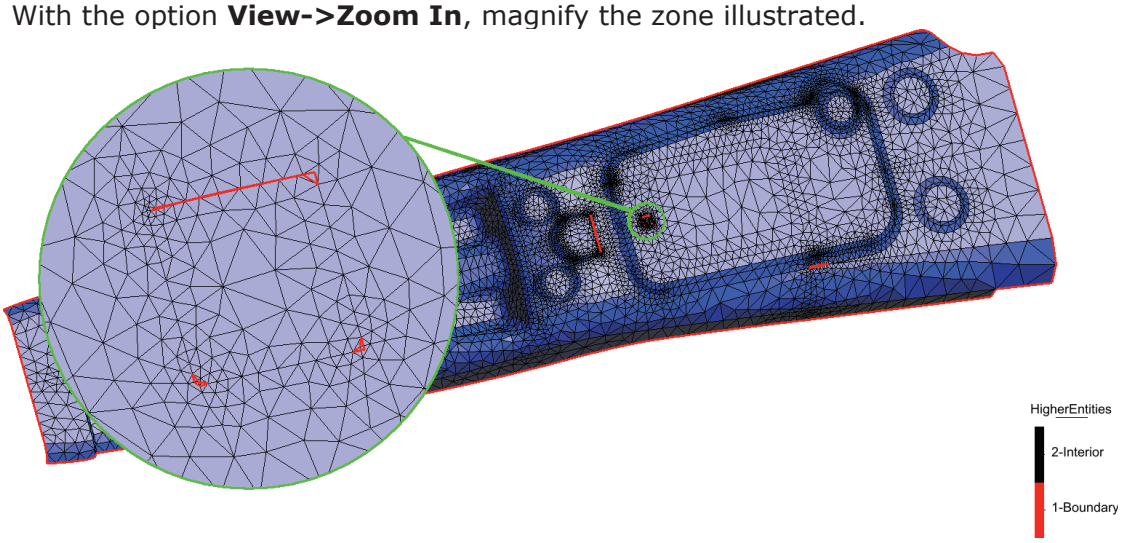
Some of the contiguous surfaces in the interior of the model have now being joined. However, there are still some surfaces that prevent the mesh from being completely conformal. These surfaces must be modified manually.



Higher edges after collapsing

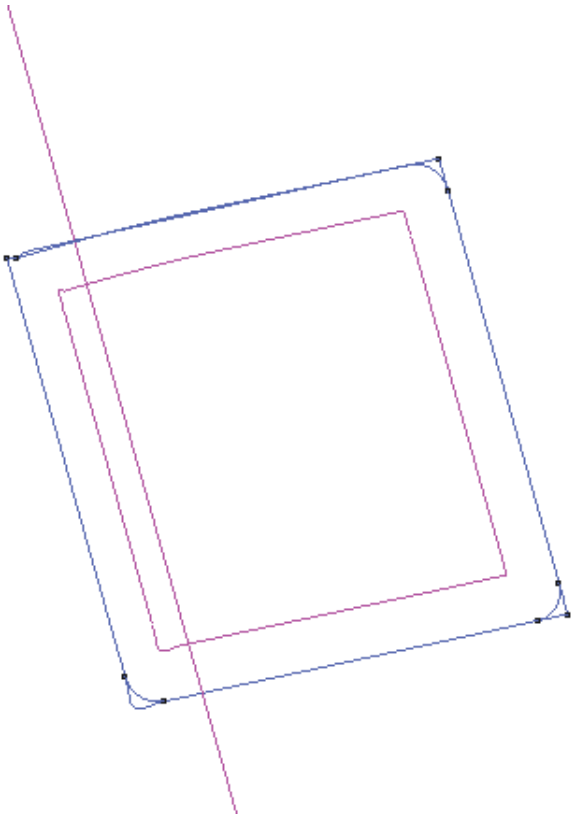
9.3.2 Correcting surfaces and creating a conformal mesh

1 . With the option **View->Zoom In**, magnify the zone illustrated.



Zone in the mesh to zoom in.

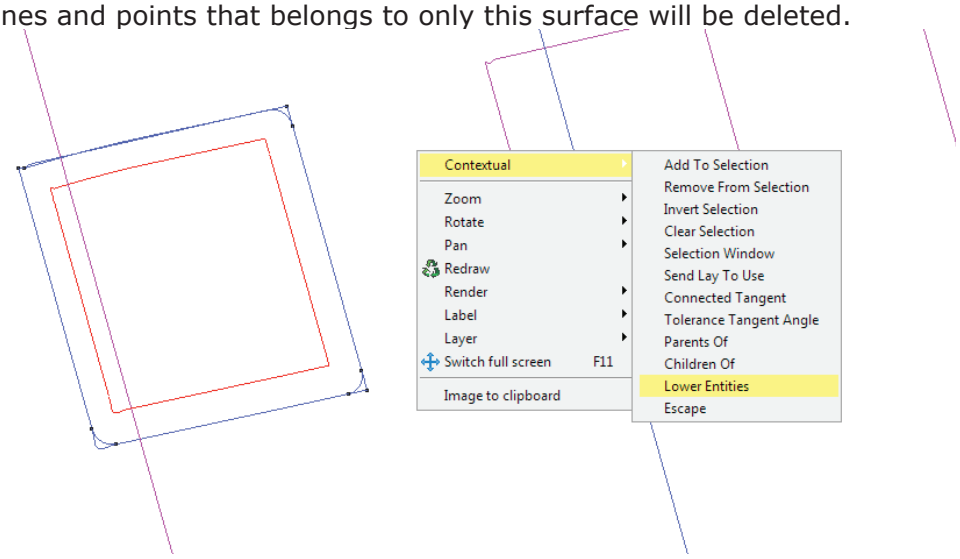
2 . Select **View->Mode->Geometry** to visualize the geometry of the piece.



The zone in geometry mode

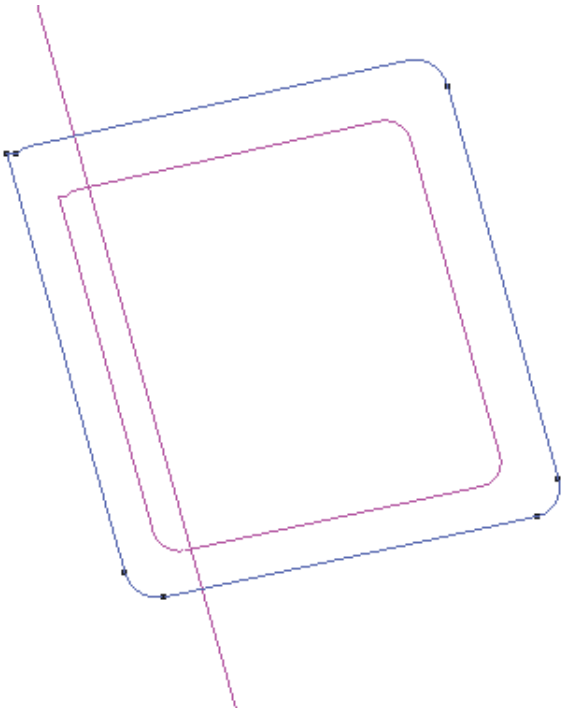
There is a rectangular surface that does not fit within the boundaries of a rounded-corner surface (a hole, in this case). We will suppose that the problematic surface is planar. This way, it can be erased and recreated in order to fit the rounded-corner boundary.

3 . Select **Geometry->Delete->Surfaces**. Select the problematic surface, but before pressing **ESC**. Go to **Contextual** menu and select **Lower Entities.** With this option, the surface and lines and points that belongs to only this surface will be deleted.



Deleting surface and its lines and points

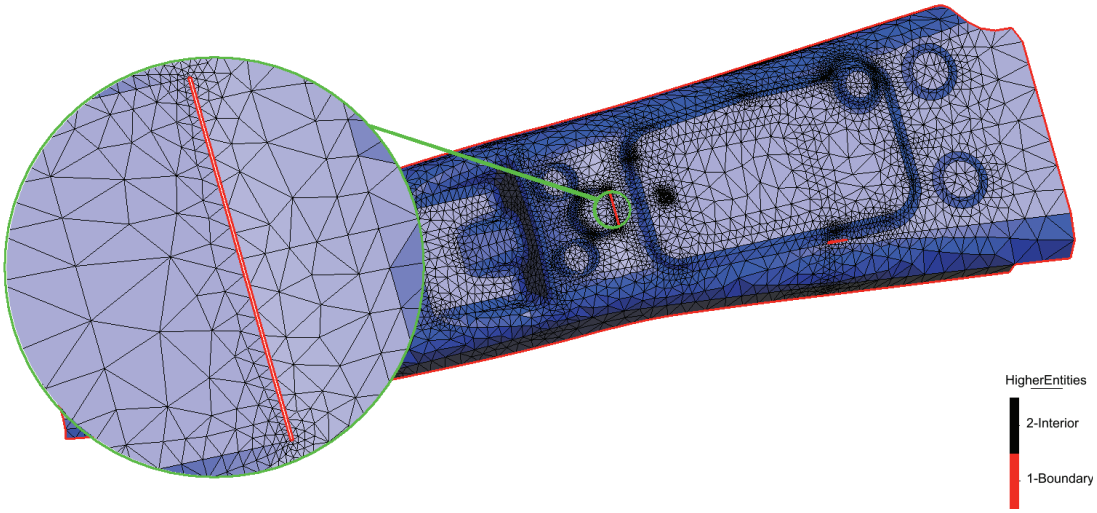
4 . With **Geometry->Create->NURBS surface->By contour** create a new surface. Select the lines defining the contourand press ESC.



result surface

5 . Visualize the mesh again **View->Mode->Mesh** You will see the previous mesh, the mesh its not recomputed. If you want to see the results of the first correction, the mesh must be regenerated with **Mesh->Generate mesh**.

6 . Use **View->Higer entities->Edges** on mesh mode, and magnify the zone indicated.

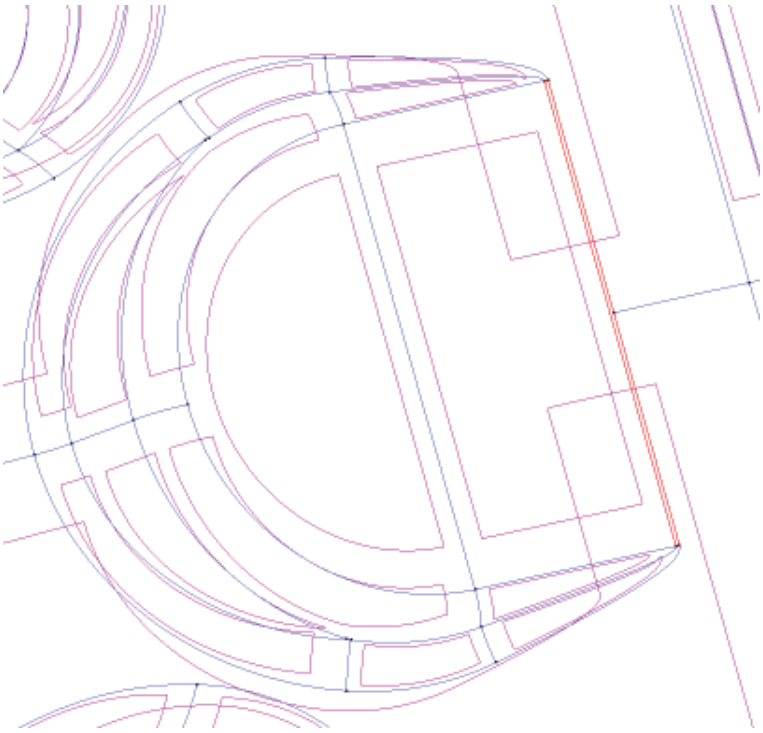


Second part to repair

7 . Select **View->Mode->Geometry**.

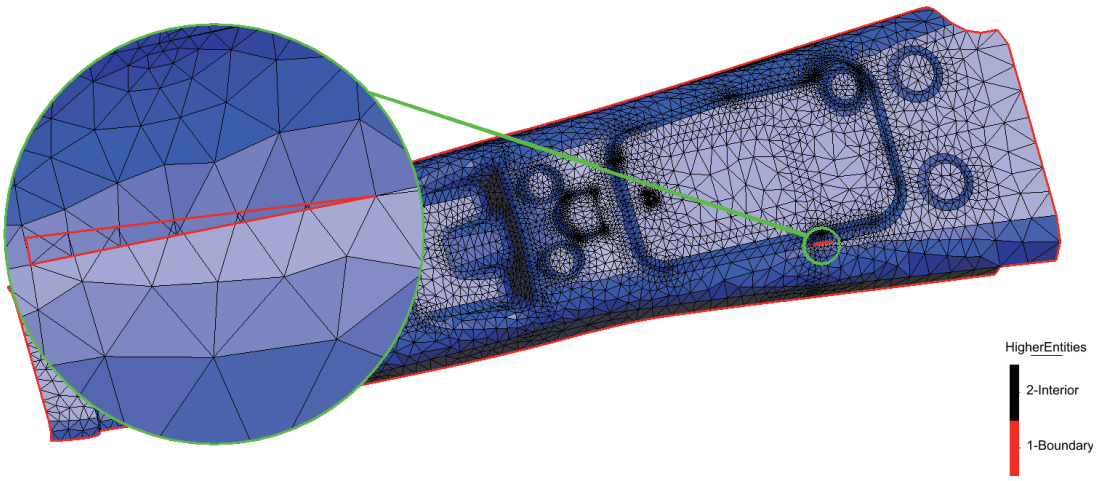
In this example, the situation involves a contour of four lines that does not correspond to any real surface (of the piece). These lines were too far apart to be collapsed.

8 . Select **Geometry->Create->NURBS surface->By contour**. Select the lines. Press **ESC** twice.



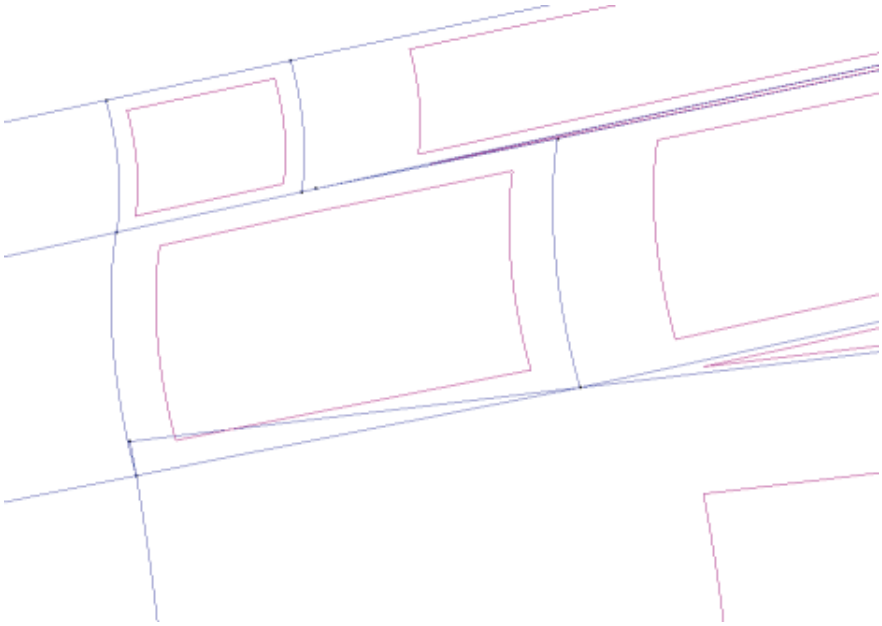
Contour lines that define the surface

9 . Visualize again higer entities **View->Higer entities->Edges** and magnify the zone indicated.



10 . Select **View->Mode->Geometry**.

There are two surfaces that overlap each other at one end.

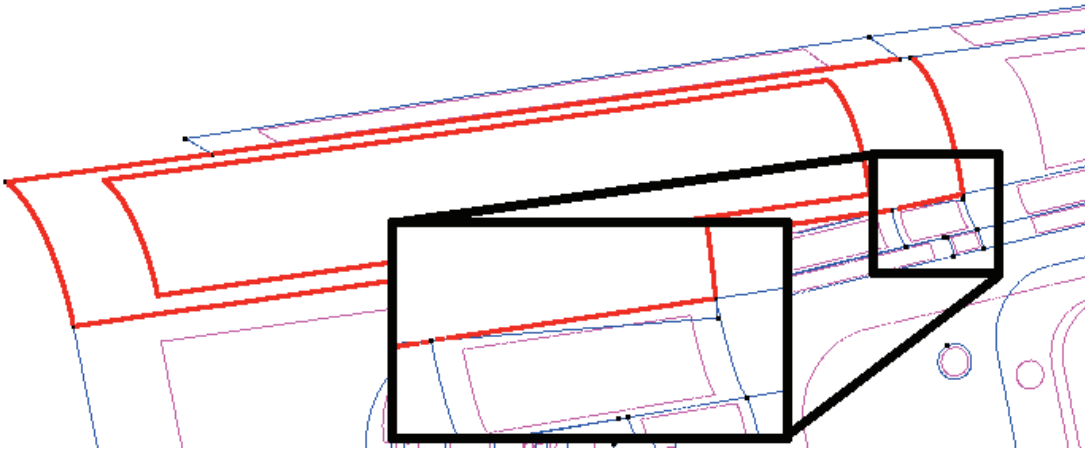


The magnified zone with two overlapping surfaces.

In this case the best solution for correcting the boundary is to trim the overlap.

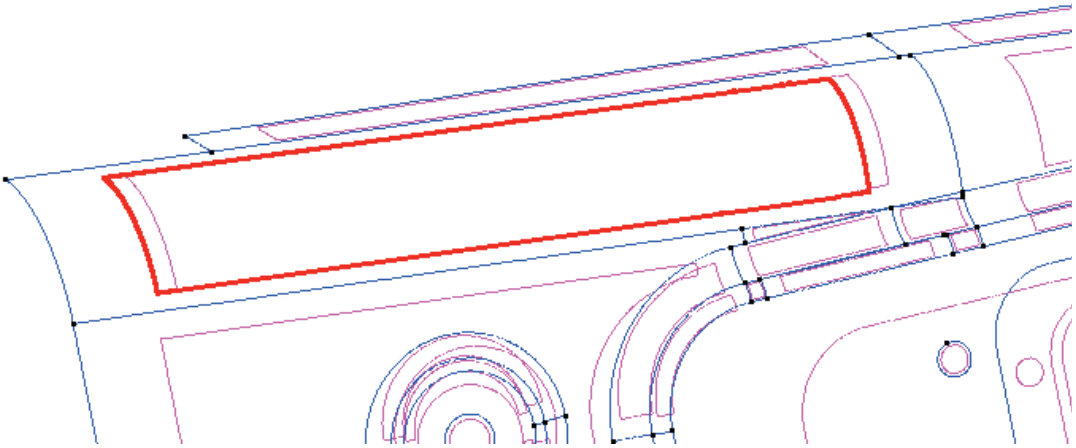
11 . Select **Geometry->Create->NURBS surface->Trimmed**.

12 . Select the surface to be trimmed. Then select the new boundary.



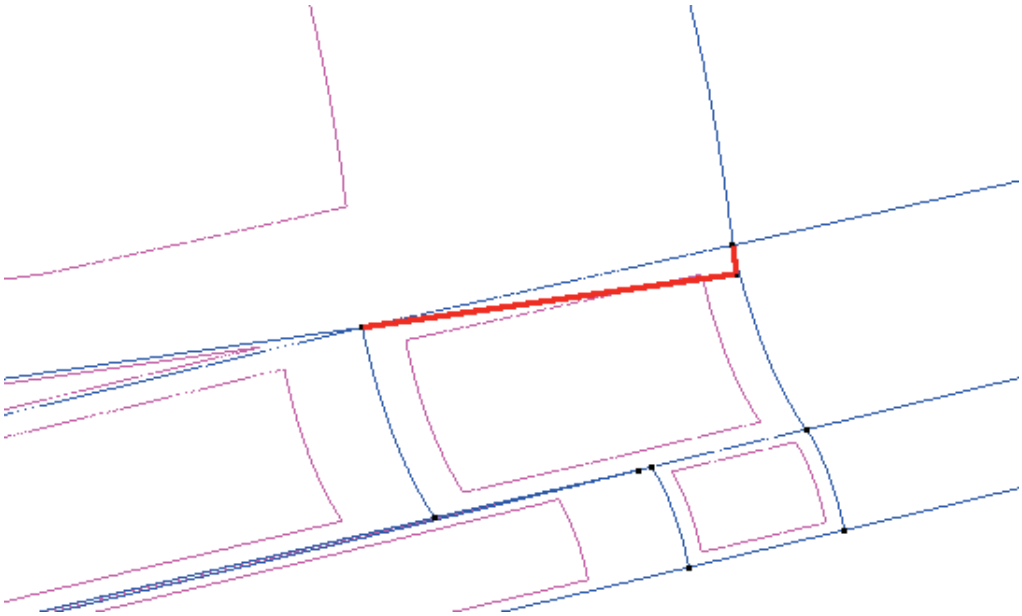
The surface to be trimmed and the new boundary.

13 . Select **Geometry->Delete->Surfaces**. Select the original surface. Press **ESC** twice.



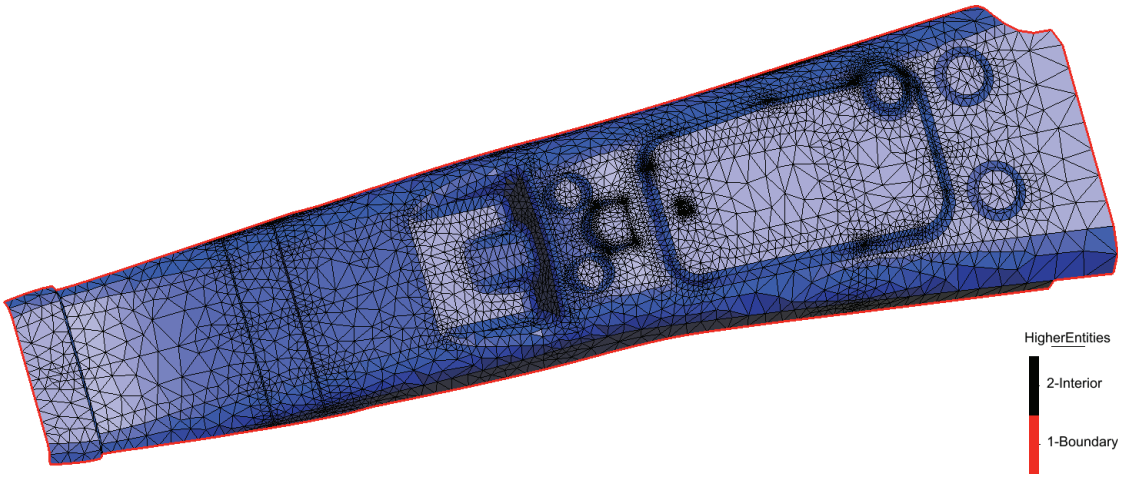
The original surface to be deleted.

14 . Use **Geometry->Delete->Lines** , and after delete the points with **Geometry->Delete->Points** to select the lines and points that belong to the surface that has been trimmed and which no longer belong to any surface. In this case, all the visible lines and ponints may be selected since the program will only eliminate those which do not have entities covering them.



Lines and point that no longer belong to any surface.

15 . Select **Mesh->Generate mesh**. Then visualize the result using the option **View->Higer entities->Edges**.



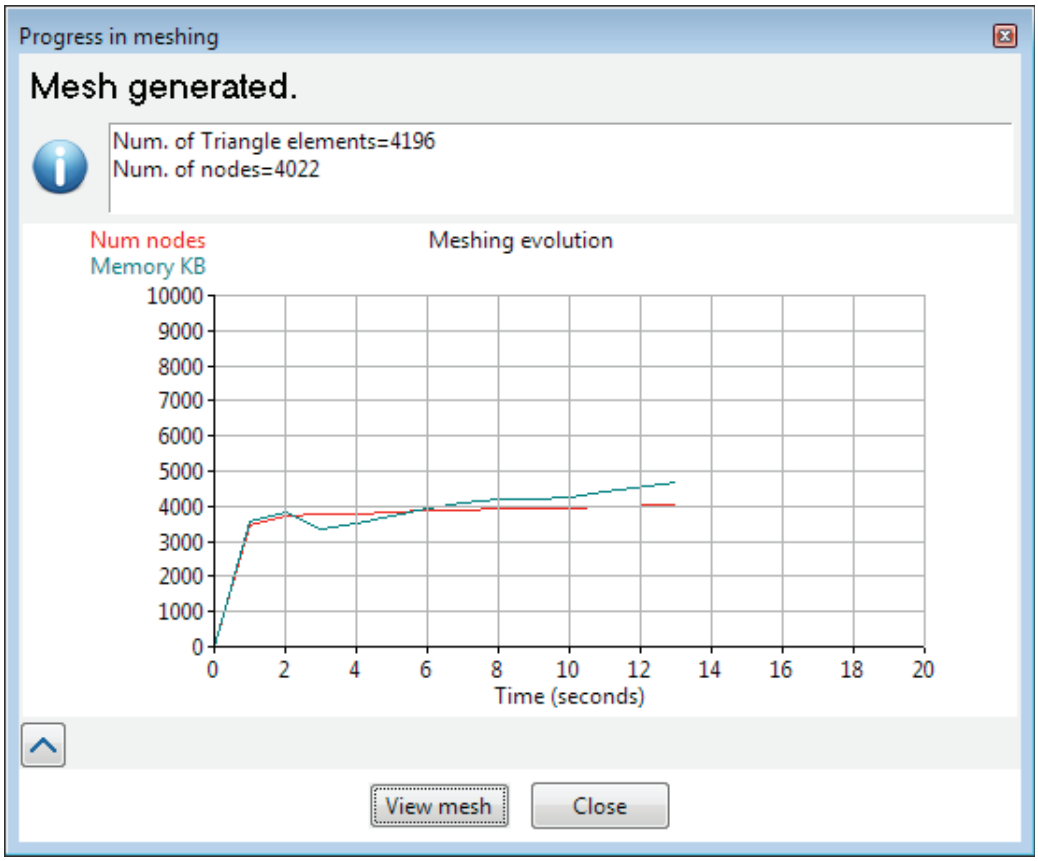
Higher entities of the result model

A conformal mesh has been achieved, all edges are interior, higer entitie 2, except the ones on the boundary with higer entitie 1.

9.3.3 Creating a non-conformal mesh

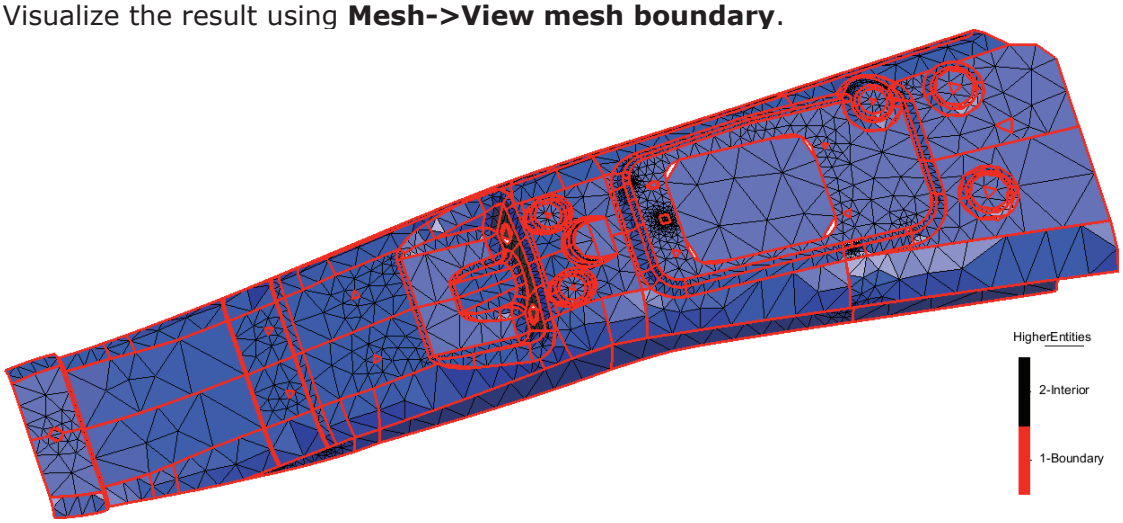
NOTE: Non-conformal meshes may be used with some calculating modules, i.e. stamping a plate. Using non-conformal meshes significantly reduces the number of elements in the mesh. This cuts down on computation time.

1 . Select **View->Mode->Geometry**.
2 . Select **Geometry->Edit->Uncollapse->Surfaces**. Select all the surfaces in the model. Press **ESC**. A sufficient number of lines is created so that no surface (of the object) shares lines with any contiguous surface.
3 . Select **Mesh->Generate Mesh**. When the mesh has been generated, a window appears with information about the mesh (Figure 29). The result is a non-conformal mesh composed of far fewer elements than the meshes generated in the previous section: about 4000 elements instead of the 10.000 needed to generate the conformal mesh.



Information about the generated mesh after uncollapse

4 . Visualize the result using **Mesh->View mesh boundary**.



edges higer entities after uncollapse

10 DEFINING A PROBLEM TYPE

This tutorial takes you through the steps involved in defining a problem type using GiD. A problem type is a set of files configured by a solver developer so that the program can prepare data to be analyzed.

A simple example has been chosen which takes us through all the associated configuration files while using few lines of code. Particular emphasis is given to the calculation of the centers of mass for two-dimensional surfaces a simple formulation both conceptually and numerically.

- The tutorial is composed of the following steps:
- Starting the 'problemtype'
- Creating the materials definition file
- Creating the general configurations file
- Creating the conditions definition file
- Creating the data format file
- Creating the calculating program file and the execution files
- Executing the calculating module and visualizing the results using GiD

By the end of the example, you should be able to create a calculating module that will interpret the mesh generated in GiD Preprocess. The module will calculate values for each element of the mesh and store the values in a file in such a way as they can be read by GiD Post-process.

10.1 Introduction

Our aim is to solve a problem that involves calculating the center of gravity (center of mass) of a 2D object. To do this, we need to develop a calculating module that can interact with GiD.

The problem: calculate the center of mass.

The center of mass (X_{CM},Y_{CM}) of a two-dimensional body is defined as

$$x_{CM} = \frac{\int_S \rho \; x \; x \; y + \sum_{i=1}^{N} m_i \; x_i}{\int_S \rho \; x \; y + \sum_{i=1}^{N} m_i} \qquad y_{CM} = \frac{\int_S \rho \; y \; x \; y + \sum_{i=1}^{N} m_i \; y_i}{\int_S \rho \; x \; y + \sum_{i=1}^{N} m_i}$$

where ρ(x,y) is the density of the material at point (x,y) and S is the surface of the body; mi are concentrated masses applied on the point (x_i,y_i).

To solve the problem numerically, the integrals will be transformed into sums:

$$x_{CM} = \frac{\rho_{clm} V_{clm} x_{clm} + \sum_{i=1}^{N} m_i x_i}{\rho_{clm} V_{clm} + \sum_{i=1}^{N} m_i} \qquad y_{CM} = \frac{\rho_{clm} V_{clm} y_{clm} + \sum_{i=1}^{N} m_i y_i}{\rho_{clm} V_{clm} + \sum_{i=1}^{N} m_i}$$

Each of the N elements is treated as concentrated weight whose mass is defined as the product of the (surface) density and the area of the element.

10.1.1 Interaction of GiD with the calculating module

GiD Preprocess makes a discretization of the object under study and generates a mesh of elements, each one of which is assigned a material and some conditions. This preprocessing information in GiD (mesh, materials, and conditions) enables the calculating module to generate results. For the present example, the calculating module will find the distance of each element relative to the center of mass of the object.

Finally, the results generated by the calculating module will be read and visualized in GiD Post-process.

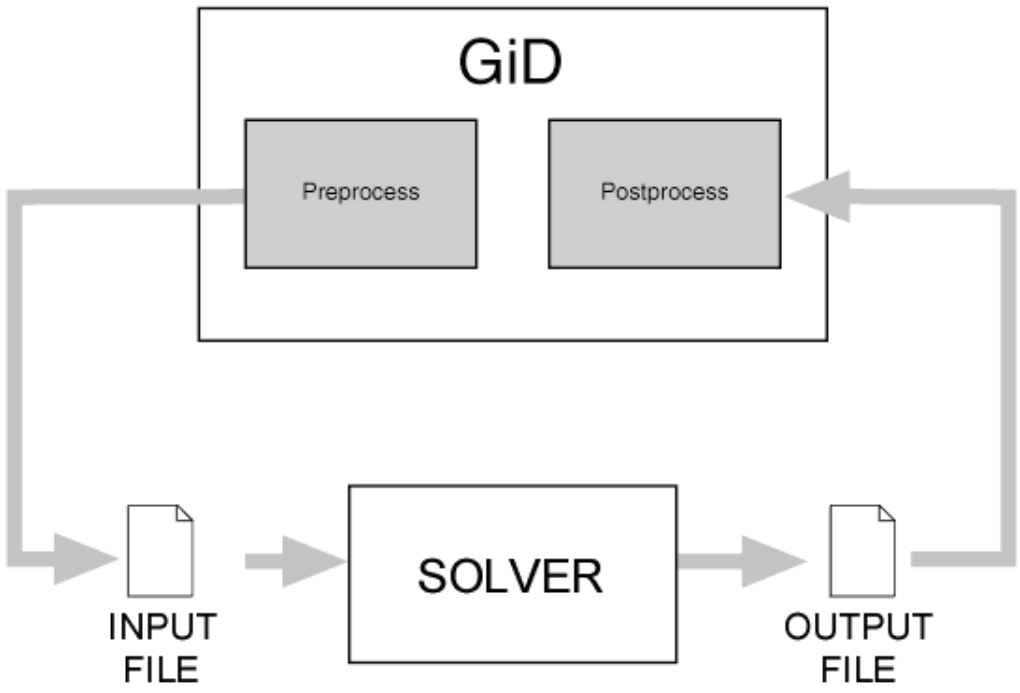


Diagram of the workflow

GiD must adapt these data to deal with them. Materials, boundary and/or load conditions, and general problem data must be defined.

GiD configuration is accomplished through text formatted files. The following files are required:

.prb: configuration of the general parameter (not associated to entities)

.mat: configuration of materials and their properties

.cnd: configuration of the conditions imposed on the calculation

.bas: (template file) the file for configuring the format of the interchange file that mediates between GiD data and the calculating module. The file for interchanging the data exported by GiD has the extension .dat. This file stores the geometric and physical data of the problem.

.bat: the file that can be executed called from GiD. This file initiates the calculating module.

The calculating module (in this example cmas2d.exe) solves the equations in the problem and saves the results in the results file. This module may be programmed in the language of your choice, 'C' in used in this example

GiD Post-process reads the following files generated by the calculating module:

project_name.post.res: results file.

Each element of the mesh corresponds to a value.

project_name.post.msh: file containing the post-process mesh. If this file does not exist, GiD uses the preprocess mesh also for postprocess.

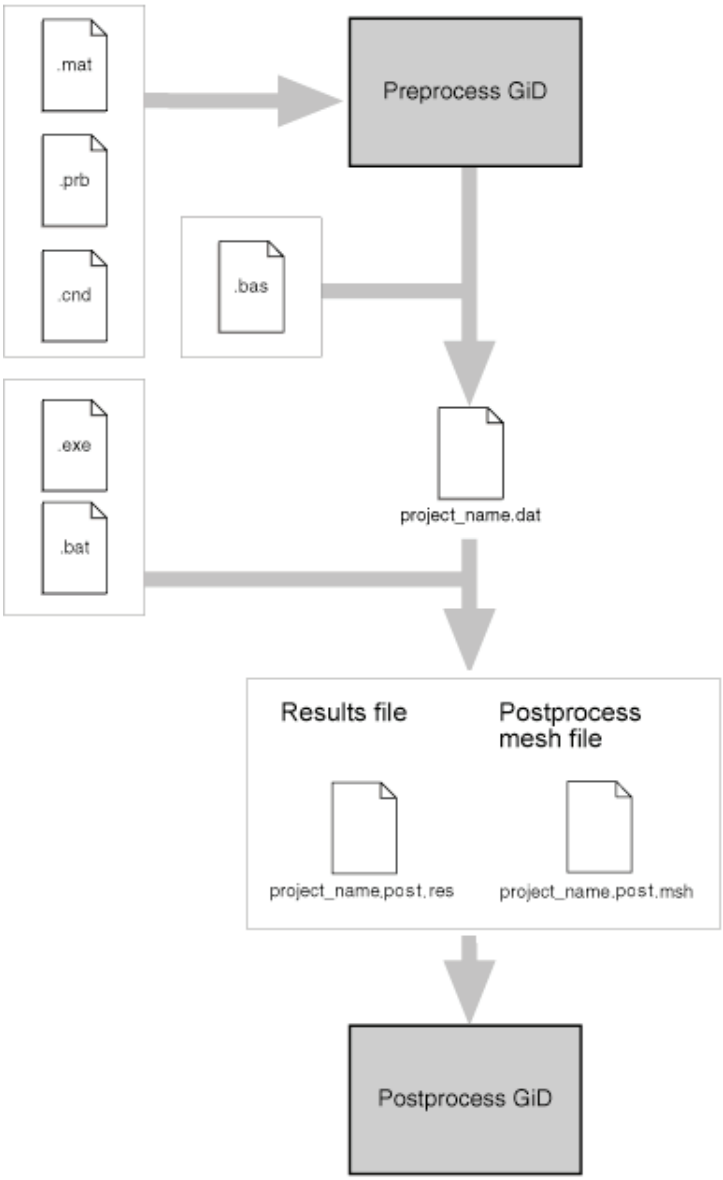


Diagram depicting the files system

10.2 Implementation

Creating the Subdirectory for the Problem Type

Create the subdirectory "cmas2d.gid". This subdirectory has a .gid extension and will contain all the configuration files and calculating module files (.prb, .mat, .cnd, .bas, .bat, .exe).

NOTE: If you want the problem type to appear in the GiD **Data->Problem type** menu, create the subdirectory within "problemtypes", located in the GiD installation folder, for example C:\GiD\Problemtypes\cmas2d.gid

10.2.1 Creating the Materials File

Create the materials file "cmas2d.mat". This file stores the physical properties of the material under study for the problem type. In this case, defining the density will be enough.

Enter the materials in the "cmas2d.mat" file using the following format:

MATERIAL: Name of the material (without spaces)

QUESTION: Property of the material. For this example, we are interested in the density of the material.

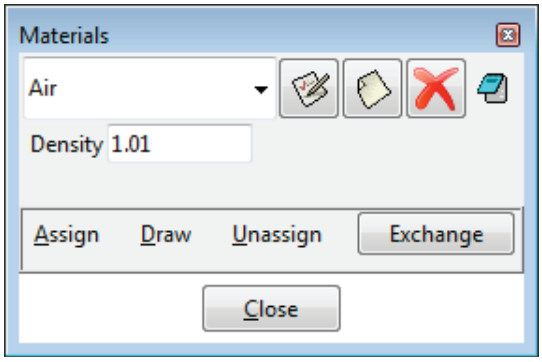
VALUE: Value of the property

HELP: A help text (optional field)

…

END MATERIAL

In GiD, the information in "cmas2d.mat" file is managed in the materials window, located in **Data->Materials**.



The GiD Materials window, for assigning materials

MATERIAL: Air

QUESTION: Density

VALUE: 1.01

HELP: material density

END MATERIAL

MATERIAL: Steel

QUESTION: Density

VALUE: 7850

HELP: material density

END MATERIAL

MATERIAL: Aluminium

QUESTION: Density

VALUE: 2650

HELP: material density

END MATERIAL

10.2.2 Creating the General File

Create the "cmas2d.prb" file. This file contains general information for the calculating module, such as the units system for the problem, or the type of resolution algorithm chosen.

Enter the parameters of the general conditions in "cmas2d.prb" using the following format:

PROBLEM DATA

QUESTION: Name of the parameter. If the name is followed by the #CB# instruction, the parameter is displayed as a combo box. The options in the menu must then be entered between parentheses and separated by commas.

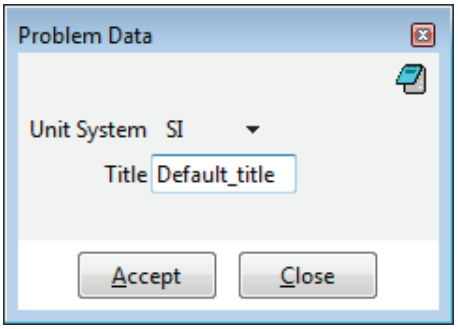
For example, Unit_System#CB#(SI,CGS,User).

VALUE: The default value of the parameter.

…

END GENERAL DATA

In GiD, the information in the "cmas2d.prb" file is managed in the problem data window, which is located in **Data->Problem Data**.



The GiD Problem Data window, for configuring of the general conditions of the cmas2d module

```
PROBLEM DATA
QUESTION: Unit_System#CB#(SI,CGS,User)
VALUE: SI
QUESTION: Title
VALUE: Default_title
END GENERAL DATA
```

10.2.3 Creating the Conditions File

Create the "cmas2d.cnd" file, which specifies the boundary and/or load conditions of the problem type in question. In the present case, this file is where the concentrated weights on specific points of the geometry are indicated.

Enter the boundary conditions using the following format:

CONDITION: Name of the condition

CONDTYPE: Type of entity which the condition is to be applied to. This includes the parameters "over points", "over lines", "over surfaces", "over volumes" or "over layers". In this example the condition is applied "over points".

CONDMESHTYPE: Type of entity of the mesh where the condition is to be applied. The possible parameters are "over nodes", "over body elements" or "over face elements". In this example, the condition is applied on nodes.

QUESTION: Name of the parameter of the condition

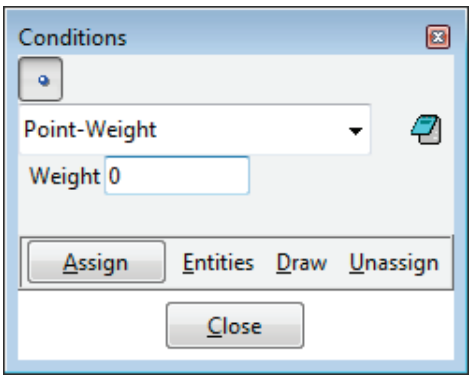
VALUE: Default value of the parameter

…

END CONDITION

…

In GiD, the information in the "cmas2d.cnd" file is managed in the conditions window, which is found in **Data->Conditions**.



The GiD Conditions window, for assigning the cmas2d boundary and load conditions

```
CONDITION: Point-Weight

CONDTYPE: over points

CONDMESHTYPE: over nodes

QUESTION: Weight

VALUE: 0.0

HELP: Concentrated mass

END CONDITION
```

10.2.4 Creating the Data Format File (Template file)

Create the "cmas2d.bas" file. This file will define the format of the .dat text file created by GiD. It will store the geometric and physical data of the problem. The .dat file will be the input to the calculating module.

NOTE: It is not necessary to have all the information registered in only one .bas file. Each .bas file has a corresponding .dat file.

Write the "cmas2d.bas" file as follows:

The format of the .bas file is based on commands. Text not preceded by an asterisk is reproduced exactly the same in the .dat file created by GiD. A text preceded by an asterisk is interpreted as a command.

Example:

.bas file

```
%%%% Problem Size %%%%
Number of Elements & Nodes:
*nelem *npoin
```

.dat file

```
%%%% Problem Size %%%%
Number of Elements & Nodes:
5379 4678
```

The contents of the "cmas2d.bas" file must be the following:

.bas file

```
=================================================================
General Data File
=================================================================
Title: *GenData(Title)
%%%%%%%%%%%%%%%%%% Problem Size %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Number of Elements & Nodes:
*nelem *npoin
```

In this first part of "cmas2d.bas" file, general information on the project is obtained.

***nelem:** returns the total number of elements of the mesh.

***npoin:** returns the total number of nodes of the mesh.

```
Coordinates:
Node X Y
*loop nodes
*format "%5i%14.5e%14.5e"
*NodesNum *NodesCoord(1,real) *NodesCoord(2,real)
*end nodes
```

This command provides a rundown of all the nodes of the mesh, listing their identifiers and coordinates.

***loop, *end:** commands used to indicate the beginning and the end of the loop. The command ***loop** receives a parameter.

***loop nodes:** the loop iterates on nodes

***loop elems:** the loop iterates on elements

***loop materials:** the loop iterates on assigned materials

***format:** the command to define the printing format. This command must be followed by a numerical format expressed in C syntax.

***NodesNum:** returns the identifier of the present node

***NodesCoord:** returns the coordinates of the present node

***NodesCoord (n, real):** returns the x, y or z coordinate in terms of the value n:

n=1 returns the **x** coordinate

n=2 returns the **y** coordinate

n=3 returns the **z** coordinate

```
Connectivities:
Element Node(1) Node(2) Node(3) Material
*set elems(all)
*loop elems
*format "%10i%10i%10i%10i%10i"
*ElemsNum *ElemsConec *ElemsMat
*end elems
```

This provides a rundown of all the elements of the mesh and a list of their identifiers, the nodes that form them, and their assigned material.

***set elems(all):** the command to include all element types of the mesh when making the loop.

***ElemsNum:** returns the identifier of the present element

***ElemsConec:** returns the nodes of an element in a counterclockwise order

***ElemsMat:** returns the number of the assigned material of the present element

```
Begin Materials
N° Materials= *nmats
```

This gives the total number of materials in the project

***nmats:** returns the total number of materials

```
Mat. Density


*loop materials
*format "%4i%13.5e"
*set var PROP1(real)=Operation(MatProp(Density, real))
*MatNum *PROP1
*end
```

This provides a rundown of all the materials in the project and a list of the identifiers and densities for each one.

***MatProp (density, real):** returns the value of the property "density" of the material in a "real" format.

***Operation (expression):** returns the result of an arithmetic expression. This operation must be expressed in C.

***Set var PROP1(real)=Operation(MatProp(Density, real)):** assigns the value returned by MatProp (which is the value of the density of the material) to the variable PROP1 (a "real" variable).

***PROP1:** returns the value of the variable PROP1.

***MatNum:** returns the identifier of the present material.

```
Point conditions

*Set Cond Point-Weight *nodes
*set var NFIX(int)=CondNumEntities(int)
Concentrate Weights
*NFIX
```

This provides the number of entities with a particular condition.

***Set Cond Point-Weight *nodes:** this command enables you to select the condition to work with from that moment on. For the present example, select the condition "Point-Weight".

***CondNumEntities(int):** returns the number of entities with a certain condition.

***Set var NFIX(int)= CondNumEntities(int):** assigns the value returned by the command CondNumEntities to the NFIX variable (an "int" variable).

***NFIX:** returns the value of the NFIX variable.

```
Potentials Prescrits:

Node Tipus
Valor/Etiqueta
*loop nodes *OnlyInCond
*NodesNum *cond(1)
*end
```

This provides a rundown of all the nodes with the condition "Point-Weight" with a list of their identifiers and the first "weight" field of the condition in each case.

***loop nodes *OnlyInCond:** executes a loop that will provide a rundown of only the nodes with this condition.

***cond(1):** returns the number 1 field of a condition previously selected with the *set cond command. The field of the condition may also be selected using the name of the condition, for example cond(weight).

cmas2d.bas

```
==================================================================
General Data File
==================================================================
```

```
%%%%%%%%%%%%%%%%%%   Problem   Size
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
Number of Elements & Nodes:
*nelem *npoin

%%%%%%%%%%%%%%%%%%%   Mesh   Database
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

Coordinates:
Node X Y
*set elems(all)
*loop nodes
*format "%5i%14.5e%14.5e"
*NodesNum *NodesCoord(1,real) *NodesCoord(2,real)
*end nodes

.................................................................

Connectivities:
Element Node(1) Node(2) Node(3) Material
*loop elems
*format "%10i%10i%10i%10i%10i"
*ElemsNum *ElemsConec *ElemsMat
*end elems

.................................................................

Begin Materials
Nº Materials= *nmats
Mat. Density
.................................................................
*loop materials
*format "%4i%13.5e"
*set var PROP1(real)=Operation(MatProp(Density, real))
*MatNum *PROP1
*end
.................................................................
Point conditions
```

*Set Cond Point-Weight *nodes

*set var NFIX(int)=CondNumEntities(int)

Concentrated Weights

*NFIX

.....

Potentials Prescrits:

Node Tipus

Valor/Etiqueta

*Set Cond Point-Weight *nodes

*loop nodes *OnlyInCond

*NodesNum *cond(1)

*end

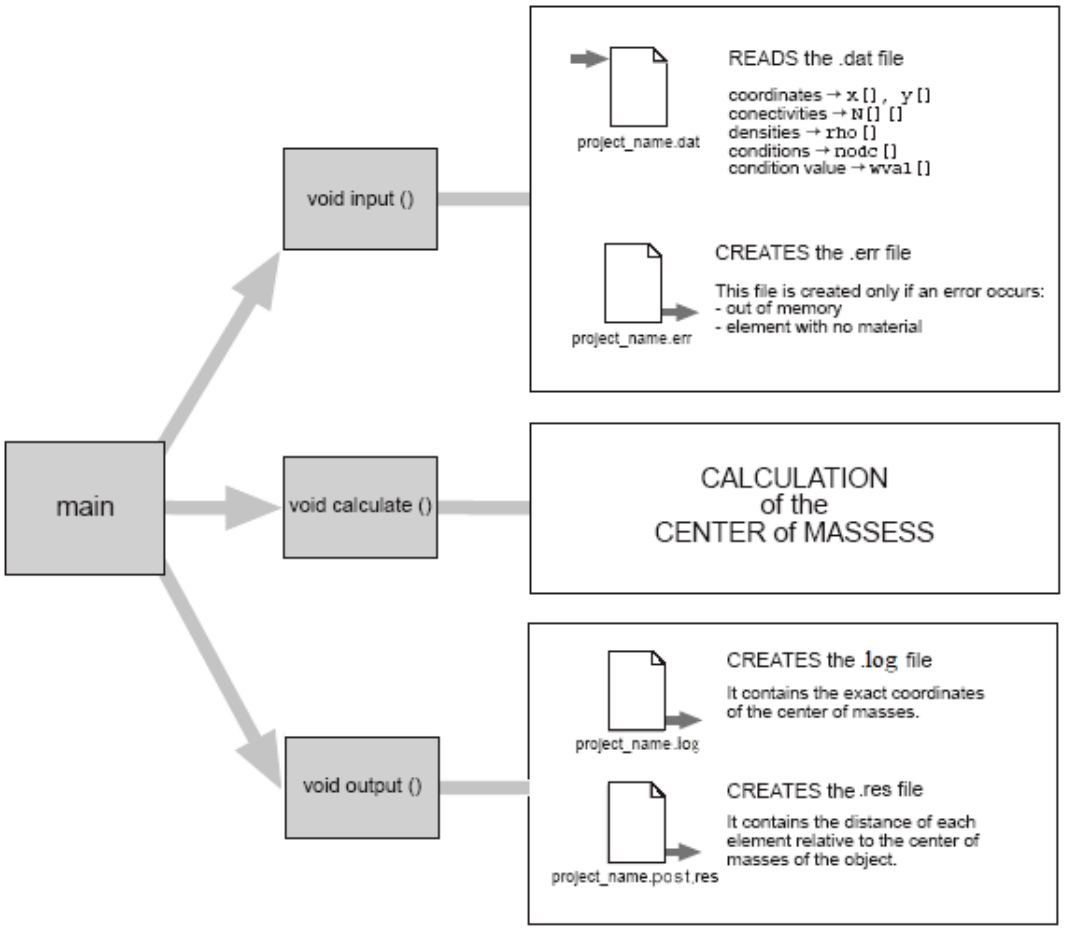
.....

10.2.5 Creating the Execution file of the Calculating Module

Create the file "cmas2d.c". This file contains the code for the execution program of the calculating module. This execution program reads the problem data provided by GiD, calculates the coordinates of the center of mass of the object and the distance between each element and this point. These results are saved in a text file with the extension .post.res.

Compile and link the "cmas2d.c" file in order to obtain the executable cmas2d.exe file.

The calculating module (cmas2d.exe) reads and generates the files described below.



cmas2d.c solver structure

NOTE: The "cmas2d.c" code is explained in the appendix.

10.2.6 Creating the Execution File for the Problem Type

Create the "cmas2d.win.bat" file. This file connects the data file(s) (.dat) to the calculating module (the cmas2d.exe program). When the GiD Calculate option is selected, it executes the .bat file for the problem type selected.

When GiD executes the .bat file, it transfers three parameters in the following way:

(parameter 3) / *.bat (parameter 2) / (parameter 1)

parameter 1: project name

parameter 2: project directory

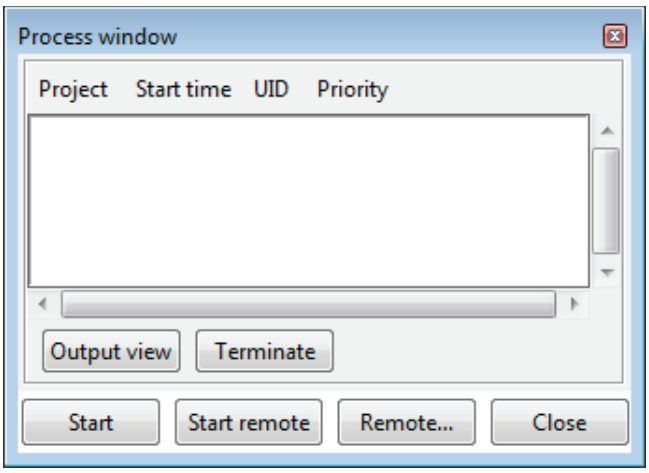
parameter 3: Problem type location directory

NOTE: The .win.bat fiile as used in Windows is explained below; the shell script for UNIX systems is also included with the documentation of this tutorial.

```
rem OutputFile: %2\%1.log
```

A comment line such as "rem OutputFile: file_name.log" means that the contents of the file indicated will be shown if the user clicks Output View in **Calculate->Calculate window**.

In this example the .log file is shown. This file contains the coordinates of the center of mass.



The process window

```
rem ErrorFile: %2\%1.err
```

A comment line such as "rem ErrorFile: file_name.err" means that the indicated file will contain the errors (if any). If the .err file is present at the end of the execution, a window comes up showing the error. The absence of the .err file indicates that the calculation is considered satisfactory.

GiD automatically deletes the .err files before initiating a calculation to avoid confusion.

```
del %2\%1.log
del %2\%1.post.res
```

This deletes results files from any previous calculations to avoid confusion.

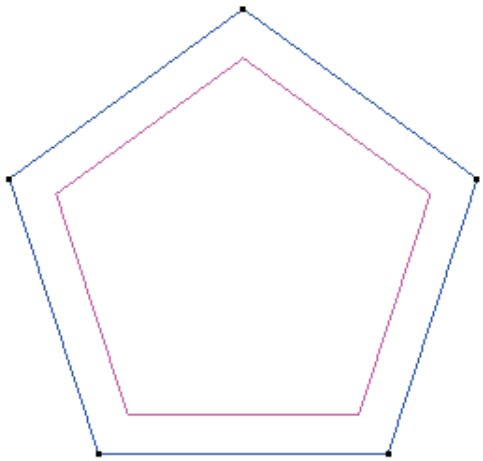
```
%3\cmas2d.exe %2\%1
```

This executing the cmas2d.exe and provide the .dat as input file file.

10.3 Using the problemtype with an example

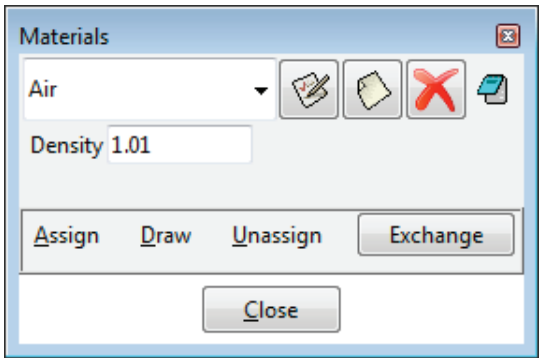
In order to understand the way the calculating module works, simple problems with limited practical use have been chosen. Although these problems do not exemplify the full potential of the GiD program, the user may intuit their answers and, therefore, compare the predicted results with those obtained in the simulations.

1 . Create a surface, for example from the menu **Geometry->Create->Object->Polygon**
2 . Create a polygon with 5 sides, centered in the (0,0,0) and located in the XY plane (normal = 0,0,1) and whit radius=1.0



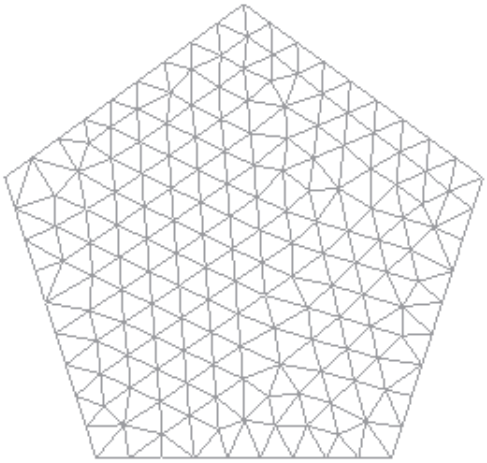
Surface used for this example

3 . Load the problemtype: menu **Data->Problem type->cmas2d**.
4 . Choose **Data->Materials**.
5 . The materials window is opened. From the Materials menu in this window, choose the option **Air**.



Materials window

6 . Click **Assign->Surfaces** and select the surface. Press **ESC** when this step is finished.
7 . Choose the **Mesh->Generate** option.
8 . A window appears in which to enter the maximum element size for the mesh to be generated. Accept the default value and click **OK**. The mesh shown will be obtained.

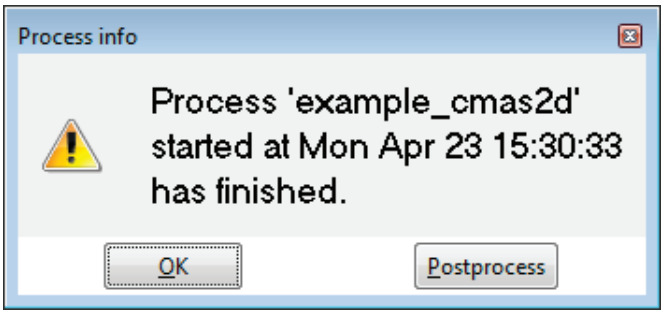


The mesh of the object

9 . Now the calculation may be initiated, but first the model must be saved (**Files->Save**), use 'example_cmas2d' as name for the model.

10 . Choose the **Calculate** option from the Calculate menu to start the calculation module.

11 . Wait until a box appears indicating the calculation has finished.



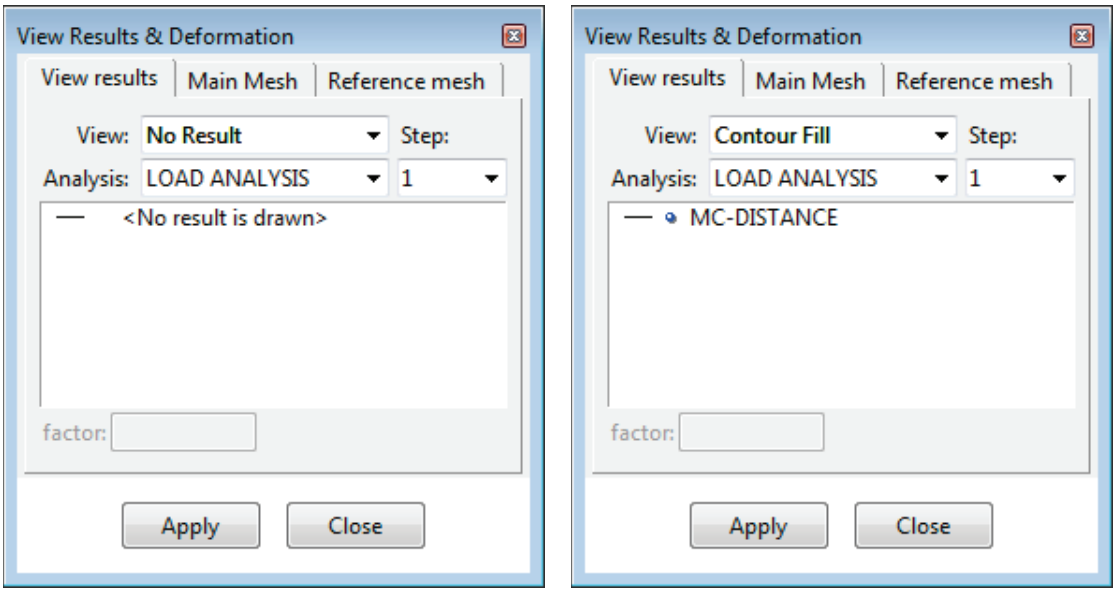
Process information window

12 . Select the option **Files->Postprocess**.

13 . Select **Window->View results**.

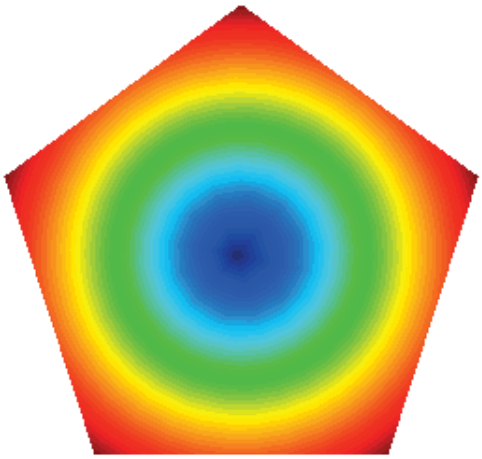
14 . A window appears from which to visualize the results. By default when changing to postprocesses mode no results is visualized.

15 . From the View combo box in the View Results window, choose the **Contour Fill** option. A set of available results (only one for this case) are displayed.



The View Results window

16 . Now choose the MC-DISTANCE result and click **Apply**. A graphic representation of the calculation is obtained.



Visualizing the distance (MC-DISTANCE) from the center of mass of the objectto each element, for an object of homogeneous material

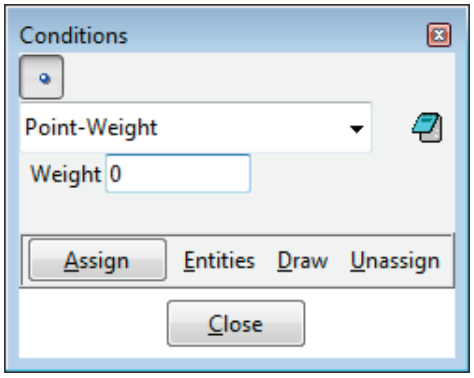
The results shown on the screen reproduce those we anticipated at the outset of the problem: the center of mass of an object made of homogeneous material coincides with its geometric center. The .log file will provide the exact coordinates of this point.

10.3.1 Executing the calculation with a concentrated weight

Executing the calculation for an object of heterogeneous material and subject to external point-weight

1 . Choose the **Files->preprocess** option (to go back to preprocess).
2 . Change to geometry view mode by **View->Mode->Geometry**.

3 . Choose the **Data->Conditions** option. A window is opened in which the conditions of the problem should be entered.



The conditions window

4 . Enter the value 1e3 in the Weight box. Click **Assign** and select the upper corner point. Press **ESC** when this step is finished.

5 . Choose **Mesh->Generate**.

6 . A window comes up asking whether the previous mesh should be eliminated. Click **Yes**.

7 . Another window appears in which the maximum element size can be entered. Leave the default value unaltered and click **OK.**

8 . Choose the Calculate option from the Calculate menu, thus executing the calculating module.

9 . Choose the **Files->Postprocess** option.

10 . Visualize the new results.

Visualization of the distance from the mass center to each element, for an object of heterogeneous material subject to point weight

Now the condition is external point-weight. As anticipated, the new center of mass is displaced toward the point under weight.

10.4 Aditional information

NOTE: In this example, a code for the program will be developed in C. Nevertheless, any programming language may be used.

The code of the program that calculates the center of mass (cmas2d.c) is as follows:

The cmas2d.c file

```
#include <stdio.h>
#include <stdlib.h>
#include <malloc.h>
#include <math.h>

#define MAXMAT 1000
#define MAXCND 1000
char projname[1024];
int i, ielem, inod, icnd;
double *x, *y;
int *N, *imat;
int nodc[MAXCND];
double rho[MAXMAT], wval[MAXCND];
int Nelem, Nnod, Nmat, Ncnd;
double x_CG, y_CG;

void input(void);
void calculate(void);
void output(void);
```

Declaration of variables and constants used in the program.

```
void main (int argc, char *argv[]) {
strcpy (projname, argv[1]);
input();
calculate();
output();
}
```

10.4.1 The main program

The main program is called from the cmas2d.win.bat file and has as parameter the name of the project. This name is stored in the variable projname.

The main program calls the input (), calculate () and output () functions.

The input function reads the .dat file generated by GiD. The .dat file contains information about the mesh. The calculate function read and processes the data and generates the results. The output function creates the results file.

```
void input () {
char filename[1024], fileerr[1024], sau1[1024], sau2[1024];
FILE *fp, *ferr;
int aux,j, error=0;
void jumpline (FILE*);
strcpy(filename, projname);
strcat(filename,".dat");
fp=fopen(filename,"r");
```

The first part of the input function links the project name with the .dat extension, thus obtaining the name of the file that is to be read. This file is opened in order to be read.

The jumpline(FILE*) function is declared. This function simply reads a line from the file that it receives as a parameter, It is used to jump lines of the text when reading the .dat file.

```
for (i=0; i<6; i++) jumpline (fp);
fscanf(fp, "%d %d", &Nelem, &Nnod);
```

The first six lines of the .dat file are jumped over since these are lines of information for the user (see .bas file). Then the total number of elements and nodes of the project are read and stored in the variables Nelem and Nnod respectively.

```
x=(double *) malloc((Nnod+1)*sizeof(double)); if (x==NULL) {error=1;}
y=(double *) malloc((Nnod+1)*sizeof(double)); if (y==NULL) {error=1;}
N= (int *) malloc((Nelem+1)*3*sizeof(int)); if (N==NULL) {error=1;}
imat=(int *) malloc((Nelem+1)*sizeof(int)); if (N==NULL) {error=1;}
if (error) {
strcpy(fileerr, projname);
strcat(fileerr,".err");
ferr = fopen(fileerr,"w");
fprintf(ferr, "***** ERROR: Not enough memory. ***** ");
fprintf(ferr, "(Try to calculate with less elements) ");
fclose(ferr);
exit(1);
}
```

```
for (i=0; i<6; i++) jumpline (fp);
```

Space is reserved for storing the coordinates of the nodes (pointers x, y), the connectivities (pointer N), and the materials corresponding to each element (pointer imat).

In case of error (insufficient memory), a file is created with the extension .err. This file contains information about the error and the program is aborted.

The next six lines are jumped over.

```
/* reading the coordinates */
for (inod=1; inod<=Nnod; inod++)
fscanf (fp, "%d %lf %lf", &aux, &x[inod], &y[inod]);
for (i=0; i<6; i++) jumpline (fp);
```

The coordinates of the nodes are read and stored in the x and y variables. The node identifier indexes the tables of coordinates.

```
/* reading connectivities */
for (ielem=1; ielem<=Nelem; ielem++){
fscanf (fp, "%d", &aux);
for(j=0;j<3;j++) fscanf (fp, "%d", &N[(ielem-1)*3+j]);
fscanf (fp, "%d", &imat[ielem]);
if (imat[ielem]==0){
strcpy(fileerr, projname);
strcat(fileerr,".err");
ferr = fopen(fileerr,"w");
fprintf(ferr, "**ERROR: Elements with no material!!** ");
fclose(ferr);
exit(1);
}
}
```

The connectivities are read and the N variable is saved. This variable is a Nelem x 3- size table with two fields. The nodes (assumed triangles of 3 nodes) forming the element are saved in the first field. The element identifiers are saved in the second one.

All the elements are checked, ensuring that they have been assigned a material. If the identifier of the material is 0 (meaning that no material has been assigned to the element), an .err file is created containing information about the error and the program is aborted.

```
for (i=0; i<5; i++) jumpline (fp);
fscanf(fp, "%s %s %d",sau1, sau2, &Nmat );
for (i=0; i<3; i++) jumpline (fp);
```

```
/* reading density of each material */
for (i=1; i<=Nmat; i++)
fscanf (fp, "%d %lf", &aux, &rho[i]);
/* reading conditions*/
for (i=0; i<4; i++) jumpline (fp);
fscanf(fp, "%d", &Ncnd);
for (i=0; i<6; i++) jumpline (fp);
for (icnd=1; icnd<=Ncnd; icnd++) {
fscanf (fp, "%d %lf", &nodc[icnd], &wval[icnd]);
jumpline (fp);
}
fclose (fp);
}
```

Reading the remaining information in the .dat file.

The total number of materials is read and stored in the Nmat variable.

The density of each material are read and stored in the rho table. The material identifier indexes the densities.

The total number of conditions is read and stored in the Ncnd variable.

The nodes associated with a condition are read and stored in the nodc table indexed by the condition identifier. The value of the condition is stored in wval, another table indexed by the condition identifier.

```
void calculate ()
{
double v,aux1,aux2,aux3;
int n1, n2, n3;
int mat;
double x_CGi, y_CGi;
double x_num=0, y_num=0, den=0;
```

This is the function that calculates the center of mass.

Declaration of the local variables used in calculate().

```
for(ielem=1;ielem<=Nelem;ielem++) {
n1= N[0+(ielem-1)*3];
n2= N[1+(ielem-1)*3];
n3= N[2+(ielem-1)*3];
/* Calculating the volume (volume is the area for surfaces) */
```

```
v=fabs(x[n1]*y[n2]+x[n2]*y[n3]+x[n3]*y[n1]-x[n1]*y[n3]-x[n2]*y[n1]-x[n3]*y[n2])/2;
x_CGi= (x[n1]+x[n2]+x[n3])/3;
y_CGi= (y[n1]+y[n2]+y[n3])/3;
mat= imat[ielem];
x_num+= rho[mat]*v*x_CGi;
y_num+= rho[mat]*v*y_CGi;
den+= rho[mat]*v;
}
/* puntual weights */
for(icnd=1;icnd<=Ncnd;icnd++) {
inod= nodc[icnd];
x_num+= wval[icnd]*x[inod];
y_num+= wval[icnd]*y[inod];
den+= wval[icnd];
}
x_CG= (x_num/den);
y_CG= (y_num/den);
```

The identifiers of the nodes of the present element are saved in n1, n2, n3.

This loop makes a rundown of all the elements in the mesh. The volume is calculated for each element. (Here, the volume is the area, provided we are dealing with 3D surfaces). The volume calculations are stored in the v variable.

The geometric center of the element is calculated (coinciding with the center of gravity) and the coordinates are stored in the x_Cgi and y_Cgi variables.

The numerator sums are calculated. When the loop is finished, the following sums are stored in the x_num and y_num variables. Finally, the result of dividing the x_num and y_num variables by the den variable is stored in the x_CG and y_CG variables.

```
void output() {
char filename[1024];
FILE *fp, *fplog;
double v;
```

The output() function creates two files: .post.res, and .log.

The results to be visualized in GiD Post-process are stored in the .post.res file. It is this file that stores the data which enables GiD to represent the distance of each point from the corresponding center of mass.

The numerical value of the center of mass is saved in the .log file. The accuracy of this value is directly proportional to the element size.

```
/* writing log information file */
strcpy(filename, projname);
strcat(filename,".log");
fplog=fopen(filename,"w");
fprintf(fplog, "CMAS2D routine to calculate the mass center ");
fprintf(fplog, "project: %s ", projname);
fprintf(fplog, "mass center: %lf %lf ", x_CG, y_CG);
fclose(fplog);
```

Creating the .log file: the .log extension is added to the project name and a file is created that will contain the numerical value of the position of the center of mass, which in turn is stored in the x_CG and y y_CG variables of the program.

Creating the .post.res file. The output data (results) are stored in this file.

The format of the .post.res file is explaned in the GiD help, see section

Posprocess data files ->Postprocess results format.

```
/* writing .post.res */
strcpy(filename,projname);
strcat(filename,".post.res");
fp=fopen(filename,"w");
fprintf(fp,"GiD Post Results File 1.0 ");
fprintf(fp,"Result MC-DISTANCE \"LOAD ANALYSIS\" 1 Scalar OnNodes ");
fprintf(fp,"ComponentNames MC-DISTANCE ");
fprintf(fp,"Values ");
for(inod=1;inod<=Nnod;inod++) {
/* distance or each node to the center of masses */
v=sqrt((x_CG-x[inod])*(x_CG-x[inod])+(y_CG-y[inod])*(y_CG-y[inod]));
fprintf(fp,"%d %lf ",inod,v);
}
fprintf(fp,"End values ");
fclose(fp);
```

In this example only a scalar result , with a single time step, is written in the .res file.

This is the full source code of this program:

```
#include <stdio.h>
#include <stdlib.h>
#include <malloc.h>
#include <math.h>
```

```
#define MAXMAT 1000
#define MAXCND 1000
char projname[1024];
int i, ielem, inod, icnd;
double *x, *y;
int *N, *imat;
int nodc[MAXCND];
double rho[MAXMAT], wval[MAXCND];
int Nelem, Nnod, Nmat, Ncnd;
double x_CG, y_CG;

void input(void);
void calculate(void);
void output(void);

void main (int argc, char *argv[]) {
strcpy (projname, argv[1]);
input();
calculate();
output();
}

void input () {
char filename[1024], fileerr[1024], sau1[1024], sau2[1024];
FILE *fp, *ferr;
int aux,j, error=0;
void jumpline (FILE*);
strcpy(filename, projname);
strcat(filename,".dat");
fp=fopen(filename,"r");
for (i=0; i<6; i++) jumpline (fp);
fscanf(fp, "%d %d", &Nelem, &Nnod);
x=(double *) malloc((Nnod+1)*sizeof(double)); if (x==NULL) {error=1;}
y=(double *) malloc((Nnod+1)*sizeof(double)); if (y==NULL) {error=1;}
N= (int *) malloc((Nelem+1)*3*sizeof(int)); if (N==NULL) {error=1;}
imat=(int *) malloc((Nelem+1)*sizeof(int)); if (N==NULL) {error=1;}
```

```
if (error) {
strcpy(fileerr, projname);
strcat(fileerr,".err");
ferr = fopen(fileerr,"w");
fprintf(ferr, "***** ERROR: Not enough memory. ***** ");
fprintf(ferr, "(Try to calculate with less elements) ");
fclose(ferr);
exit(1);
}
for (i=0; i<6; i++) jumpline (fp);
/* reading the coordinates */
for (inod=1; inod<=Nnod; inod++)
fscanf (fp, "%d %lf %lf", &aux, &x[inod], &y[inod]);
for (i=0; i<6; i++) jumpline (fp);
/* reading connectivities */
for (ielem=1; ielem<=Nelem; ielem++){
fscanf (fp, "%d", &aux);
for(j=0;j<3;j++) fscanf (fp, "%d", &N[(ielem-1)*3+j]);
fscanf (fp, "%d", &imat[ielem]);
if (imat[ielem]==0){
strcpy(fileerr, projname);
strcat(fileerr,".err");
ferr = fopen(fileerr,"w");
fprintf(ferr, "**ERROR: Elements with no material!!** ");
fclose(ferr);
exit(1);
}
}
for (i=0; i<5; i++) jumpline (fp);
fscanf(fp, "%s %s %d",sau1, sau2, &Nmat );
for (i=0; i<3; i++) jumpline (fp);
/* reading density of each material */
for (i=1; i<=Nmat; i++)
fscanf (fp, "%d %lf", &aux, &rho[i]);
/* reading conditions*/
```

```
for (i=0; i<4; i++) jumpline (fp);
fscanf(fp, "%d", &Ncnd);
for (i=0; i<6; i++) jumpline (fp);
for (icnd=1; icnd<=Ncnd; icnd++) {
fscanf (fp, "%d %lf", &nodc[icnd], &wval[icnd]);
jumpline (fp);
}
fclose (fp);
}

void calculate () {
double v;
int n1, n2, n3;
int mat;
double x_CGi, y_CGi;
double x_num=0, y_num=0, den=0;
for(ielem=1;ielem<=Nelem;ielem++) {
n1= N[0+(ielem-1)*3];
n2= N[1+(ielem-1)*3];
n3= N[2+(ielem-1)*3];
/* Calculating the volume (volume is the area for surfaces) */
v=fabs(x[n1]*y[n2]+x[n2]*y[n3]+x[n3]*y[n1]-x[n1]*y[n3]-x[n2]*y[n1]-x[n3]*y[n2])/2;
x_CGi= (x[n1]+x[n2]+x[n3])/3;
y_CGi= (y[n1]+y[n2]+y[n3])/3;
mat= imat[ielem];
x_num+= rho[mat]*v*x_CGi;
y_num+= rho[mat]*v*y_CGi;
den+= rho[mat]*v;
}
/* puntual weights */
for(icnd=1;icnd<=Ncnd;icnd++) {
inod= nodc[icnd];
x_num+= wval[icnd]*x[inod];
y_num+= wval[icnd]*y[inod];
den+= wval[icnd];
```

```
}
x_CG= (x_num/den);
y_CG= (y_num/den);
}

void output() {
char filename[1024];
FILE *fp, *fplog;
double v;
/* writing log information file */
strcpy(filename, projname);
strcat(filename,".log");
fplog=fopen(filename,"w");
fprintf(fplog, "CMAS2D routine to calculate the mass center ");
fprintf(fplog, "project: %s ", projname);
fprintf(fplog, "mass center: %lf %lf ", x_CG, y_CG);
fclose(fplog);
/* writing .post.res */
strcpy(filename,projname);
strcat(filename,".post.res");
fp=fopen(filename,"w");
fprintf(fp,"GiD Post Results File 1.0 ");
fprintf(fp,"Result MC-DISTANCE \"LOAD ANALYSIS\" 1 Scalar OnNodes ");
fprintf(fp,"ComponentNames MC-DISTANCE ");
fprintf(fp,"Values ");
for(inod=1;inod<=Nnod;inod++) {
/* distance or each node to the center of masses */
v=sqrt((x_CG-x[inod])*(x_CG-x[inod])+(y_CG-y[inod])*(y_CG-y[inod]));
fprintf(fp,"%d %lf ",inod,v);
}
fprintf(fp,"End values ");
fclose(fp);
free(x);
free(y);
free(N);
```

```
free(imat);
}

void jumpline (FILE* filep) {
char buffer[1024];
fgets(buffer,1024,filep);
}
```