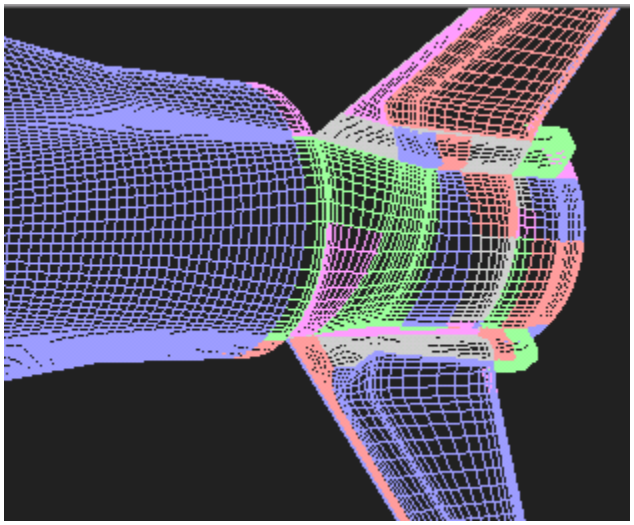
Application Package
OMS



ProGraph

Version 3.1

USER's GUIDES

2006

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Chapter 1. Creation of simple Geometries (using File menu)

Step 1. How to input data at the beginning of work using keyboard

Introduction. Use this command as an additional possibility to input small data volumes. As a rule, mathematical model of geometry is assumed to create with the use of well-known construction system, such as UniGraphics. Then this model may be converted in some conventional format. Nevertheless, it may useful, in some cases, to create necessary templates of grids immediately during the experiment or its processing. For this purpose, the dialog box below may be used.

This command permits to input a structured grid in APT or SKL formats. But it isn't as essential restriction. When a non-structured grid is necessary, you may input an appropriate structured grid and, then, convert it to non-structured one. For more information see **Step 2**.)

Some designation are used in this dialog box. When you input three coordinates (X, Y, Z), you input a point (a node of grid). The nodes are combined into lines. To begin input of a new line, click the **New line** radio button and input coordinates of the first point of this new line. The lines are combined into patches. To begin input of a new patch, click the **New patch** radio button and input coordinates of the first point of the first line of a new patch.

When all the lines of a patch contain the same number of points, then a file of APT format will be obtained. When the lines of a patch contain different numbers of points, then a file of SKL format will be obtained. It should be noted, that SKL format can't be converted into non-structured VRML format.

A simple editor permits to edit the Geometry immediately during the input. For example, if it's necessary to input the same point some times, one may place its coordinates into the Clipboard (using the **Copy** radio button) and duplicate them (using the **Copy** check box).

1. After running *ProGraph*:
   - Choose the **New...** command from the **File** menu.

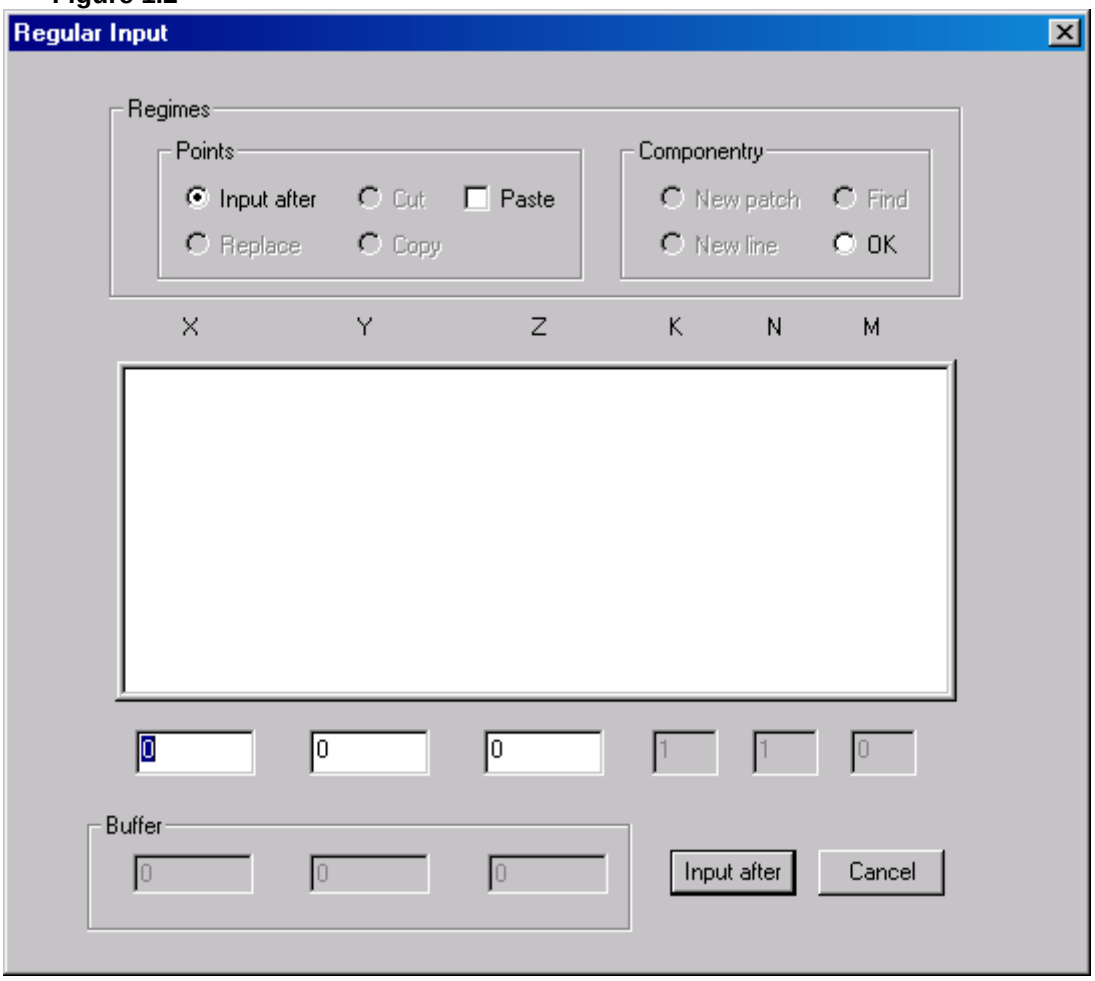
     or

   - Click the following icon from the upper toolbar:

Figure 1.1

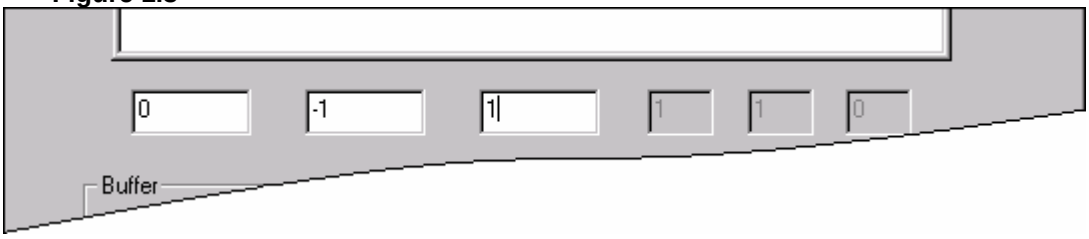
Then the ***Regular Input Dialog Box*** will appear on your screen.

Figure 1.2



2. Input the coordinates of the point. Type "0", "-1" and "1" in text boxes as shown below.

Figure 1.3



3. Save the inputted coordinates in keyboard buffer.

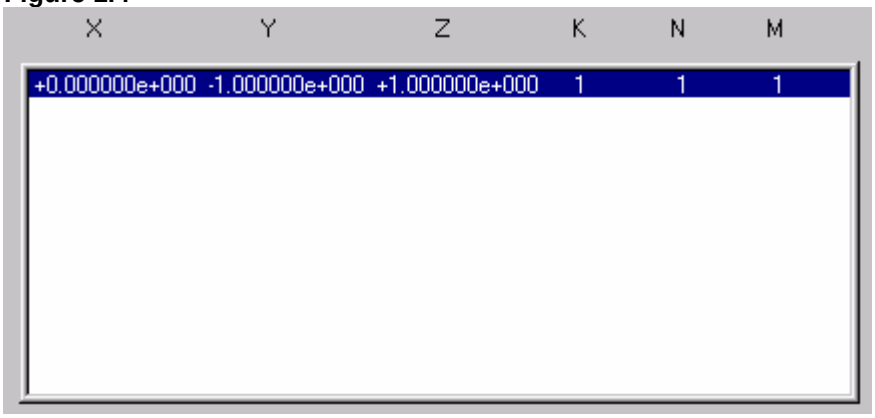
- Click the **Input after** control button.

or

- Press Enter.

Note. Inputted coordinates appear in the list above. **X, Y** and **Z** are the coordinates of this point; **K** is the number or patch, **N** is the number of section and **M** is the number of point in this section.

Figure 1.4

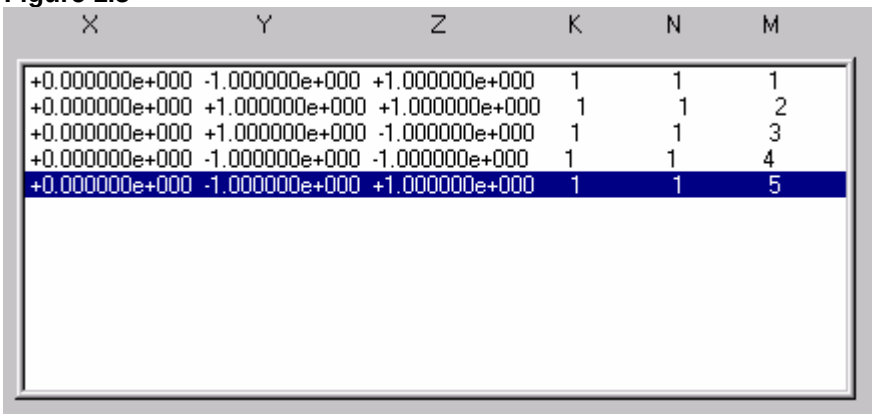


4. Repeat steps 2-3 to input the coordinates of the following points.

X	Y	Z
0	1	1
0	1	-1
0	-1	-1
0	-1	1

Note. The inputted points will appear in the list below.

Figure 1.5



5. Click the **Cut** radio button the in **Points** pane. It permits to turn on regime of working with Clipboard.

6. Select the second point in the list above with the use of mouse.

Note. You also may click the list and use the following keys to move in the list:

→, ↓ - upward

↑, ← - downward

PgUp, Home – to the beginning of the list

PgDn, End – to the end of the list.

7. Cut the second point into the Clipboard.

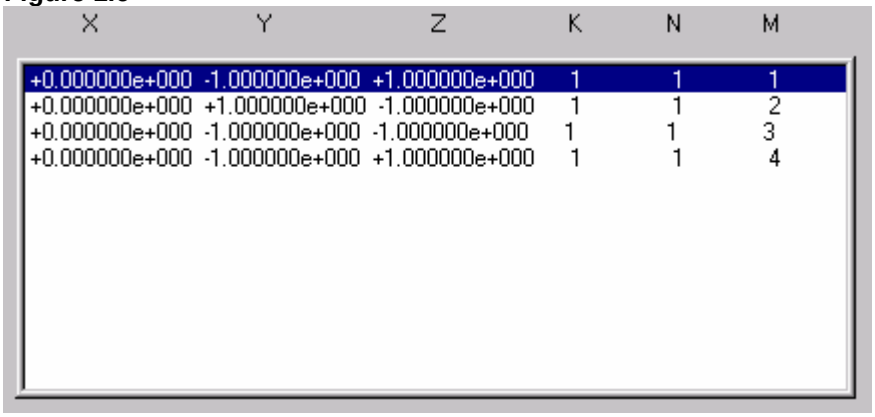
   - Click the **Cut** control button.

   or

   - Press Enter.

   Note. The second point is removed from the list and placed into the Clipboard. The rest points are renumbered.

Figure 1.6



8. Turn on the **Paste** check box in the **Points** pane.

9. Select the last point in the list.

10. Put the content of Clipboard to the end of list.

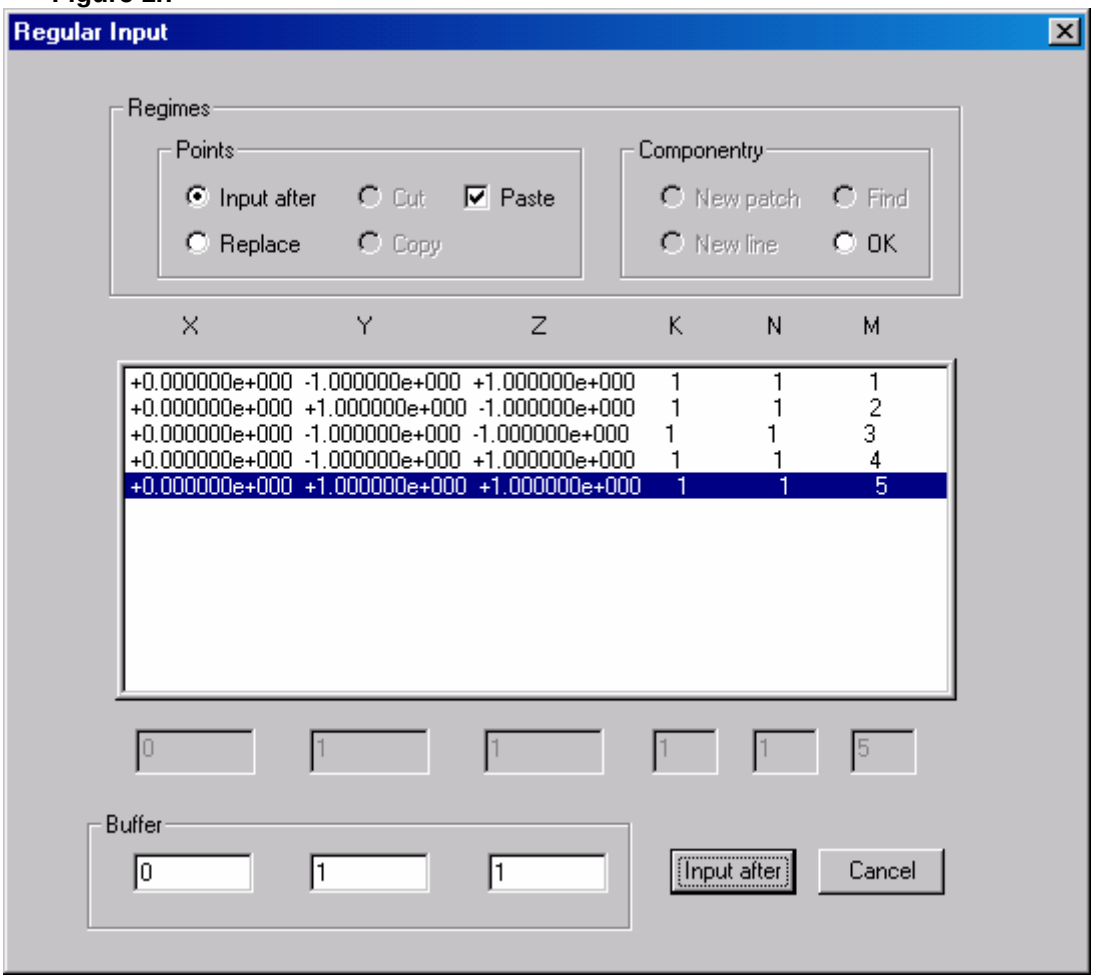
    - Click the **Input after** control button.

    or

    - Press Enter.

    Note. The fifth point appears in the list.

Figure 1.7



11. Input a new content to Clipboard. Type "0", "2" and "2" in text boxes in the **Buffer** pane.

12. Select the fourth point in the list.

13. Click the **Replace** radio button in the **Points** pane to replace the selected point with a Clipboard contents.

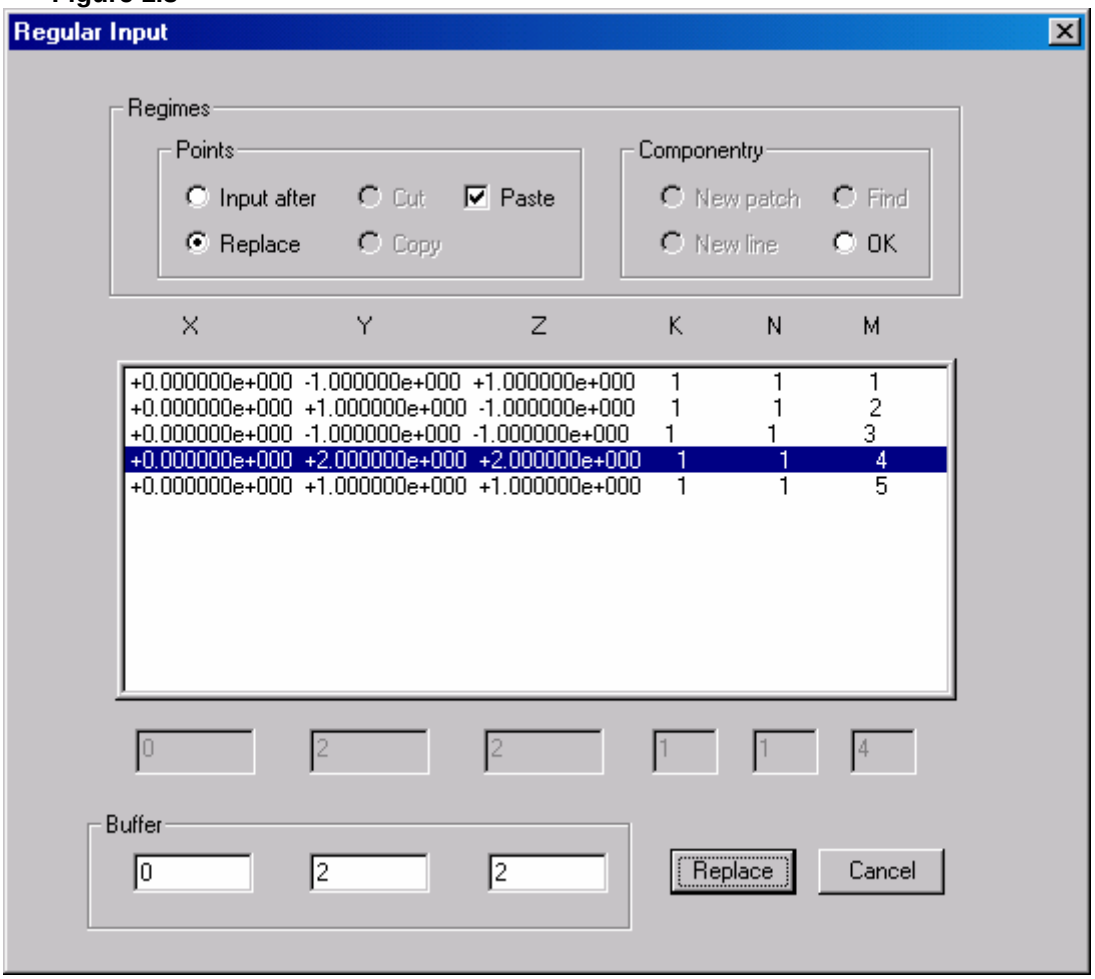
14. Save the inputted coordinates in keyboard buffer.

    - Click the **Replace** control button.

      or

    - Press Enter.

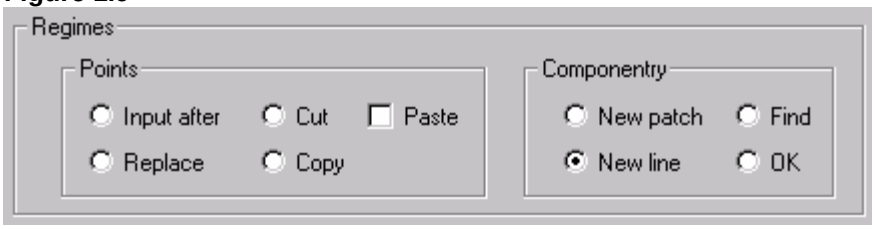
Figure 1.8



15. Turn off the **Paste** check box in the **Points** pane (click it by mouse).

16. Click the **New line** radio button in the **Componentry** pane to input a new section.

Figure 1.9



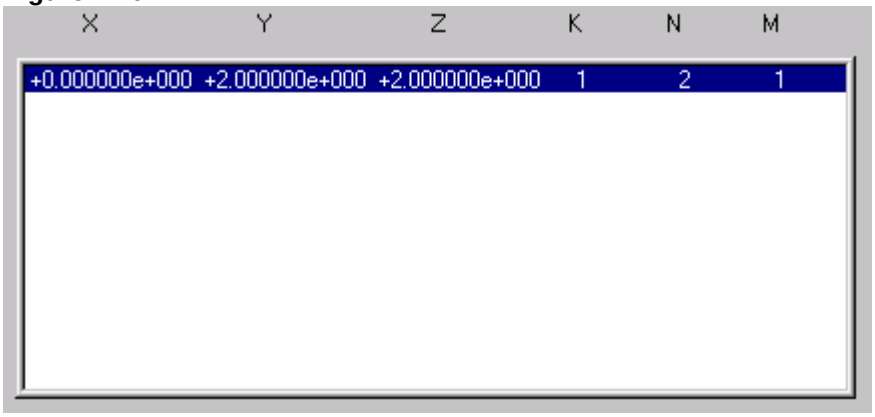
17. Click the **New line** control button.

or

Press Enter.

Note. The first point of a new line is the point that has been selected in the first line.

Figure 1.10



18. Click the **Find** radio button in the **Componentry** pane to find some inputted point with the use of its integer-valued address (**K, N** and **M** indices).

19. Then:

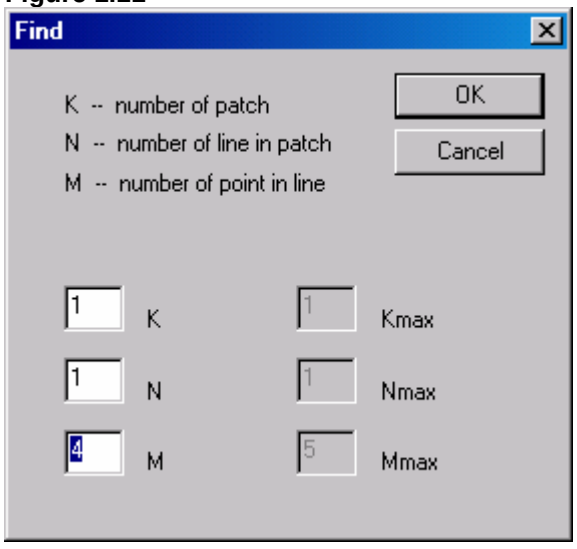
- Click the **Find** control button.

or

- Press Enter.

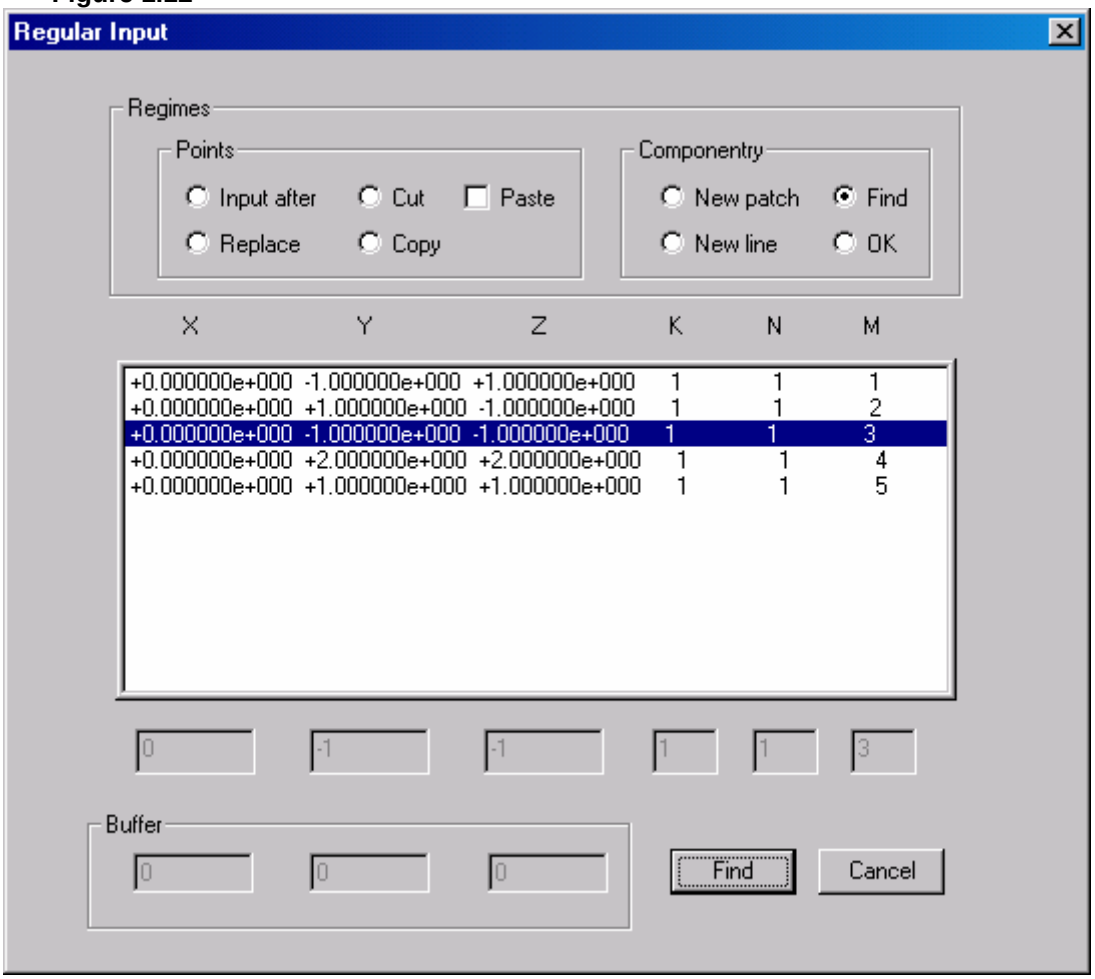
Then the ***Find Dialog Box*** will appear on your screen.

Figure 1.11



20. Type "1", "1" and "3" in the text boxes and click the **Find** control button. Then this point will be selected in the list of inputted points.

Figure 1.12



21. Click the **OK** radio button in **Componentry** pane to finish the input.

22. Then:

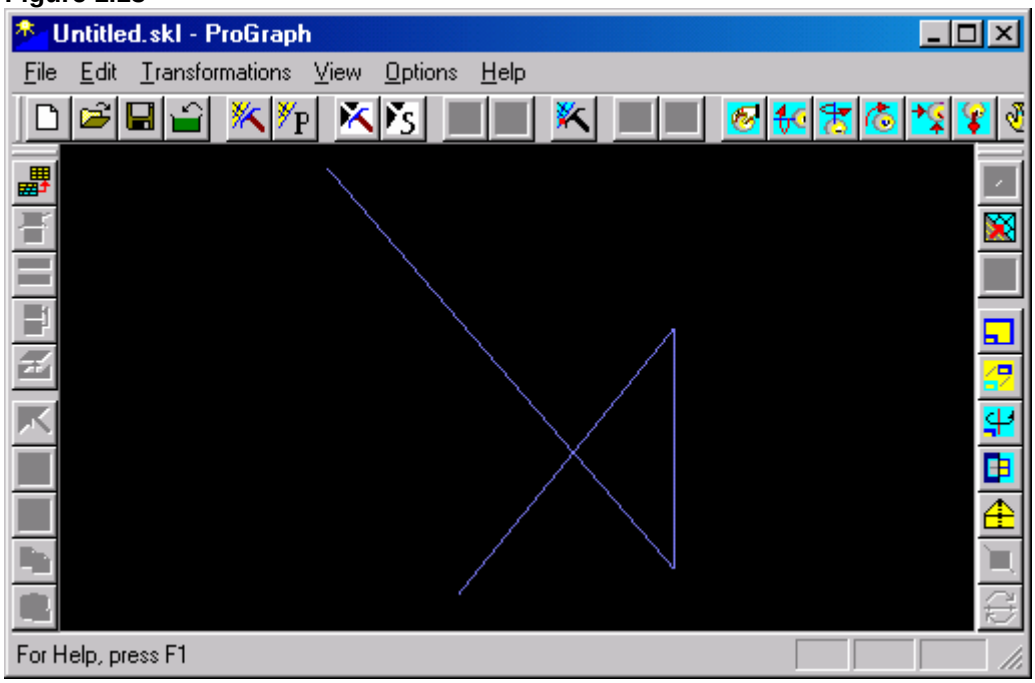
- Click the **OK** control button.

  or

- Press Enter.

Then the ***Regular Input Dialog Box*** will be closed and the Geometry will appear on your screen.

Figure 1.13


Untitled.skl - ProGraph
File Edit Transformations View Options Help
For Help, press F1

Step 2. How to open a file containing the Geometry

Introduction. *ProGraph* uses grids at the geometry surfaces. Therefore, some universally recognized geometrical formats are absent among formats used by *ProGraph* (IGS, for example). As a rule, grid files are created by the main constructor systems and may be used for further work. Among formats listed in this **Step**, DAT (Tecplot©), WRL and STL formats are well-known. APT (SKL) format is used as internal one and it is simplification of DAT format. So, for successful work with *ProGraph*, it is necessary to master one of well-known constructor system where mathematical models of geometry will be created.

ProGraph uses Geometries created by different geometrical systems such as AutoCAD© 14, Tecplot©, UniGraphics©.

Geometry is preliminary prepared and converted to one of six formats: APT, SKL, DAT, WRL, STL or GRD.

1) When APT file is opened, its format remains the same and file isn't converted. Its patches are painted with following colors: the first – with a blue, the second – with a green, the third – with a red, the fourth – with a white and the fifth – with a petunia color. If the number of patches is more than five, the color scheme is repeated in period.

2) When SKL file is opened, two cases may take place.

   - Some sections of Geometry have different number of points. In this case the file isn't converted and it appears on your screen as a series of sections. The colors of these sections correspond to the numbers of patches (see the first point).

   or

   - All sections of Geometry have the same number of points. In this case the file is converted to APT one automatically. The colors of the patches correspond to its numbers (see the first point).

3) When DAT file is opened, three cases may take place.

   - DAT file contains a structured grid only. In this case the file is converted to APT one automatically. The colors of the patches correspond to the numbers of patches (see the first point).

   or

   - DAT file contains a unstructured grid only. In this case the file appears on your screen as a number of triangles. The colors of the patches correspond to its numbers (see the

first point). *ProGraph* uses only triangles as an element of unstructured grid. Another polyhedrons are converted to triangles automatically or they aren't permitted.

or

- DAT file contains both structured and unstructured grid. In this case the file is converted to unstructured grid and it appears on your screen as a number of triangles (see the previous point).

4) When WRL file is opened, it is converted to unstructured DAT format automatically (see the previous point).

5) When STL file is opened, it is converted to unstructured DAT format automatically (see the point 3).

6) When GRD file is opened, it is converted to unstructured DAT format automatically (see the point 3).

1. To open an existing file STEP_2.APT that is presented in subfolder SAMPLES of the current folder:

   - Choose the **Open...** command from the **File** menu.

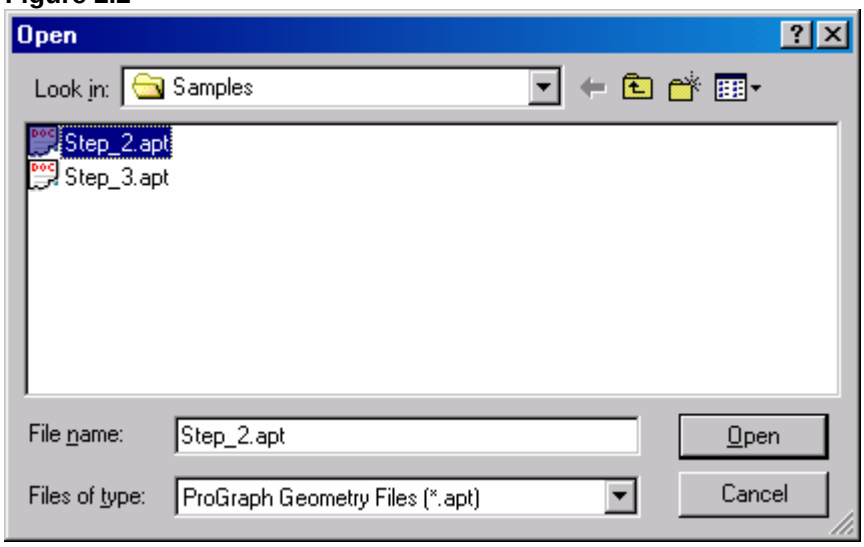
   or

   - Click the following icon from the upper toolbar:

Figure 2.1

Then the standard ***Open Dialog Box*** will appear on your screen.

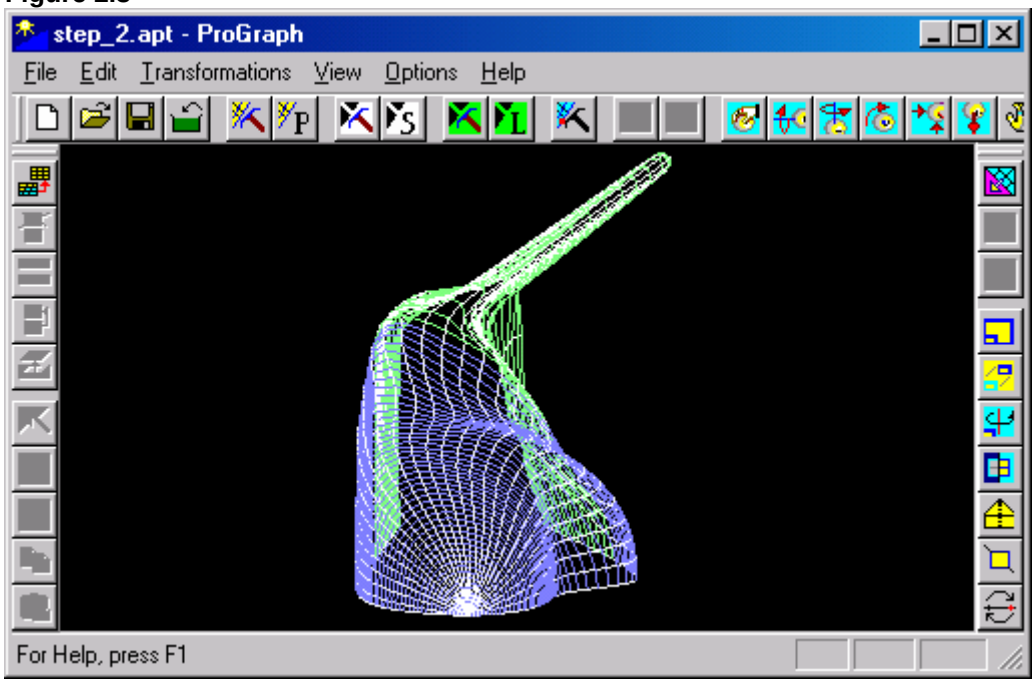
Figure 2.2



2. Choose the file STEP_2.APT and click the **Open** control button. Then the ***Open Dialog Box*** will be closed and the Geometry will appear on your screen.

   Note. One may open several files at once. Choose them with the use of Shift or CTRL keys (just as *Explorer*).

Figure 2.3



Step 3. How to append a Geometry file with another one

Introduction. During the work sometimes a necessity to append a geometry by some new parts arises. It may be useful when a preliminary inputted geometry, for example wing, is deformed and, after it, a flap is appended, for example. Of coarse, one may perform it otherwise. One may deform the geometry, save the results of work as some new files, close *ProGraph* and run it again and open these new and necessary additional files at once (for example, wing and flap). Nevertheless, appending procedure is more convenient because there are no intermediate actions (reading-saving).

The procedure of appending depends on the format of opened file.

1) When APT file is opened, only APT, SKL or DAT file may be appended. A new file is converted in accordance with the rule described at **Step 2**. If appended DAT file contains unstructured grid, then whole Geometry is converted into unstructured DAT format. If SKL file is appended, then whole Geometry is converted into SKL format.

2) When SKL file is opened, only APT or SKL file may be appended. A new file is converted in accordance with the rule described at **Step 2**.

3) When unstructured DAT file is opened, only DAT, WRL or STL file may be appended. Appended file is converted into unstructured DAT format.

4) When WRL file is opened, only DAT, WRL or STL file may be appended. Whole Geometry is converted into unstructured DAT format

4) When STL file is opened, only DAT, WRL or STL file may be appended. Whole Geometry is converted into unstructured DAT format

1. To append an existing file STEP_3.APT that is presented in subfolder SAMPLES of the current folder to the existing file STEP_2.APT opened at **Step 2**:

   - Choose the **Append...** command from the **File** menu.

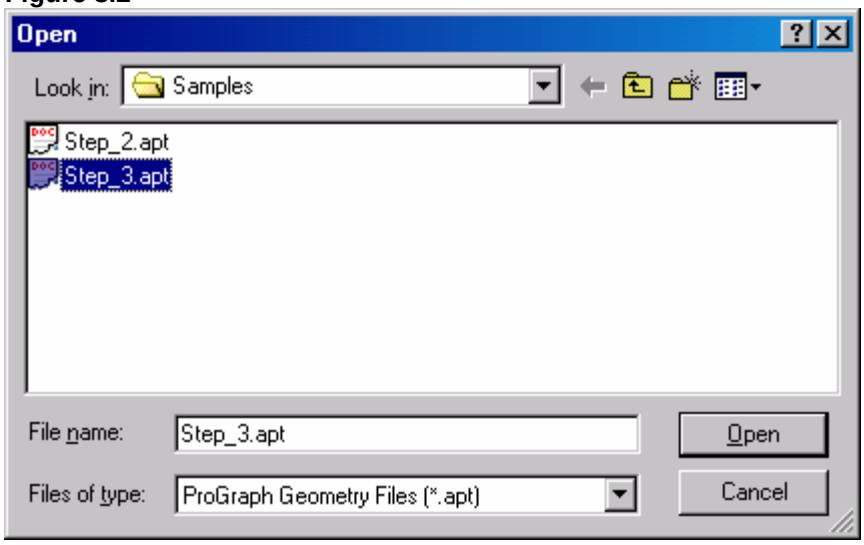
   or

   - Click the following icon from the upper toolbar:

Figure 3.1

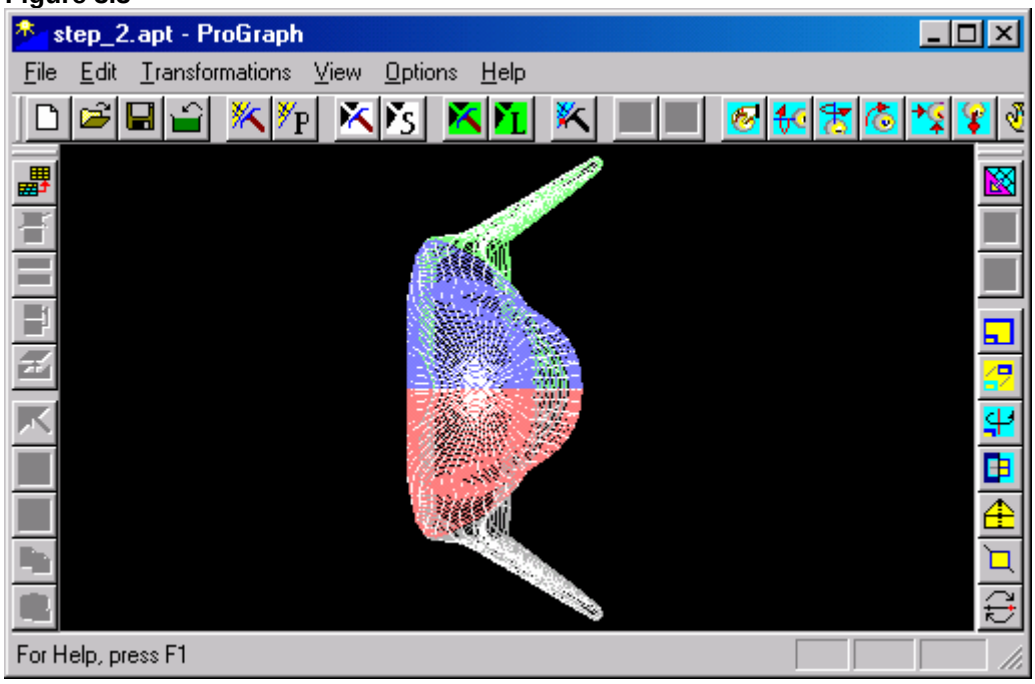
Then the standard ***Open Dialog Box*** will appear on your screen.

Figure 3.2



2. Choose an existing file STEP_3.APT. Then the Geometry will appear on your screen.

Figure 3.3



Step 4. How to save a Geometry file on the disk

Introduction. The procedure of saving depends on the format of created file.

1) When file of APT format has been created, it may be saved as a file of APT, SKL, DAT, WRL or STL format.

2) When file of SKL format has been created, it may be saved as a file of SKL format only.

3) When file of unstructured DAT format has been created, it may be saved as a file of unstructured DAT, WRL or STL format only.

1. To save a file created at **Step 3** with a new name STEP_4.APT to subfolder SAMPLES of the current folder:

   - Choose the **Save As...** command from the **File** menu.

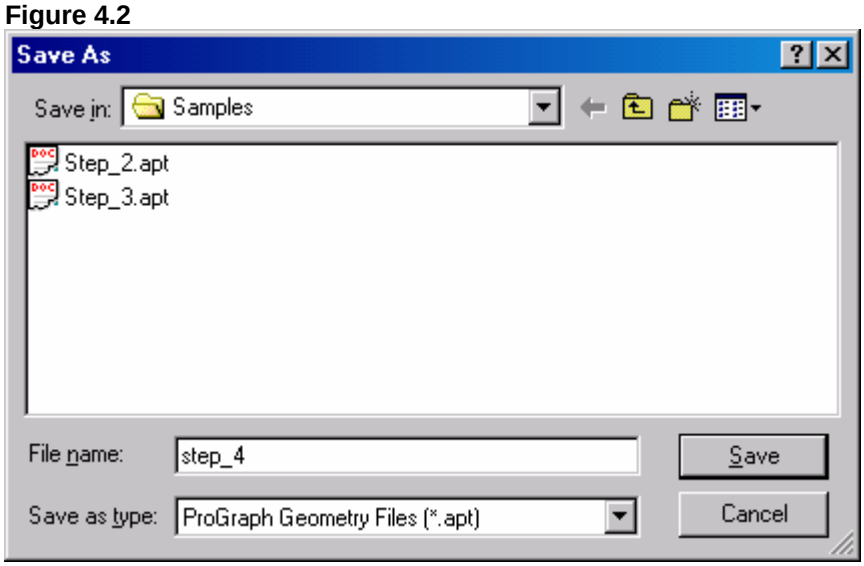
   or

   - Click the following icon from the upper toolbar:

Figure 4.1

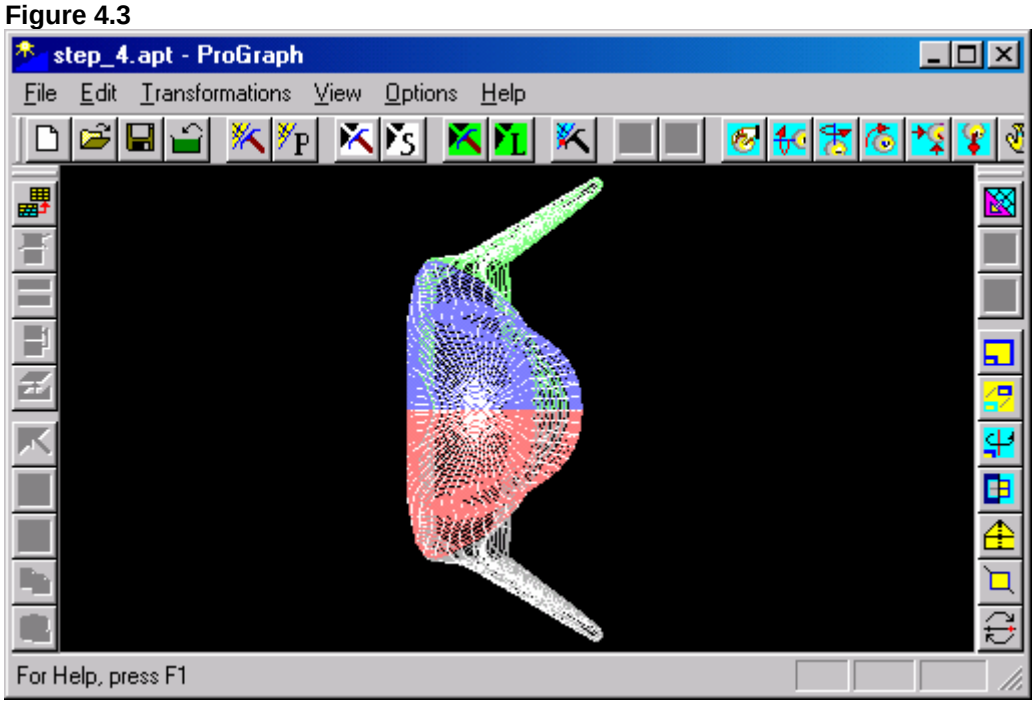
Then the standard ***Save As Dialog Box*** will appear on your screen.

Figure 4.2



2. Type "STEP_4" in the **File name** text box and click the **Save** control button. Then the ***Save As Dialog Box*** will be closed and the file will be saved with the new name.

Figure 4.3



Chapter 2. Geometry editing (using Edit menu)

Introduction. During the work it is necessary to edit the Geometry so to receive the result that is the most acceptable for successful processing the experimental data. As a rule, the initial Geometry is created to satisfy requirements of different users. For example, the same Geometry may be used both in calculation and in experiment. Common approaches to Geometry sometimes lead to misunderstanding. Some details, which are very important for experimental processing are not essential for CFD. For example, during processing the PSP experiment, sharp edges on wings are of the special importance. As a result, it is necessary to compress the grid and to select special patches in these zones.

This **Chapter** describes how to rebuild and correct grid surfaces given by both structured and non-structured files.

Step 5. How to capture a patch and to create a block

Introduction. The special attention in *ProGraph* ideology is devoted to a block. If it is necessary to edit only a part of Geometry, one should to capture it into the block. In this case, most of commands will be applied to this block only. The block may contain one or several patches. Yellow color attracts your attention to patches included into block.

1. Open an existing file STEP_2.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

2. To capture the patch:

   - Choose the **Patches ~ Capture** command from the **Edit** menu.

     or

   - Click the following icon from the upper toolbar:

   Figure 5.1

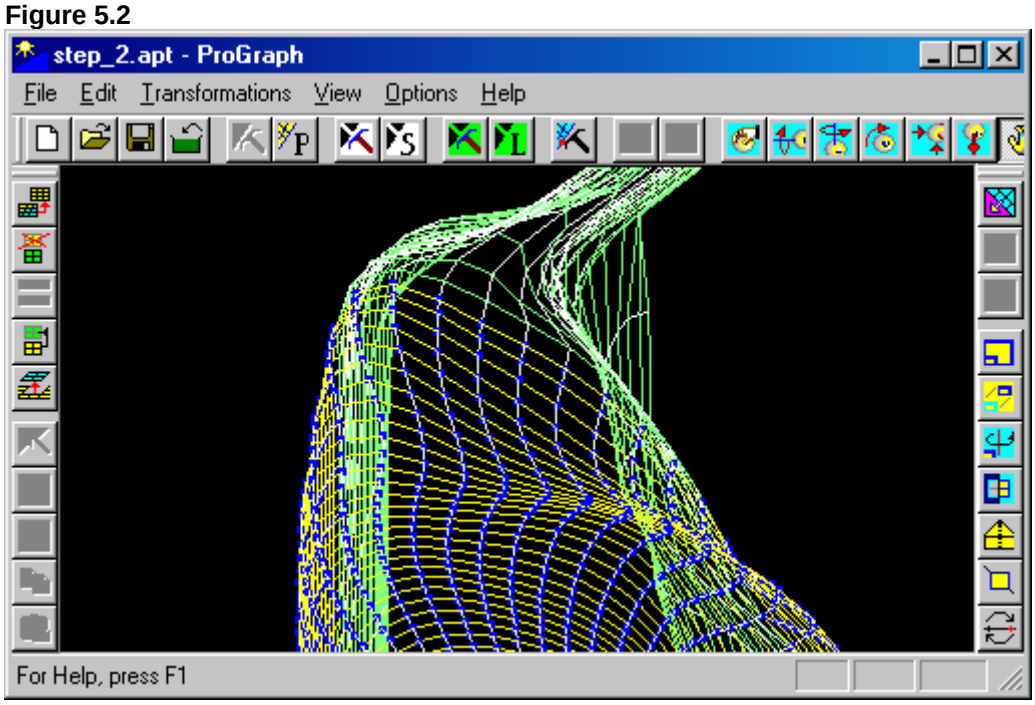
   Then cursor shape will be changed to .

3. Click the patch. Then the captured patch will be painted with a yellow color and its points will be represented as blue markers. The captured patch will

be inputted to the block and its number will appear in Status Bar.

The patch that is included in block as the second one will be represented with green markers, the third – with red, the fourth – with white and the fifth – with petunia markers. If the number of captured patches is more than five, the color scheme will be repeated in period.

Figure 5.2



Step 6. How to capture a patch and to add it to the block with the use of *Input & Add to block* command

1. Open an existing file STEP_2.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

2. To capture the patch:

   - Choose the **Patches ~ Input & Add to block...** command from the **Edit** menu.

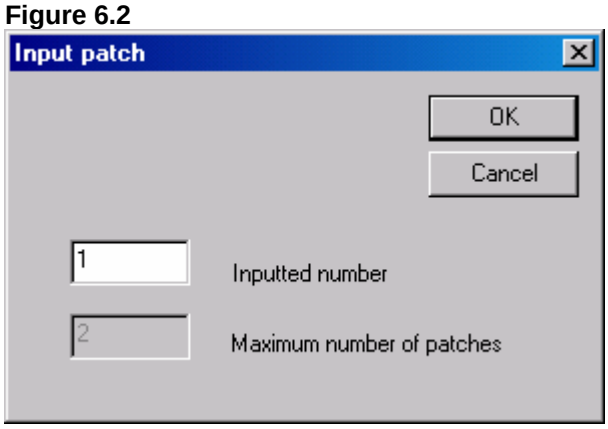
   or

   - Click the following icon from the upper toolbar:

Figure 6.1

Then the ***Input Patch Dialog Box*** will appear on your screen.

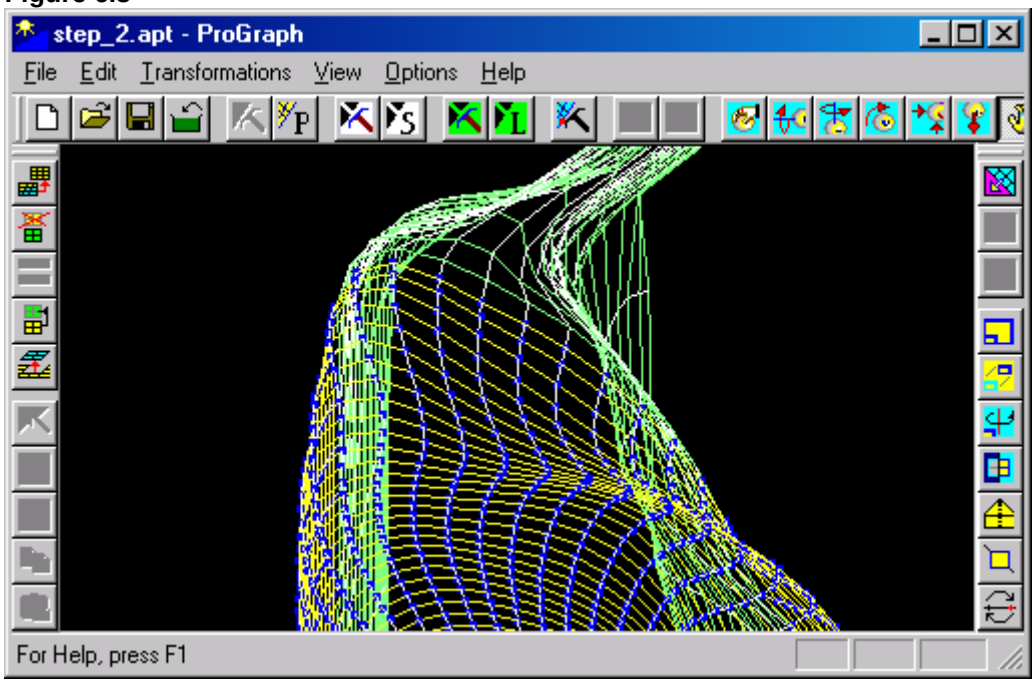
Figure 6.2



3. Choose all needed parameters in the ***Input Patch Dialog Box*** as shown above.

4. Click the **OK** control button. Then the captured patch will be painted with a yellow color and its points will be represented as blue markers. (For more information about colors see **Step 5**.) The captured patch will be inputted to the block and its number will be in Status Bar.

Figure 6.3


step_2.apt - ProGraph
File Edit Transformations View Options Help
For Help, press F1

Step 7. How to capture a patch and to add it to non-empty block

1. To add a new patch to the block created at **Step 6**:

   - Press right mouse button and choose the **Add to block** command from the context menu.

     or

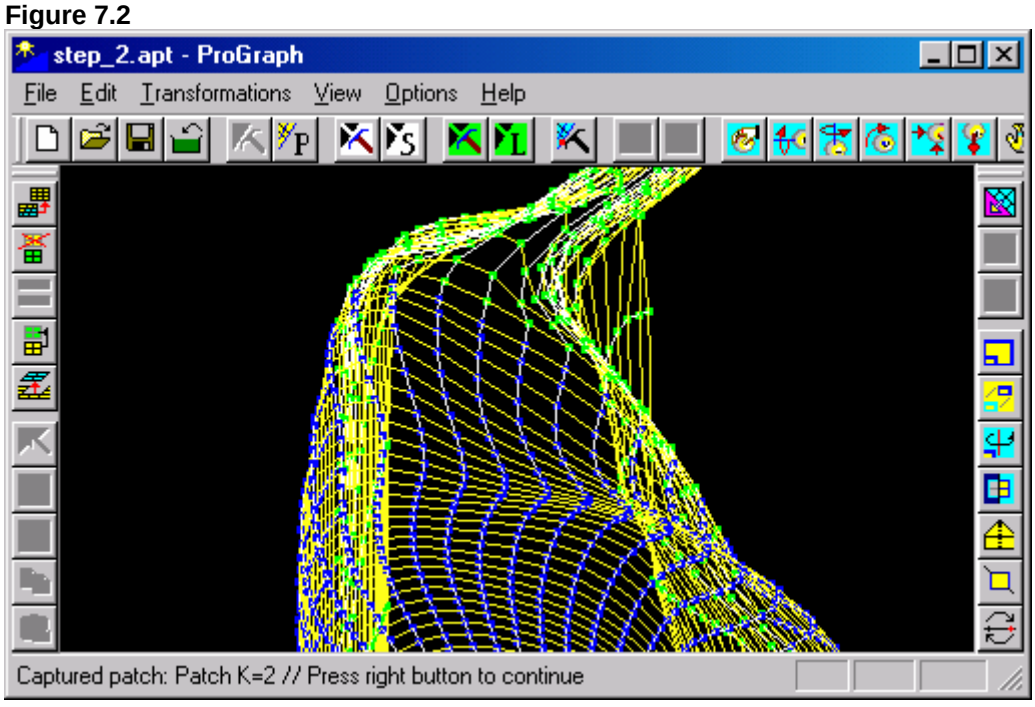
   - Click the following icon from the left toolbar:

   Figure 7.1

   Then cursor shape will be changed to .

2. Click the patch. Then the captured patch will be painted with a yellow color and its points will be represented as green markers. The captured patch will be inputted to the block and its number will appear in Status Bar. (For more information about colors see **Step 5**.)

   Figure 7.2



Step 8. How to remove a patch from the block

1. To remove a patch from the block created at **Step 7**:

   - Press right mouse button and choose the **Remove from block** command from the context menu.

   or

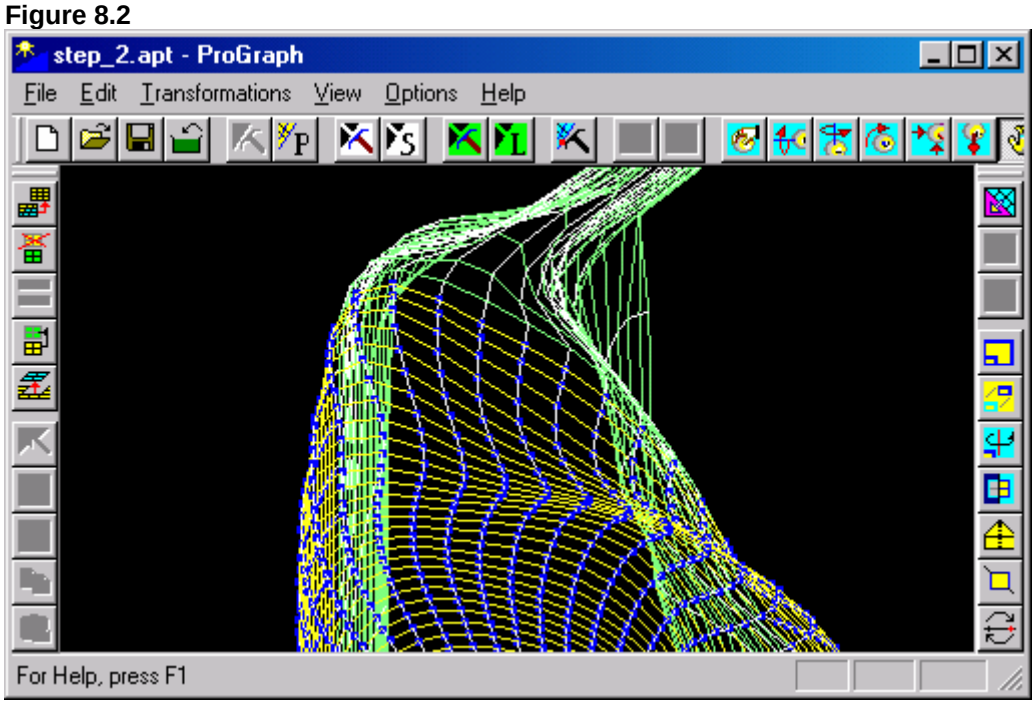
   - Click the following icon from the left toolbar:

   Figure 8.1

   Then cursor shape will be changed to .

2. Click the patch. Then the initial color of removed patch will be restored. (For more information about colors see **Step 2** and **Step 5**.) The patch isn't deleted from the Geometry and remains on its place.

   Figure 8.2



Step 9. A set of one-action operations with block

1. To delete all needed patches included in the block created at **Step 8**:

   - Choose the **Patches ~ Block delete** command from the **Edit** menu.

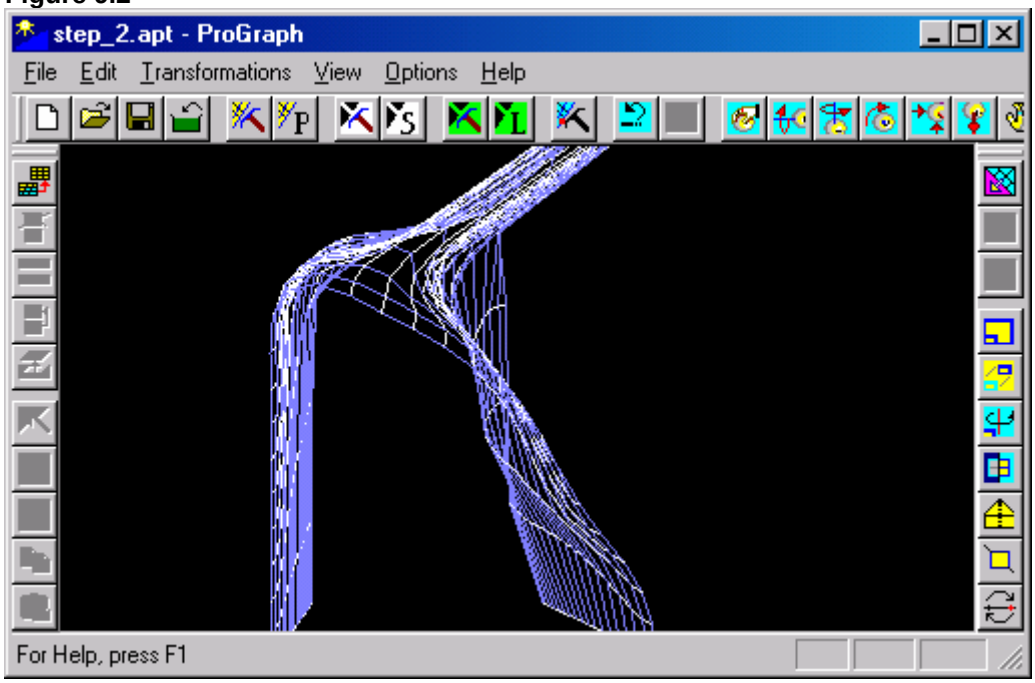
     or

   - Click the following icon from the left toolbar:

Figure 9.1

Only the patches that aren't included in the block remain on your screen. Their colors are changed. (For more information about colors see **Step 2.**)

Figure 9.2



2. To undo all changes:

   - Choose the **Patches ~ Undo** command from the **Edit** menu.

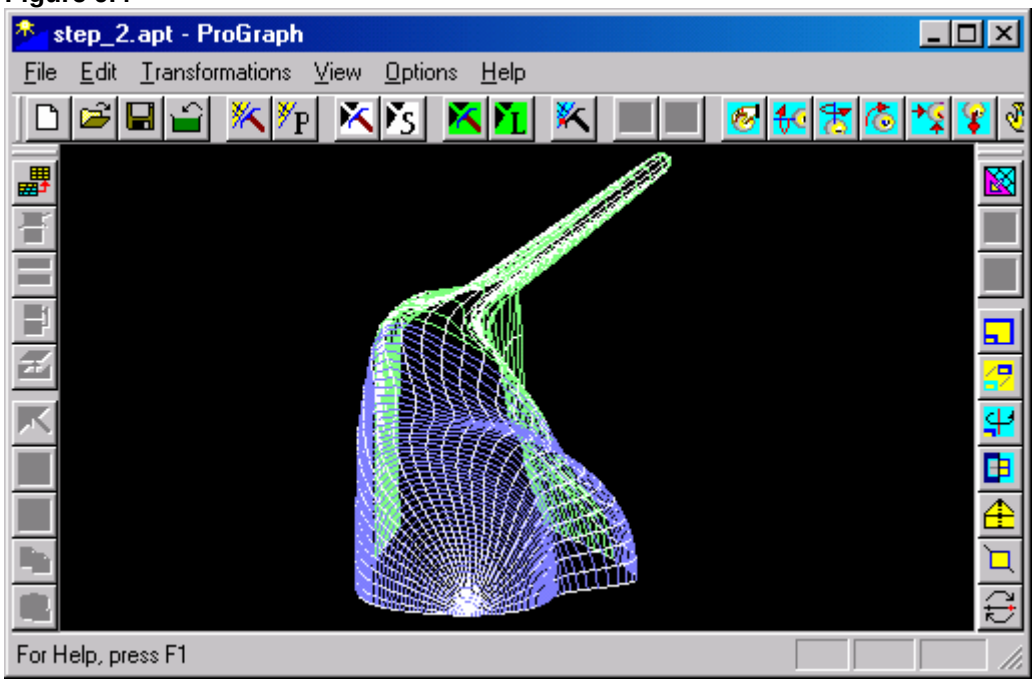
     or

   - Click the following icon from the upper toolbar:

Figure 9.3

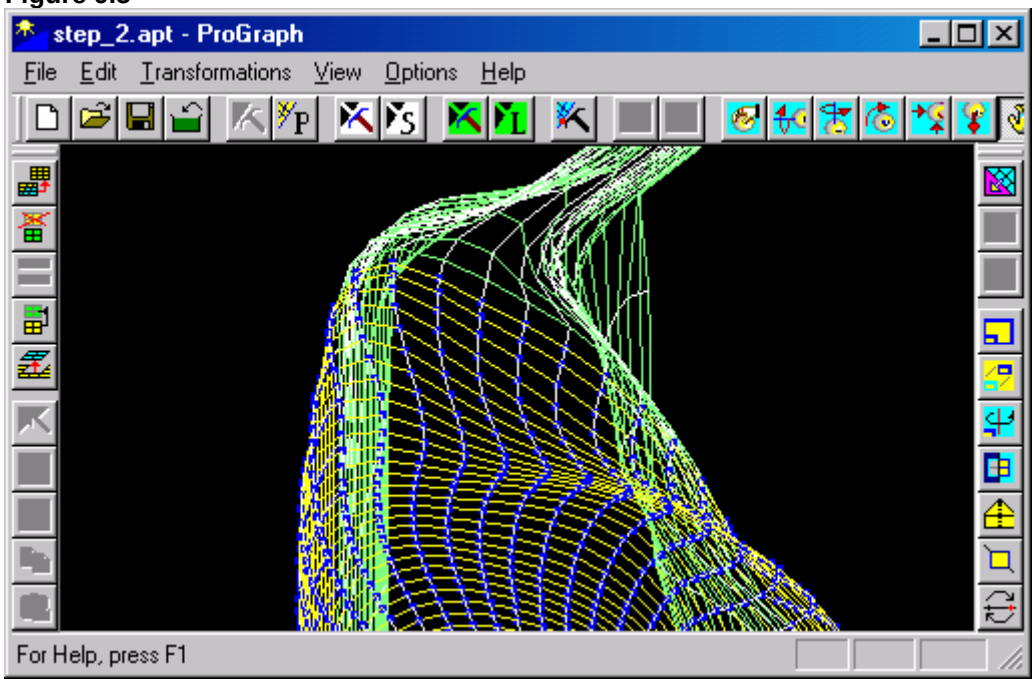
Then old Geometry will appear on your screen again.

Figure 9.4



3. Capture the patch with the number 1. (For more information see steps 2-3 of **Step 5**.)

Figure 9.5



4. To keep all the patches included in the block:

   - Choose the **Patches ~ Block extract** command from the **Edit** menu.

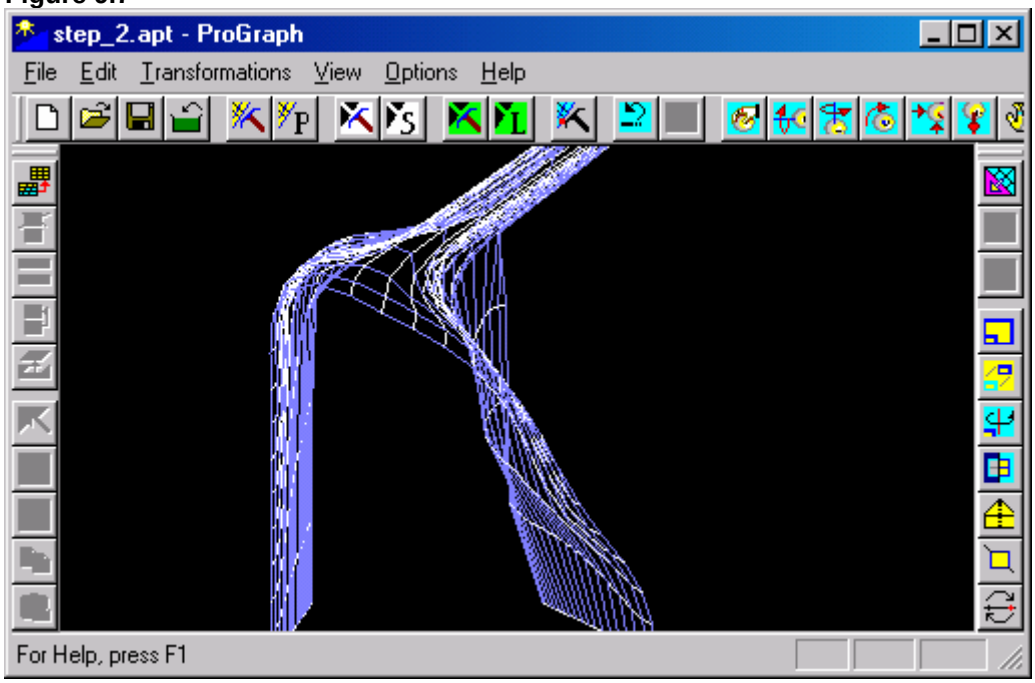
or

- Click the following icon from the left toolbar:

Figure 9.6

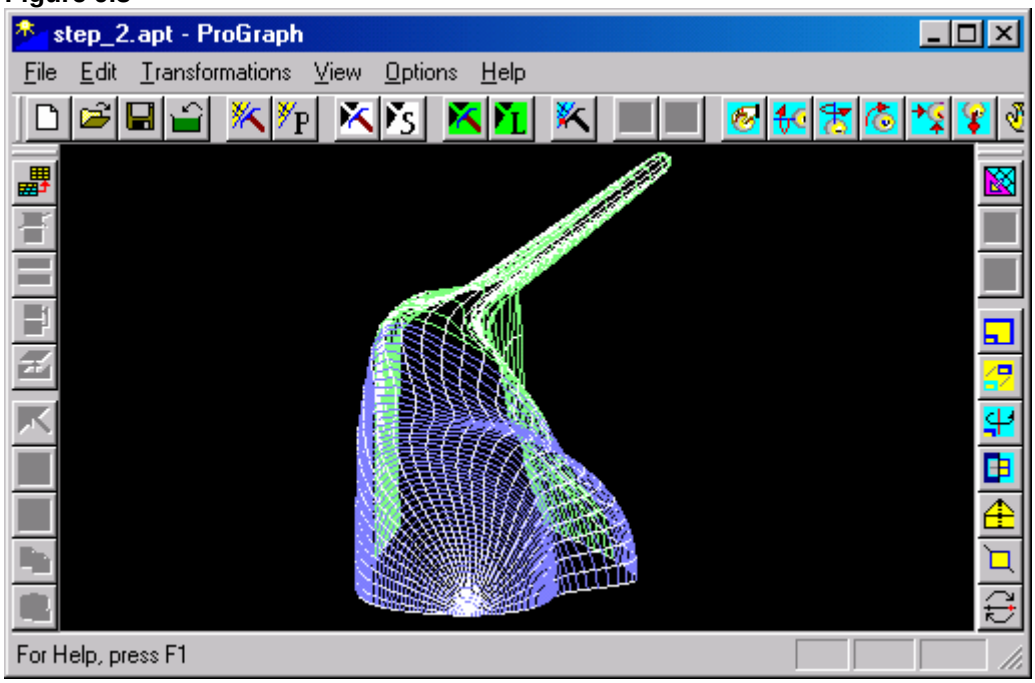
Only the patches included in the block remain on your screen. Their colors may be changed. (For more information about colors see **Step 2.**)

Figure 9.7



5. To undo all changes choose the **Patches ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

Figure 9.8

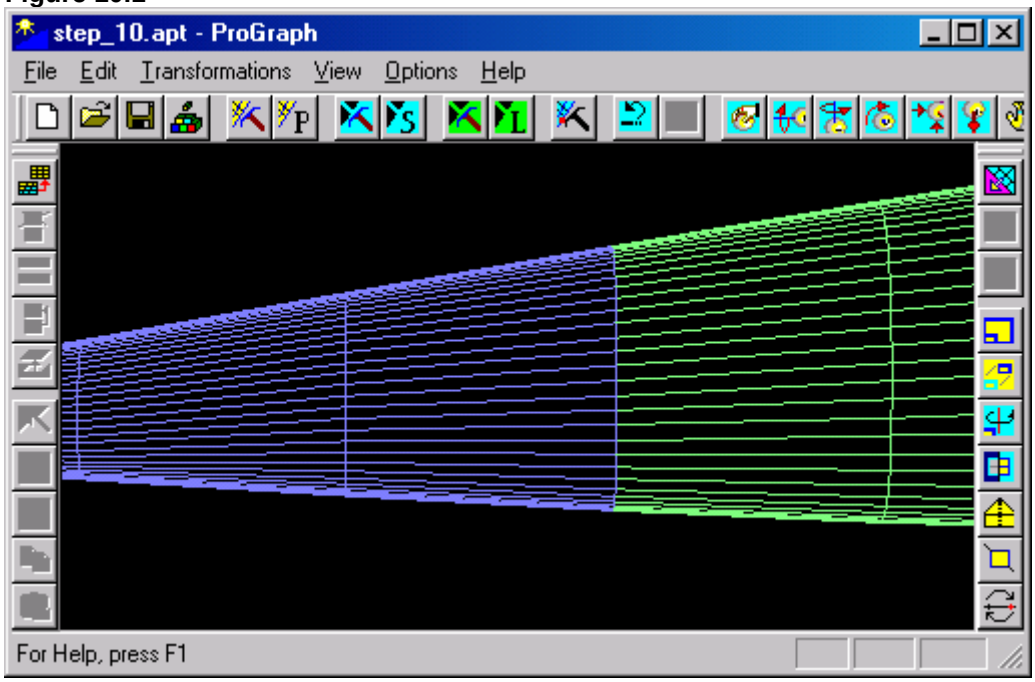

step_2.apt - ProGraph
File Edit Transformations View Options Help
For Help, press F1

Step 10. How to convert files to another format

Introduction. In *ProGraph* the main attention is paid on editing structured grid surfaces. So, during the work with non-structured grids, it is convenient to convert them into structured format (APT). It permits to use many commands of *ProGraph*. When it is necessary, structured grid may be easily converted back into non-structured grid format (VRML)

1. Open an existing file STEP_10.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

Figure 10.1



2. To convert this file to DAT format:

   - Choose the **Convert to ~ VRML or DAT** command from the **Transformations** menu.

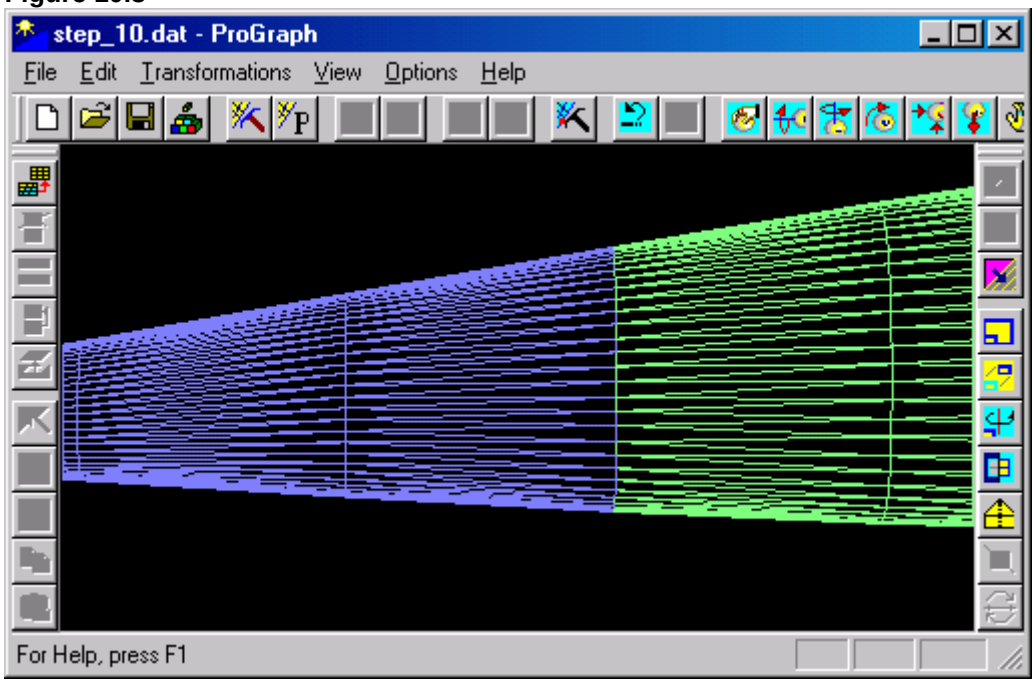
   or

   - Click the following icon from the right toolbar:

Figure 10.2

Then the file of DAT format will appear on your screen.

Figure 10.3



3. To convert this file to SKL format:

   - Choose the **Convert to ~ SKL...** command from the **Transformations** menu.

     or

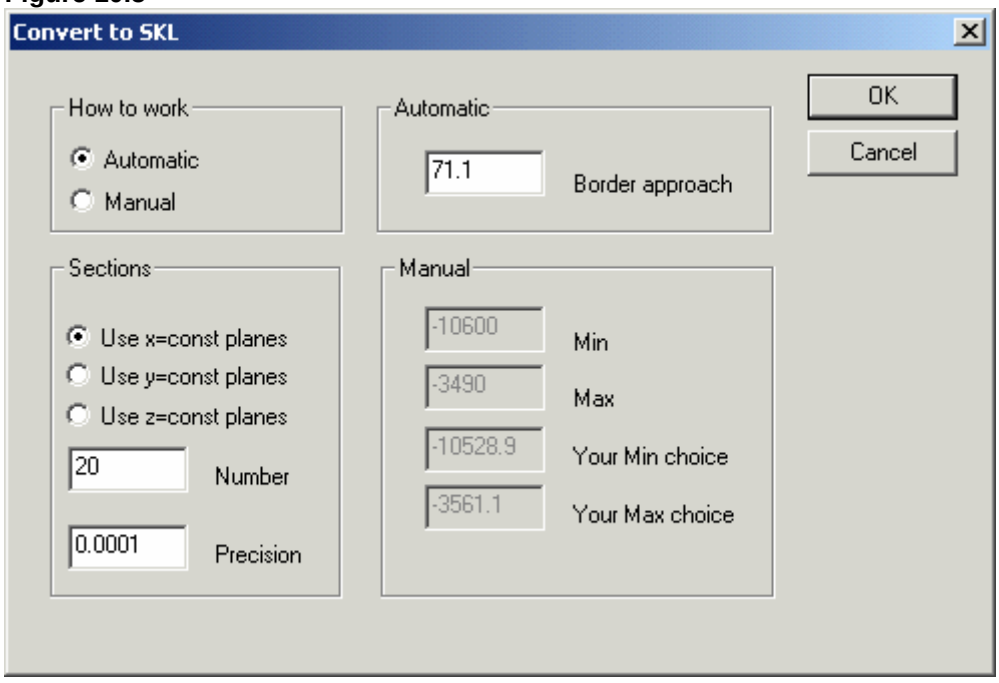
   - Click the following icon from the right toolbar:

   Figure 10.4

   Then the ***Convert to SKL Dialog Box*** will appear on your screen.

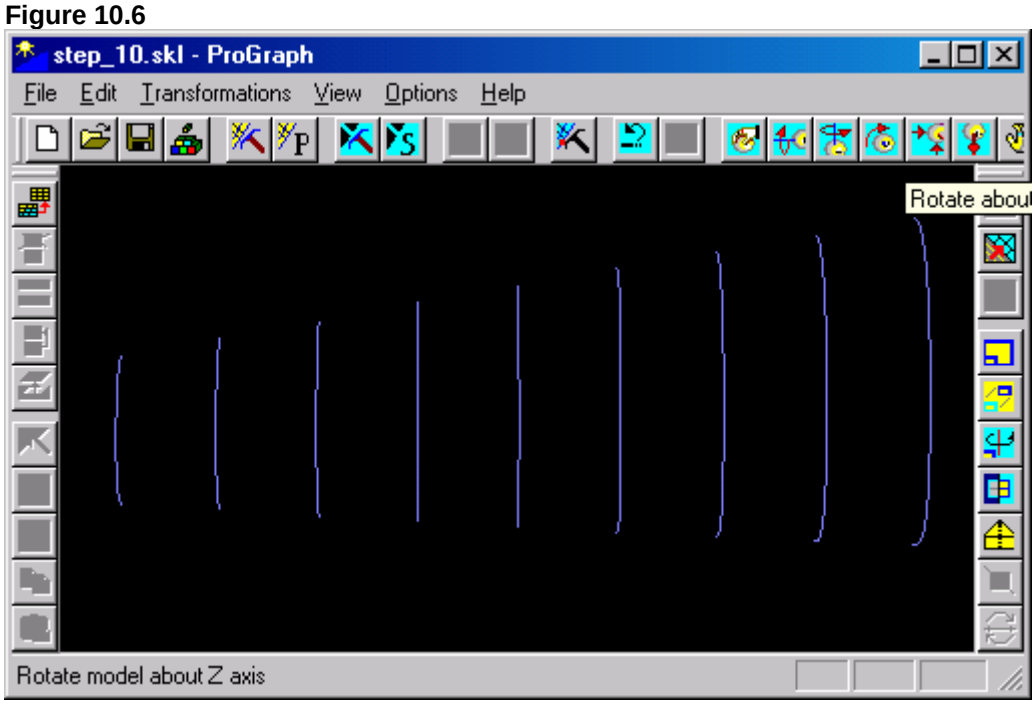
4. Choose all needed parameters in the ***Convert to SKL Dialog Box*** as shown below.

Figure 10.5



5. Click the **OK** control button. Then the file of SKL format will appear on your screen.

Figure 10.6



6. To undo all changes:

- Choose the **Patches ~ Undo** command from the **Edit** menu.

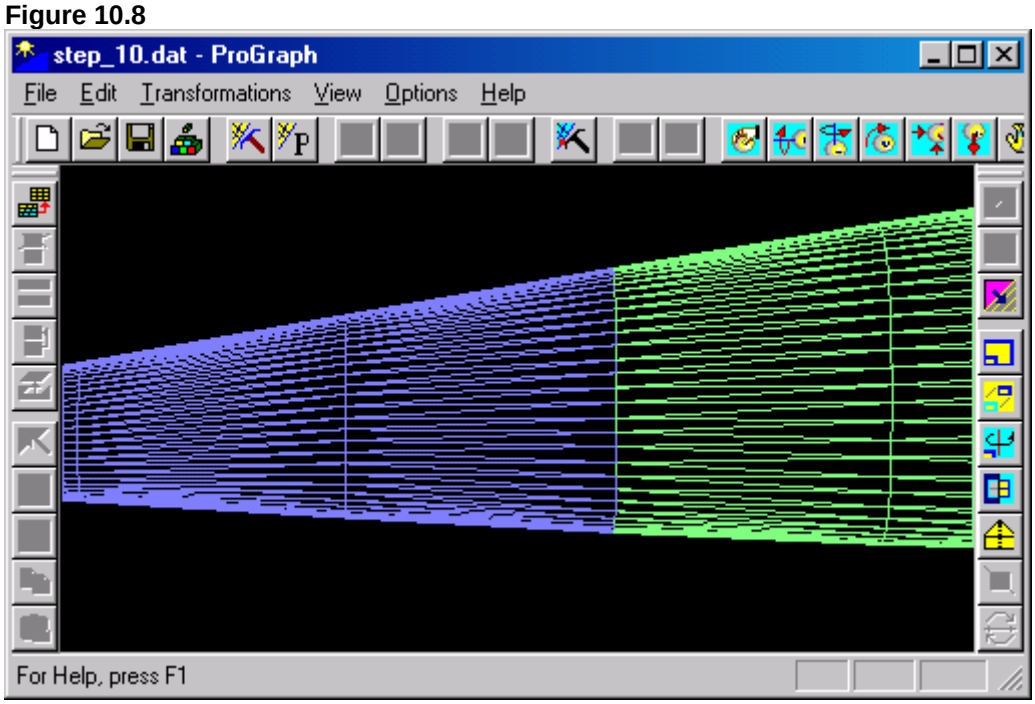
or

- Click the following icon from the upper toolbar:

Figure 10.7

Then old Geometry will appear on your screen again.

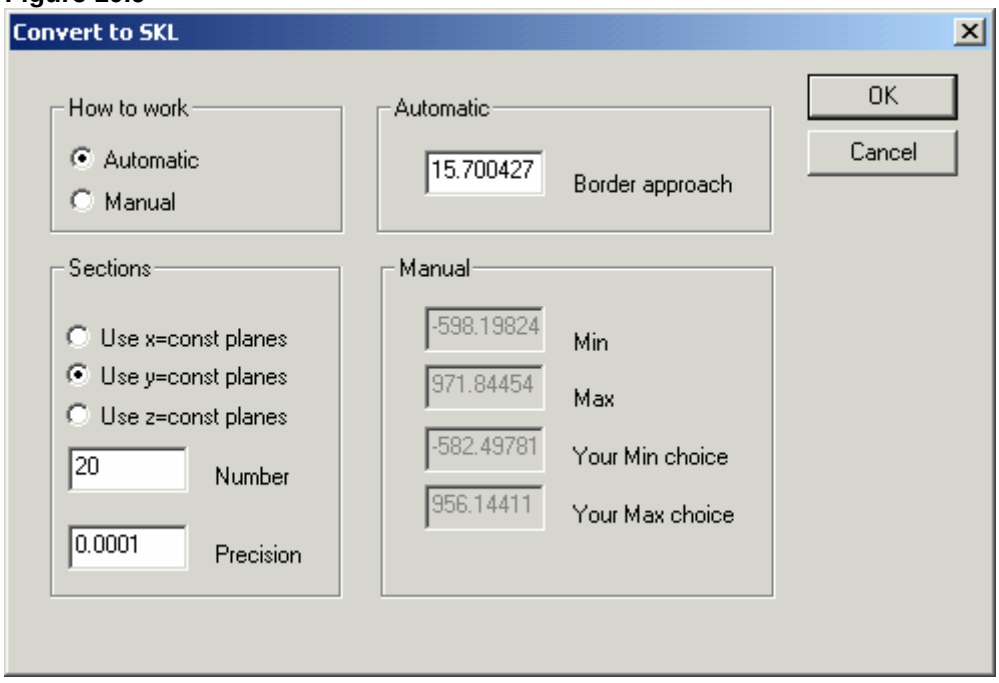
Figure 10.8



7. Choose the **Convert to ~ SKL...** command from the **Transformations** menu again. Then the ***Convert to SKL Dialog Box*** will appear on your screen.

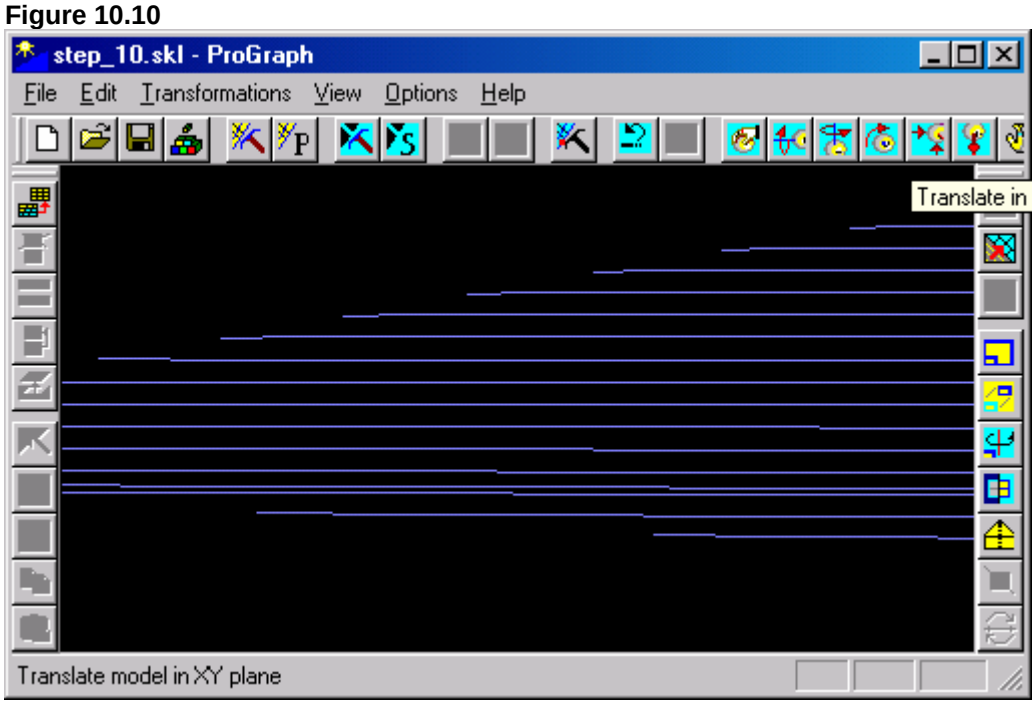
8. Choose all needed parameters in the ***Convert to SKL Dialog Box*** as shown below.

Figure 10.9



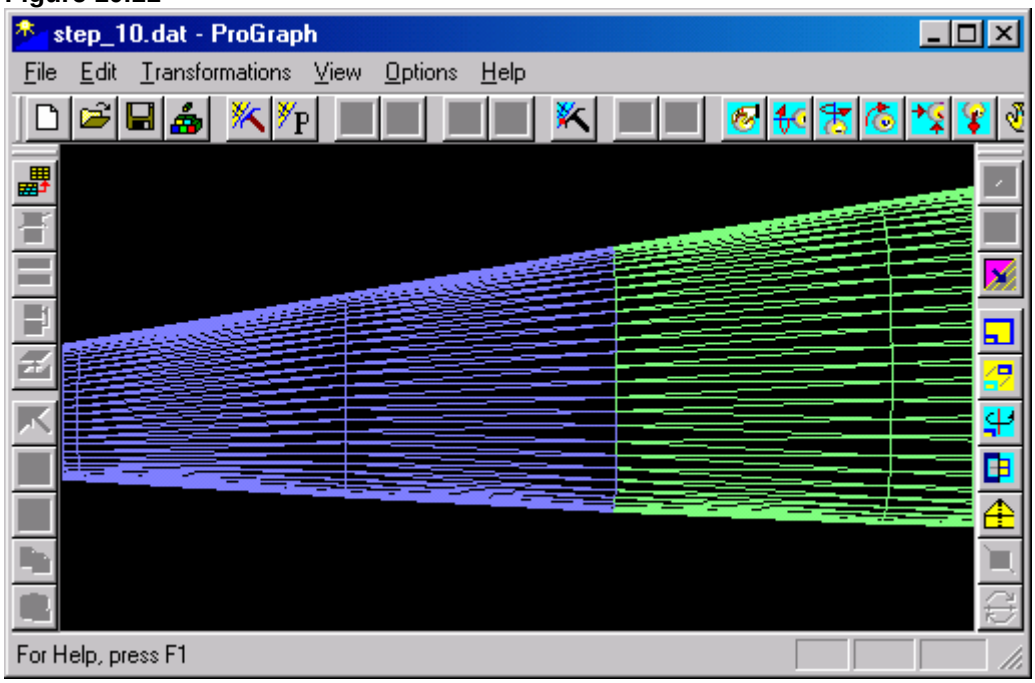
9. Click the **OK** control button. Then the file of SKL format will appear on your screen.

Figure 10.10



10. To undo all changes choose the **Patches ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

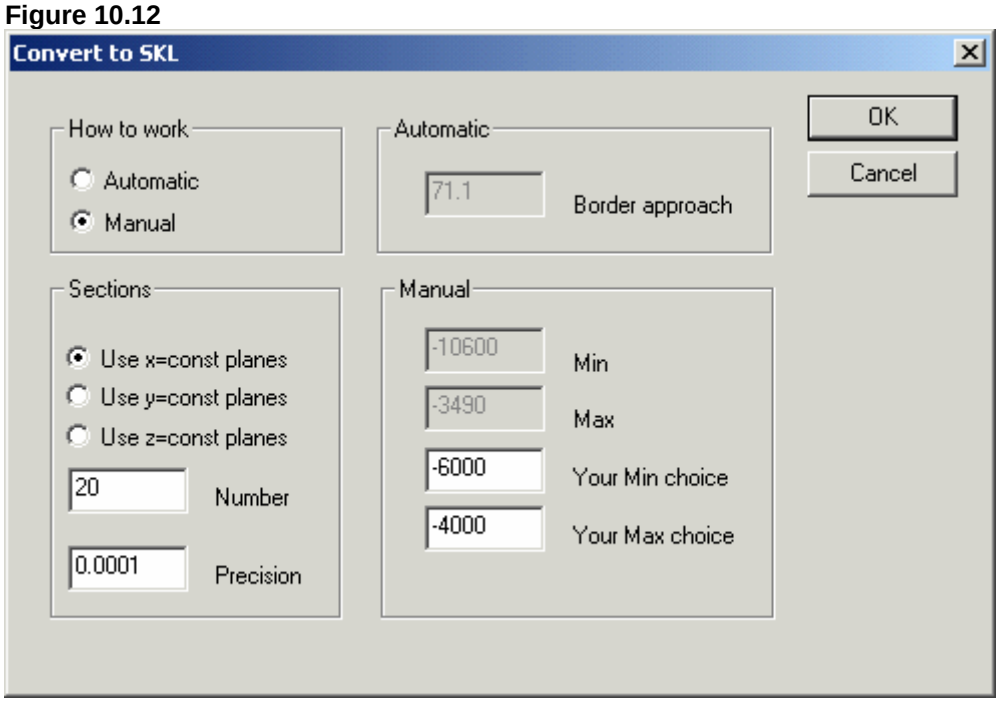
Figure 10.11



11. Choose the **Convert to ~ SKL...** command from the **Transformations** menu again. Then the ***Convert to SKL Dialog Box*** will appear on your screen.

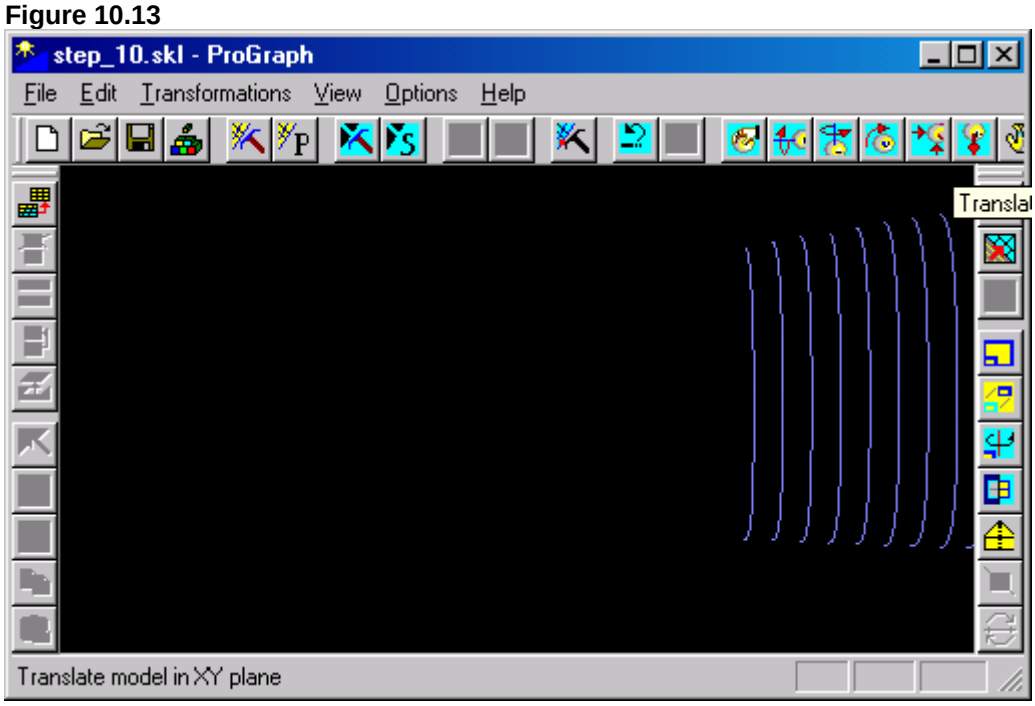
12. Choose all needed parameters in the ***Convert to SKL Dialog Box*** as shown below.

Figure 10.12



13. Click the **OK** control button. Then the file of SKL format will appear on your screen.

Figure 10.13



14. To convert this file to APT format:

- Choose the **Convert to ~ APT...** command from the **Transformations** menu.

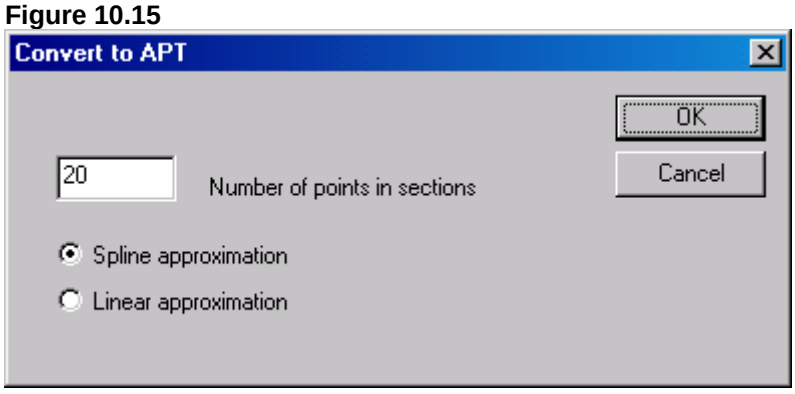
or

- Click the following icon from the right toolbar:

Figure 10.14

Then the ***Convert to APT Dialog Box*** will appear on your screen.

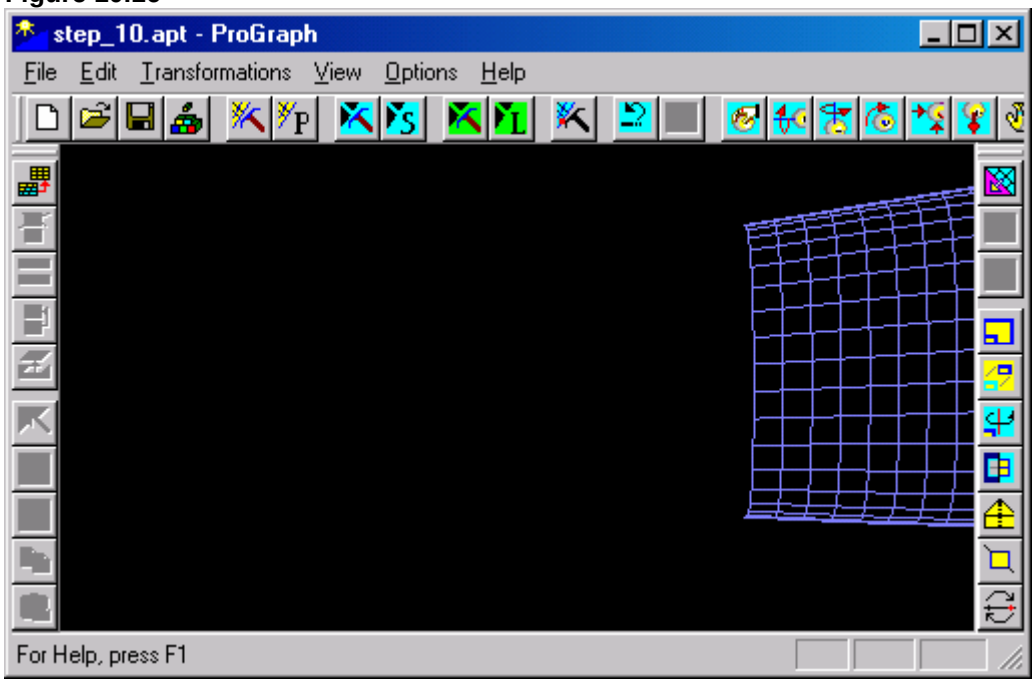
Figure 10.15



15. Choose all needed parameters in the ***Convert to APT Dialog Box*** as shown above.

16. Click the **OK** control button. Then the file of APT format will appear on your screen.

Figure 10.16



Step 11. How to capture a section

Introduction. The special attention in *ProGraph* ideology is devoted sections and lines (structured grid). For example, sections are fuselage frames and lines are fuselage stringers. Mathematically, sections correspond to columns of matrix that defines the Geometry grid and lines correspond to its rows.

In some cases, the Geometry is defined partly. For example, the Geometry is given by reading a sketch using Digitizer. Then each section may contain arbitrary number of points (the matrix isn't filled in). In this case, there are sections but there are no lines (SKL format).

Section (line) capturing is the first operation in local editing the Geometry. After section (line) capturing, all the commands that are available in right-mouse menu will act on captured section (line) only. For example, one can capture a point that belongs to captured section (line) only.

This **Step** describes one of the most frequently used procedures - how to capture a section.

1. Open an existing file STEP_2.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

2. To capture the section:

   - Choose the **Lines ~ Capture ~ Section** command from the **Edit** menu.

   or

   - Click the following icon from the upper toolbar:

   Figure 11.1

   Then cursor shape will be changed to .

3. Then:

   - Press left mouse button and drag the mouse. The points of section under cursor will be painted with a white color and section and patch numbers will appear in Status Bar. Releasing the mouse button captures the section.

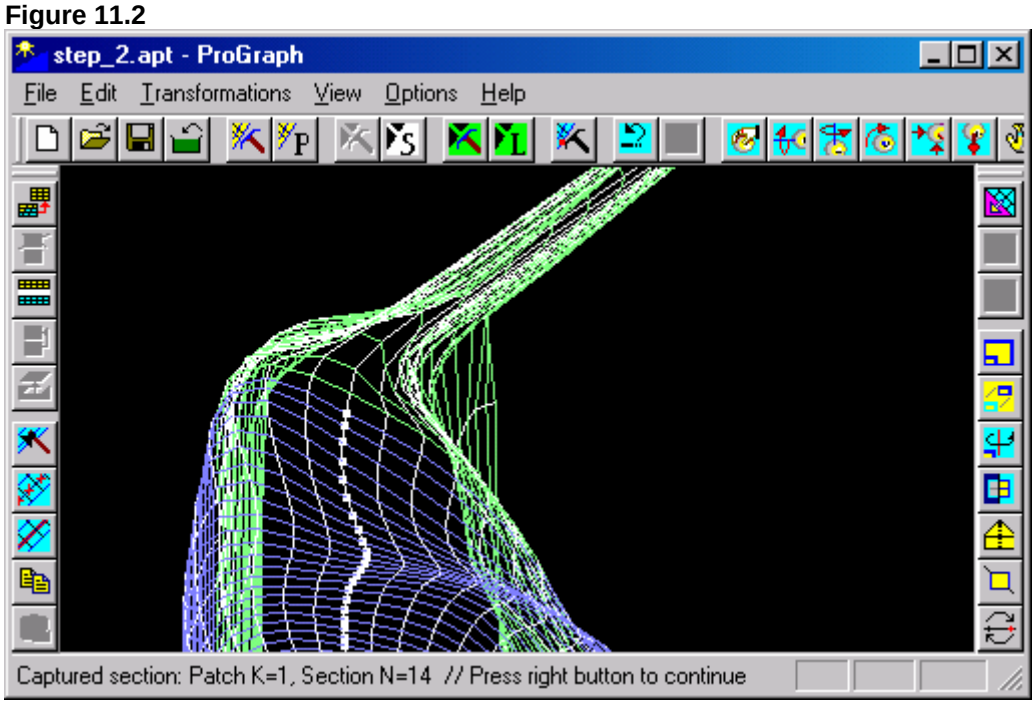
   or

   - Click the section.

Then the points of captured section will be painted with a white color.

When a block has been created, only a section belonging to this block may be captured. When no patches are included in the block, any section may be captured.

Figure 11.2



Step 12. How to capture a section with the use of *Input ~ Section* command

1. Open an existing file STEP_2.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

2. To capture the section:

   - Choose the **Lines ~ Input ~ Section...** command from the **Edit** menu.

   or

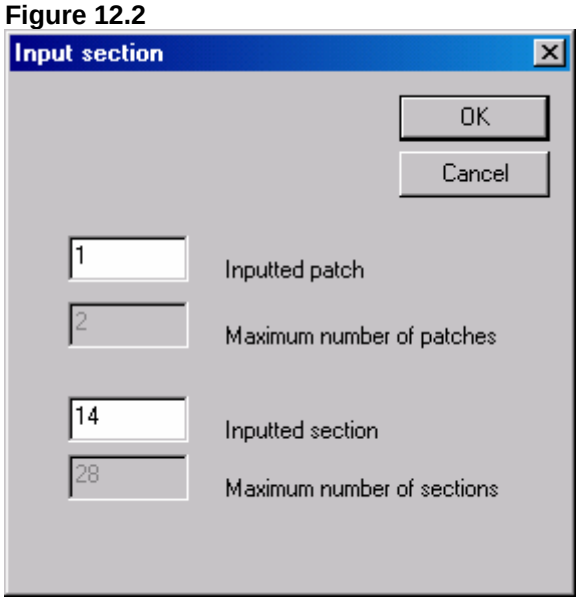
   - Click the following icon from the upper toolbar:

   Figure 12.1

   Then the ***Input section Dialog Box*** will appear on your screen.

3. Choose all needed parameters in the ***Input section Dialog Box*** as shown below.

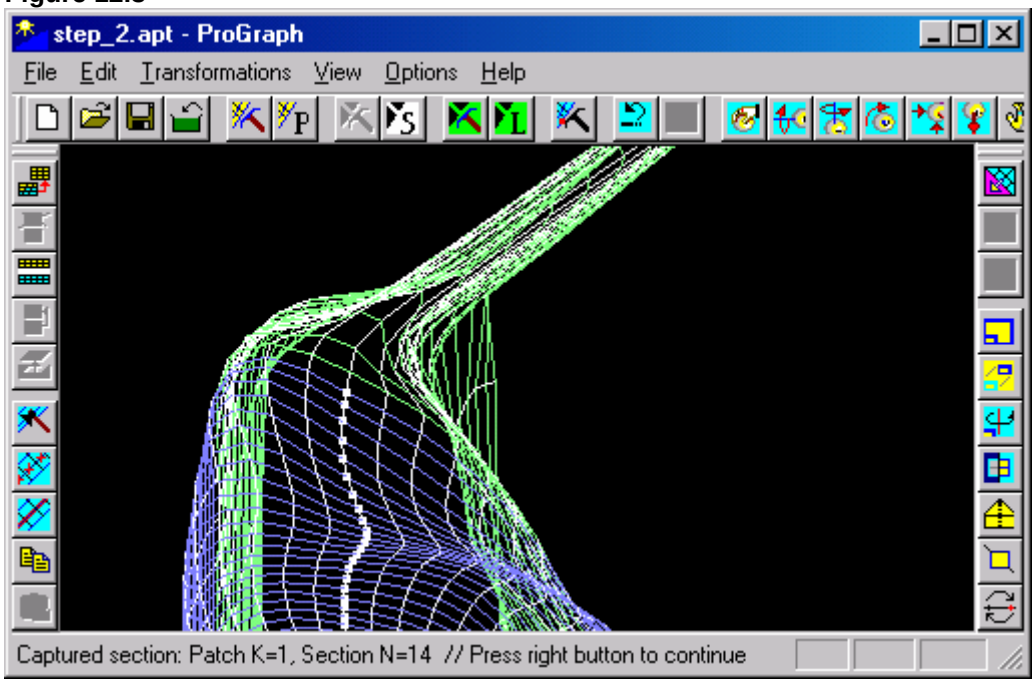
   Figure 12.2

4. Click the **OK** control button. The points of captured section are painted with a white color and section and patch numbers appear in Status Bar.

   When a block has been created, only a section belonging to this block may be captured. When no patches are included in the block, any section may be captured.

Figure 12.3


step_2.apt - ProGraph
File Edit Transformations View Options Help
Captured section: Patch K=1, Section N=14 // Press right button to continue

Step 13. How to capture a line

1. Open an existing file STEP_2.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

2. To capture the line:

   - Choose the **Lines ~ Capture ~ Line** command from the **Edit** menu.

   or

   - Click the following icon from the upper toolbar:

   Figure 13.1

   Then cursor shape will be changed to .

3. Then:

   - Press left mouse button and drag the mouse. The points of line under cursor will be painted with a white color and line and patch numbers will appear in Status Bar. Releasing the mouse button captures the line.

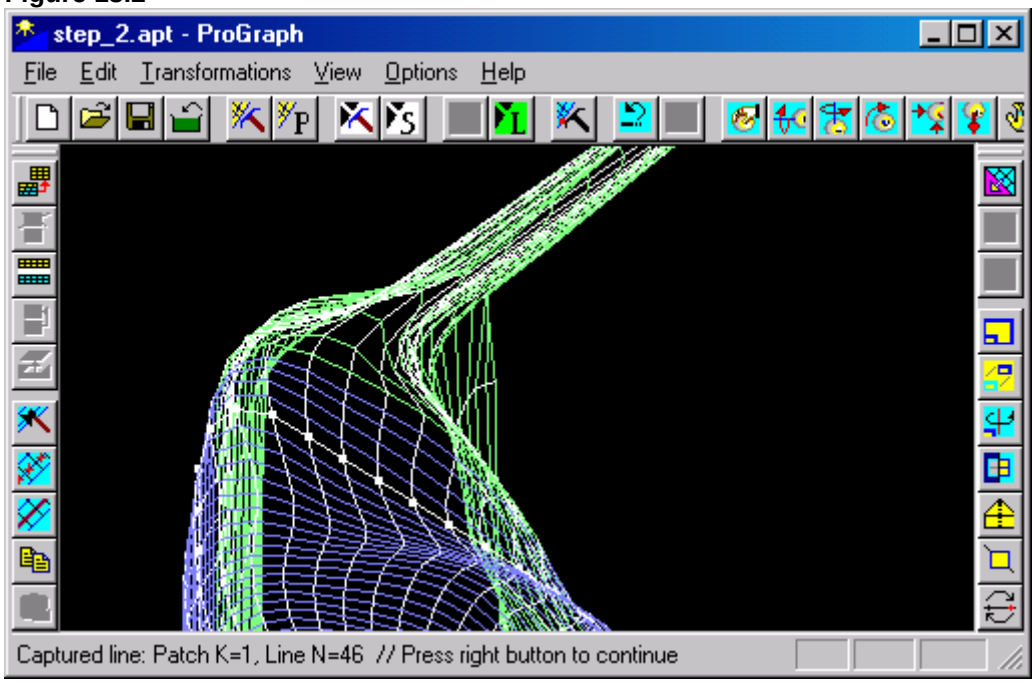
   or

   - Click the line.

   Then the points of captured line will be painted with a white color.

   When a block has been created, only a line belonging to this block may be captured. When no patches are included in the block, any line may be captured.

Figure 13.2


step_2.apt - ProGraph
File Edit Transformations View Options Help
Captured line: Patch K=1, Line N=46 // Press right button to continue

Step 14. How to capture a line with the use of *Input ~ Line* command

1. Open an existing file STEP_2.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

2. To capture the line:

   - Choose the **Lines ~ Input ~ Line...** command from the **Edit** menu.

   or

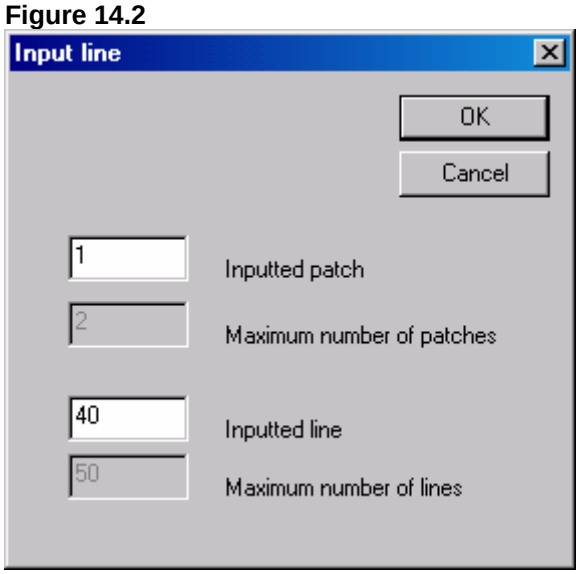
   - Click the following icon from the upper toolbar:

   Figure 14.1

   Then the ***Input line Dialog Box*** will appear on your screen.

3. Choose all needed parameters in the ***Input line Dialog Box*** as shown below.

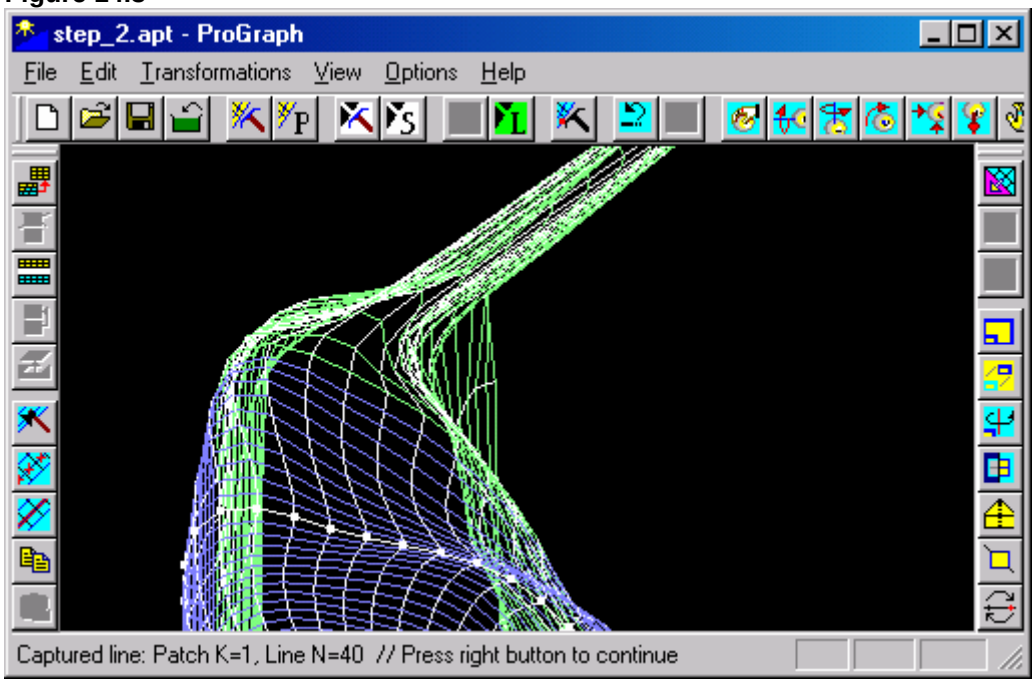
   Figure 14.2

4. Click the **OK** control button. The points of captured line are painted with a white color and line and patch numbers appear in Status Bar.

   When a block has been created, only a line belonging to this block may be captured. When no patches are included in the block, any line may be captured.

Figure 14.3


step_2.apt - ProGraph
File Edit Transformations View Options Help
Captured line: Patch K=1, Line N=40 // Press right button to continue

Step 15. How to split a patch on two patches

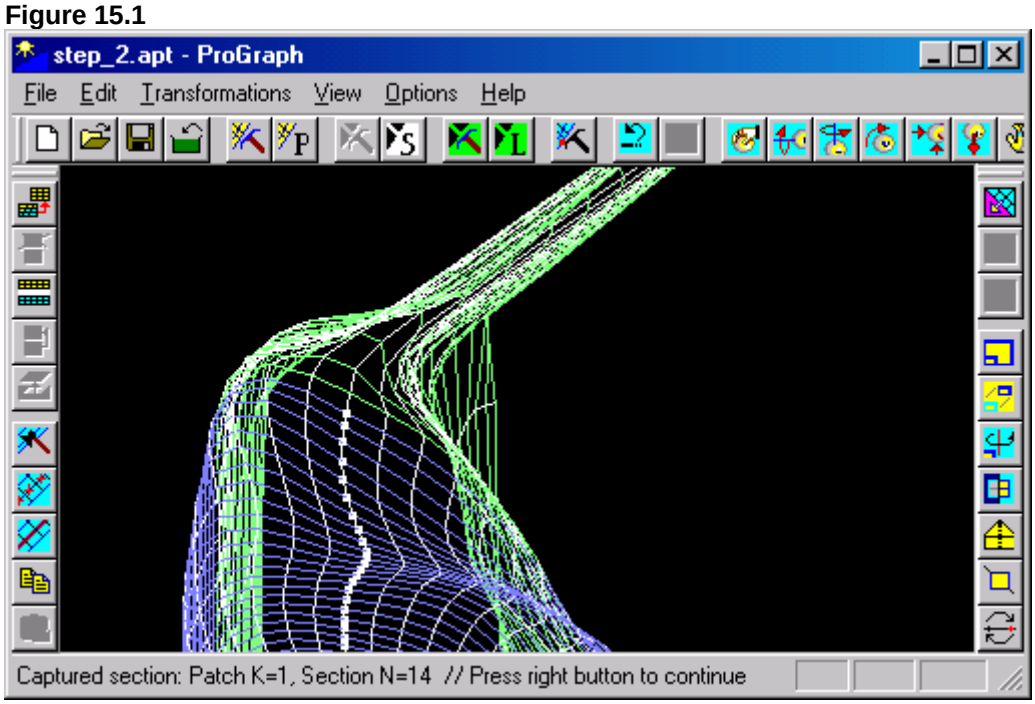
Introduction. During the work with *ProGraph*, sometimes it is necessary to create additional patches. We recommend you to do it when you need to select the Geometry part for detailed approximation of this zone during processing the experimental data.

This **Step** describes how to create additional patches, in the case of structured Geometry grid. In the case of non-structured grid, it is recommended to convert it into a structured format as it is shown in **Step 10**.

1. Open an existing file STEP_2.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

2. Capture a section. (For more information see steps 2-3 of **Step 11**.)

Figure 15.1



3. To split a patch on two patches:

   - Press right mouse button and choose the **Split patch in block** command from the context menu.

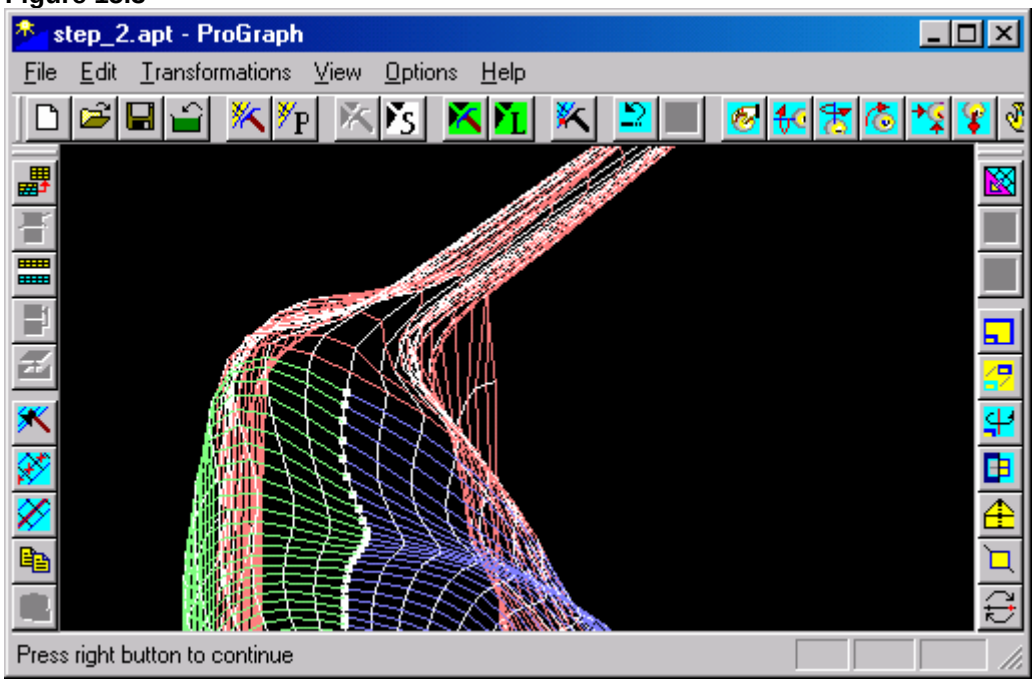
   or

   - Click the following icon from the left toolbar:

Figure 15.2

Then the patch that contains the captured section will be split. This section is used as a border of two new patches. The captured section belongs to both patches. The colors of patches will be changed. (For more information about colors see **Step 2.**)

Figure 15.3



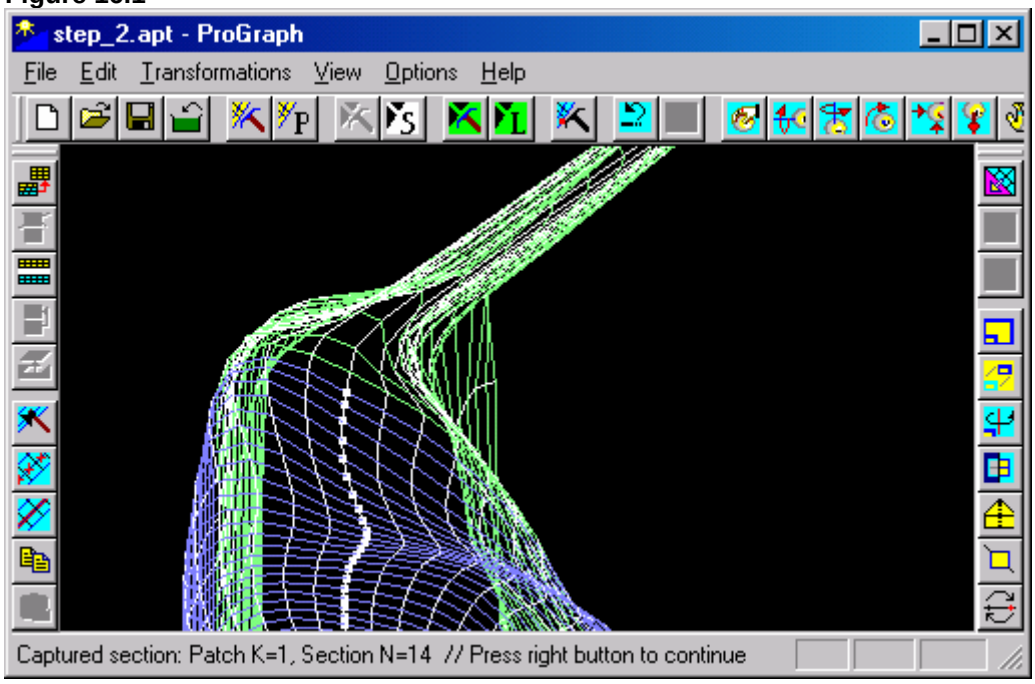
Step 16. A set of one-action operations with sections

Introduction. In this **Step** the most frequently used commands are described. Use them for Geometry editing.

1. Open an existing file STEP_2.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

2. Capture a section. (For more information see steps 2-3 of **Step 11**.)

Figure 16.1



3. To delete the captured section:

   - Press right mouse button and choose the **Delete** command from the context menu.

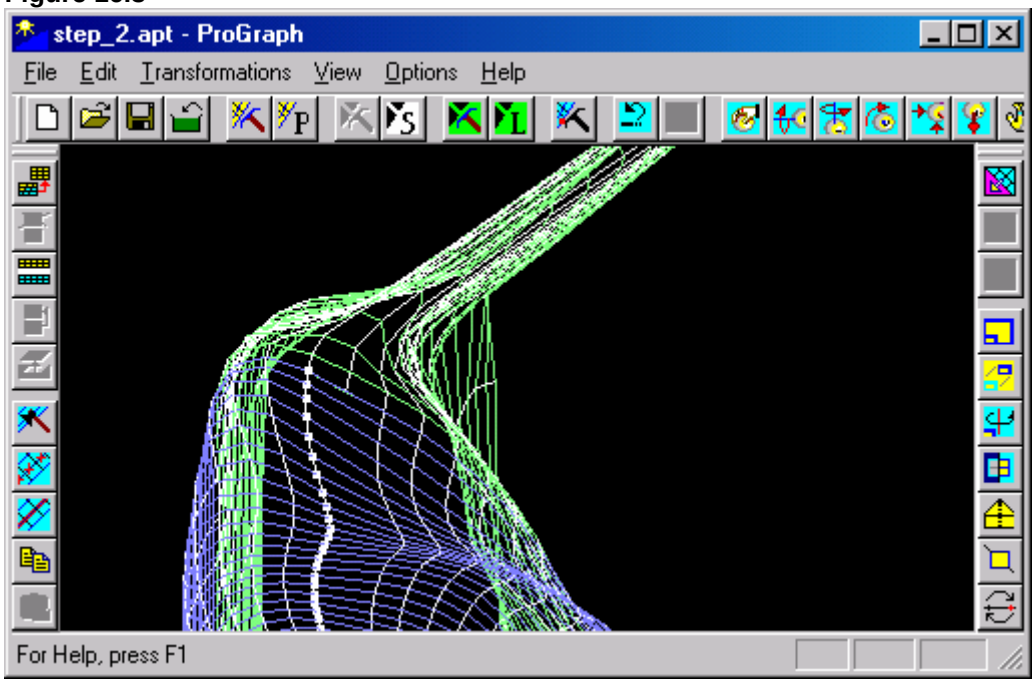
     or

   - Click the following icon from the left toolbar:

Figure 16.2

Then the captured section will be deleted. The next section becomes the captured one.

Figure 16.3



4. To undo all changes:

   - Choose the **Lines ~ Undo** command from the **Edit** menu.

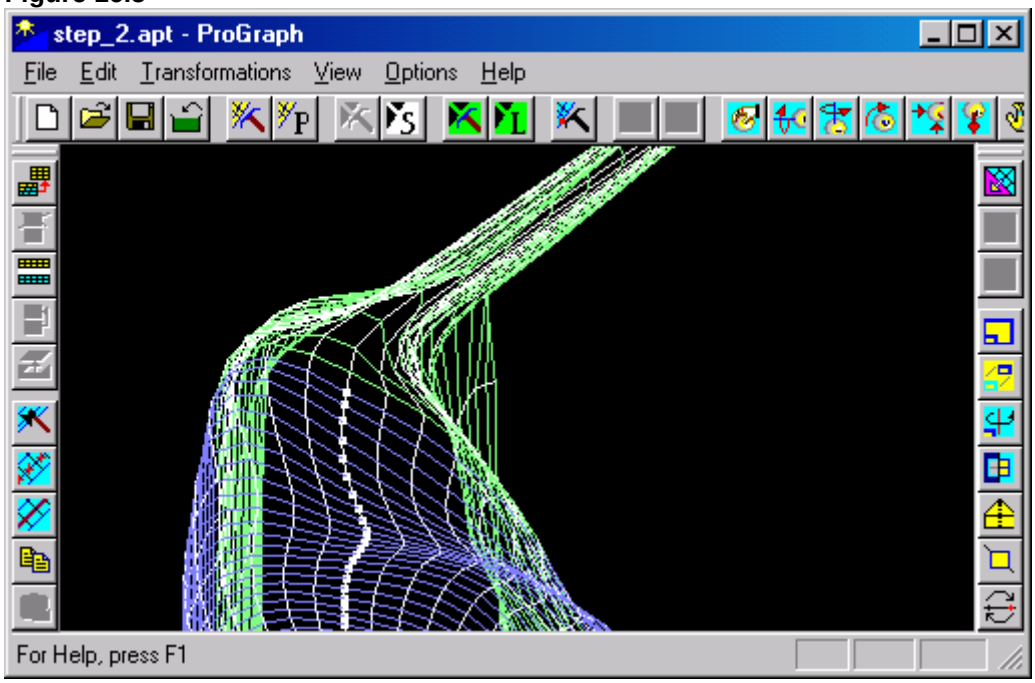
     or

   - Click the following icon from the upper toolbar:

Figure 16.4

Then old Geometry will appear on your screen again.

Figure 16.5



5. To copy the captured section:

   - Press right mouse button and choose the **Duplicate...** command from the context menu.

   or

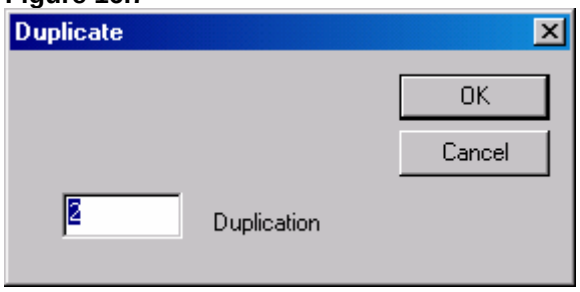
   - Click the following icon from the left toolbar:

Figure 16.6

Then the ***Duplicate Dialog Box*** will appear on your screen.

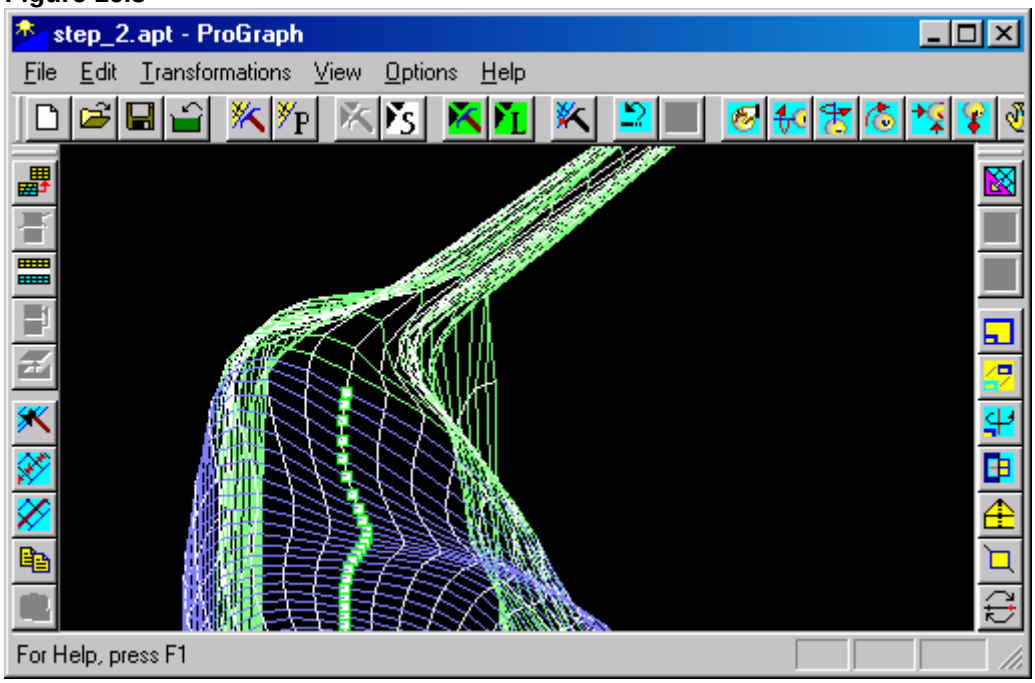
6. Choose all needed parameters in the ***Duplicate Dialog Box*** as shown below.

Figure 16.7



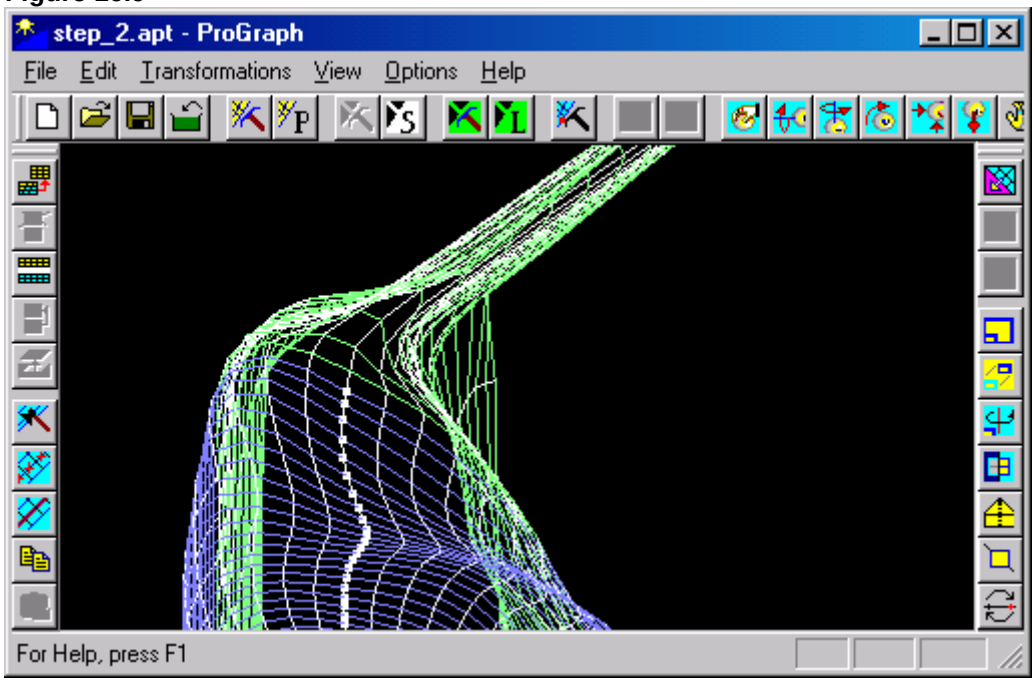
7. Click the **OK** control button. Then the captured section will be duplicated and its points will be distinguished as a white markers with green border.

Figure 16.8



8. To undo all changes choose the **Lines ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

Figure 16.9



9. To copy the captured section to Clipboard:

   - Press right mouse button and choose the **Copy** command from the context menu.

or

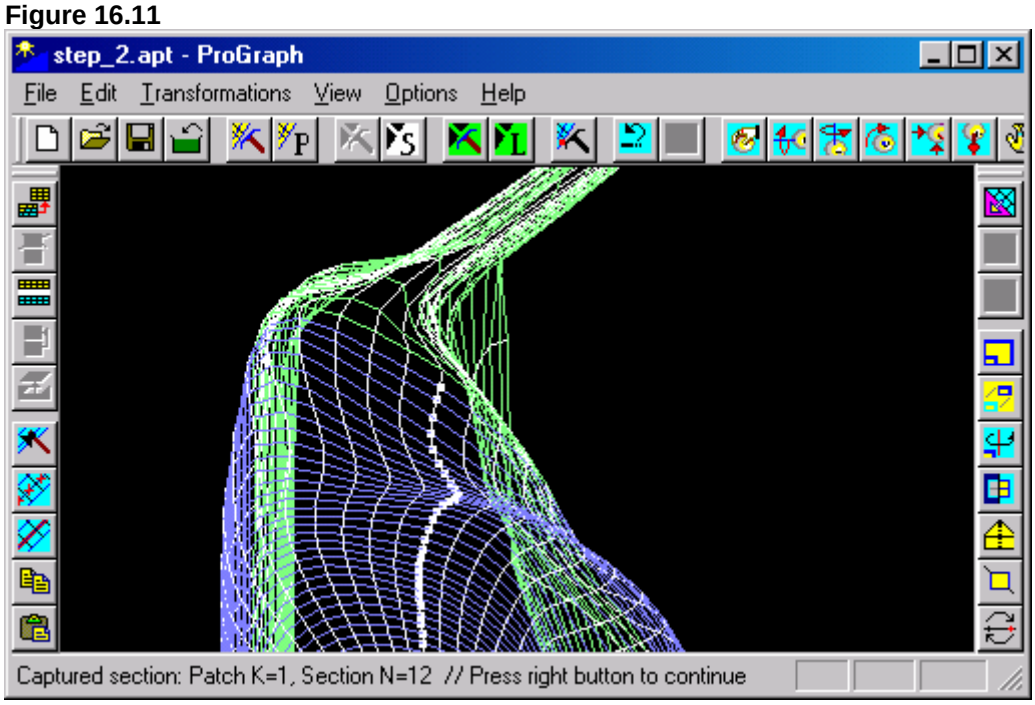
- Click the following icon from the left toolbar:

Figure 16.10

Then the captured section will be copied to Clipboard. It may be placed at any position.

10. To capture another section press right mouse button, choose the **Next Section (Line)** command from the context menu and capture necessary section. (For more information see steps 2-3 of **Step 11**.)

Figure 16.11



11. To place the Clipboard content instead of the captured section:

- Press right mouse button and choose the **Paste** command from the context menu.

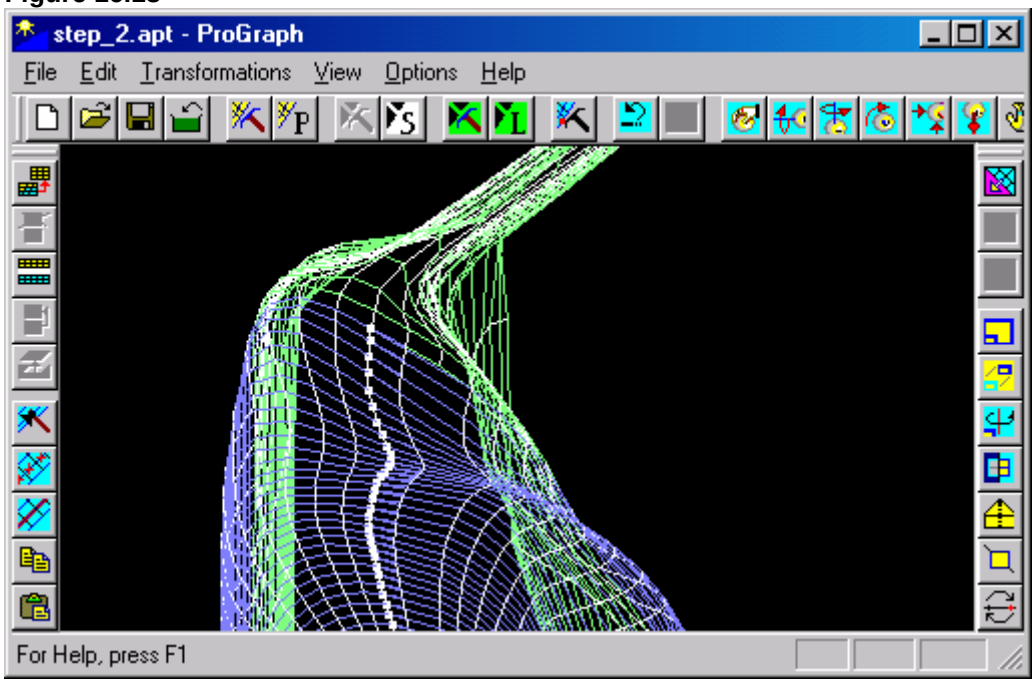
or

- Click the following icon from the left toolbar:

Figure 16.12

Then the Clipboard content will replace the captured section.

Figure 16.13


step_2.apt - ProGraph
File Edit Transformations View Options Help
For Help, press F1

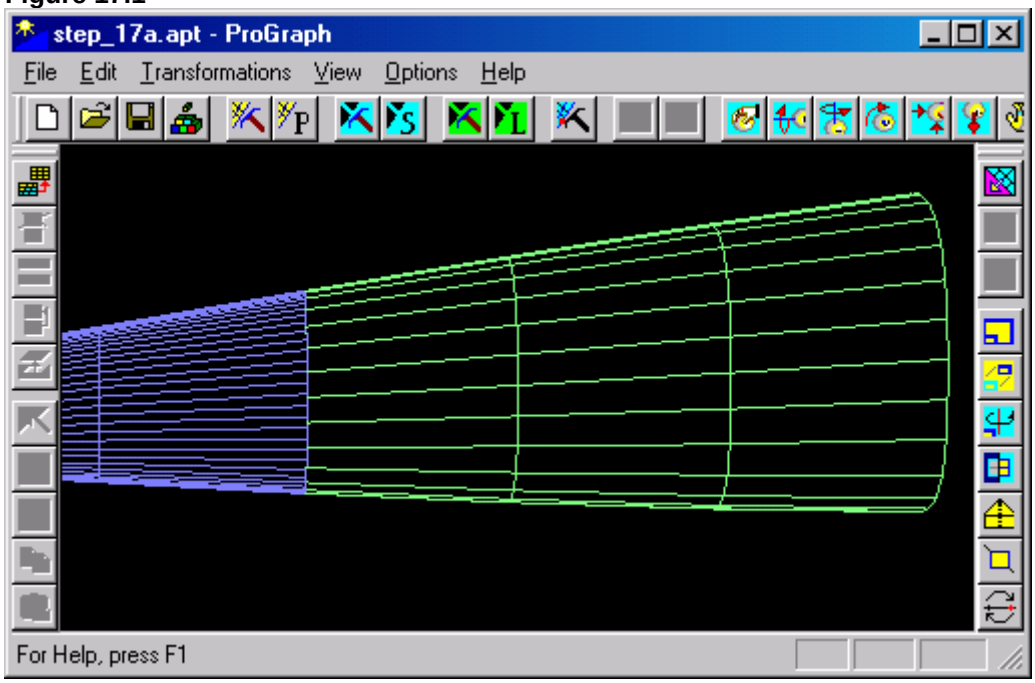
Step 17. How to rebreak a section

Introduction. This command is used most often for practical work. It should be noted that Geometry grid may be deviated from initial one because of this command implementation. It is because smoothing splines act in the framework of some accuracy. So, there is a complex problem: either to agree with oscillations of function defined surface grids or to smooth the Geometry and, hence, to distort it slightly.

This **Step** contains some examples how to use numerous possibilities of the command.

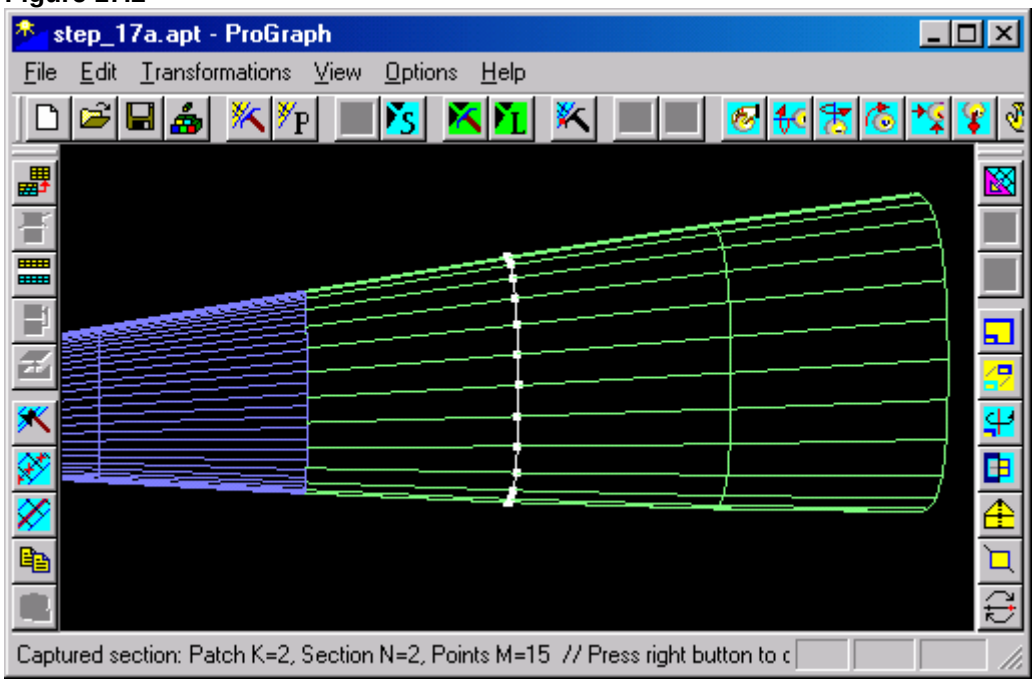
1. Open an existing file STEP_17a.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.) Then the Geometry will appear on your screen.

Figure 17.1



2. Capture the second section of a green patch. (For more information see steps 2-3 of **Step 11**.)

Figure 17.2



3. To rebreak the captured section:

   - Press right mouse button and choose the **Rebreak...** command from the context menu.

   or

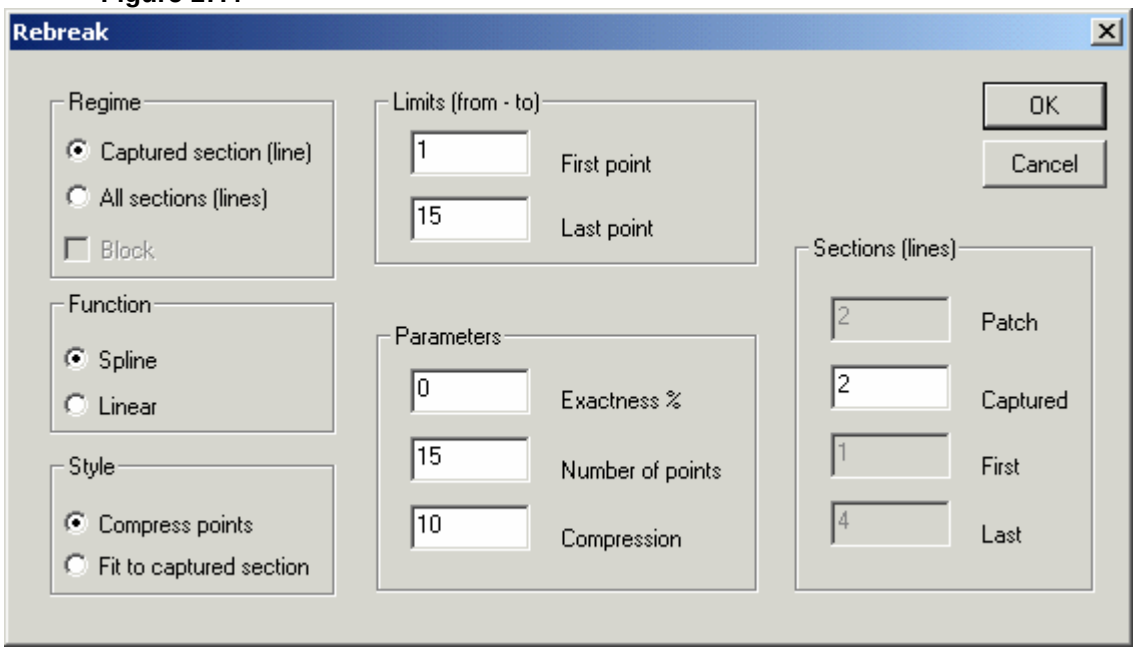
   - Click the following icon from the left toolbar:

   Figure 17.3

   Then the ***Rebreak Dialog Box*** will appear on your screen.

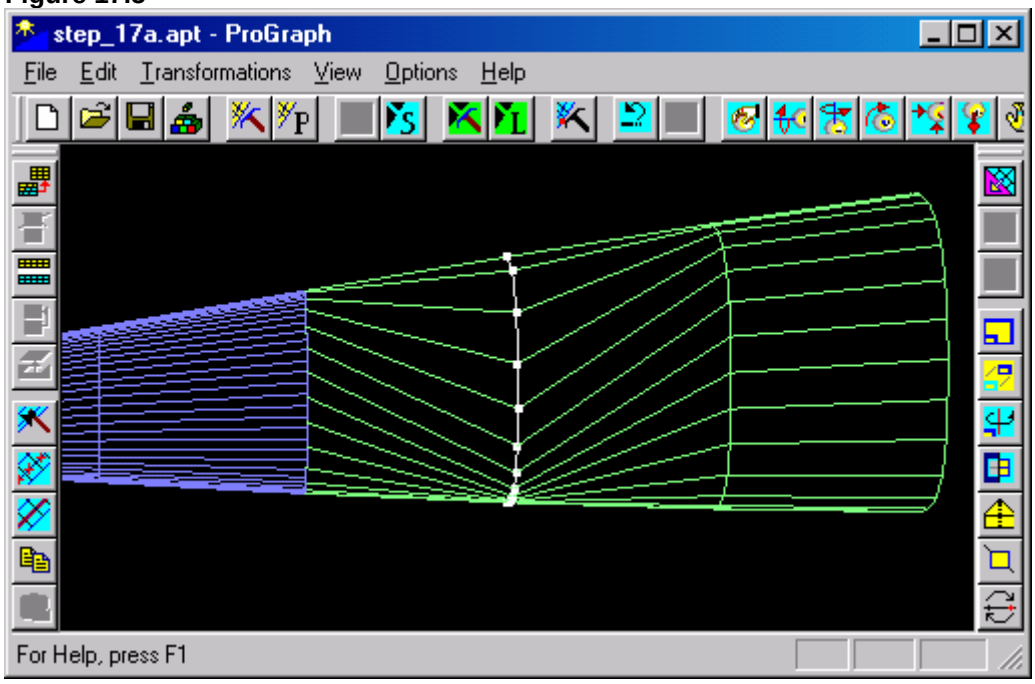
4. Choose all needed parameters in the ***Rebreak Dialog Box*** as shown below.

Figure 17.4



5. Click the **OK** control button. Then the captured section will be rebroken.

Figure 17.5



6. To undo all changes:

- Choose the **Lines ~ Undo** command from the **Edit** menu.

or

- Click the following icon from the upper toolbar:

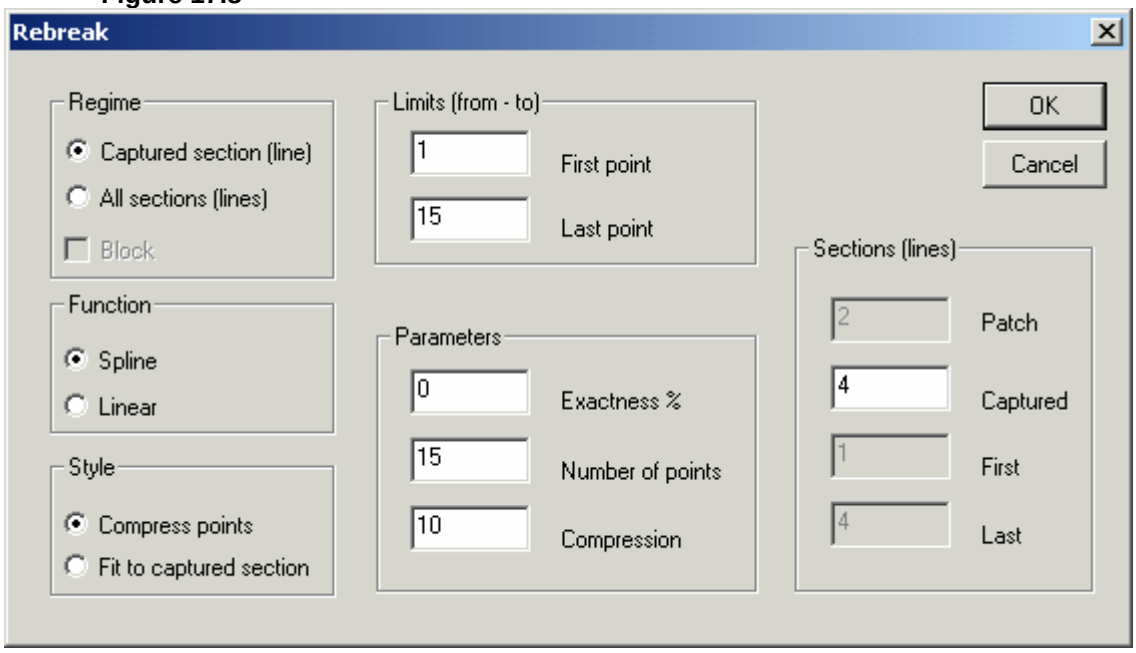
Figure 17.7

Then old Geometry will appear on your screen again.

7. To rebreak another section press right mouse button and choose the **Rebreak...** command from the context menu again. Then the ***Rebreak Dialog Box*** will appear on your screen.

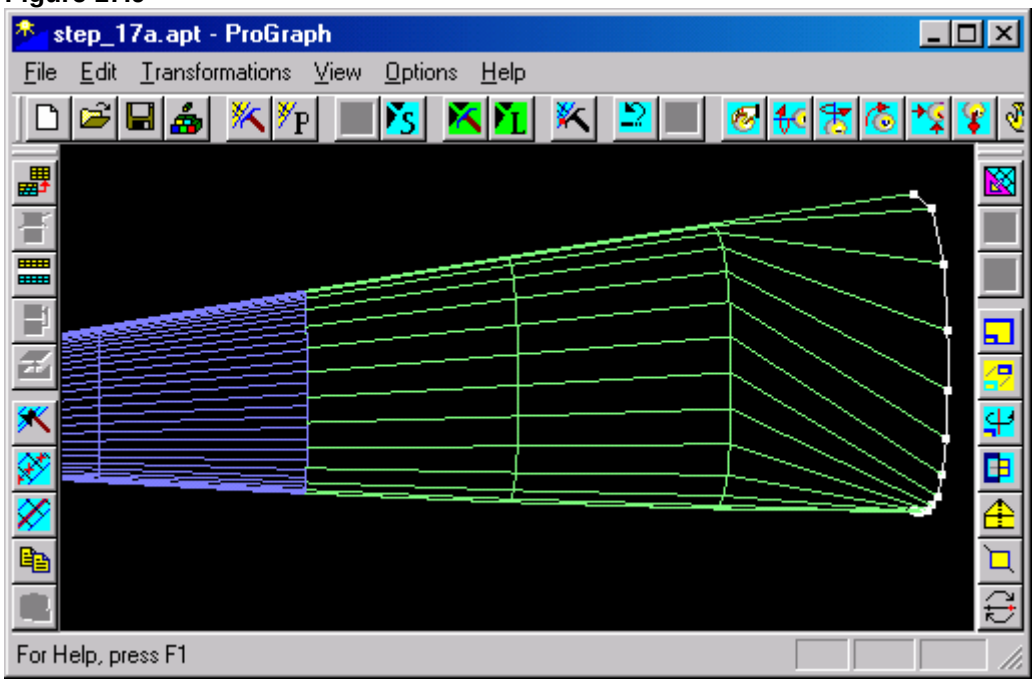
8. Choose all needed parameters in the ***Rebreak Dialog Box*** as shown below.

Figure 17.8



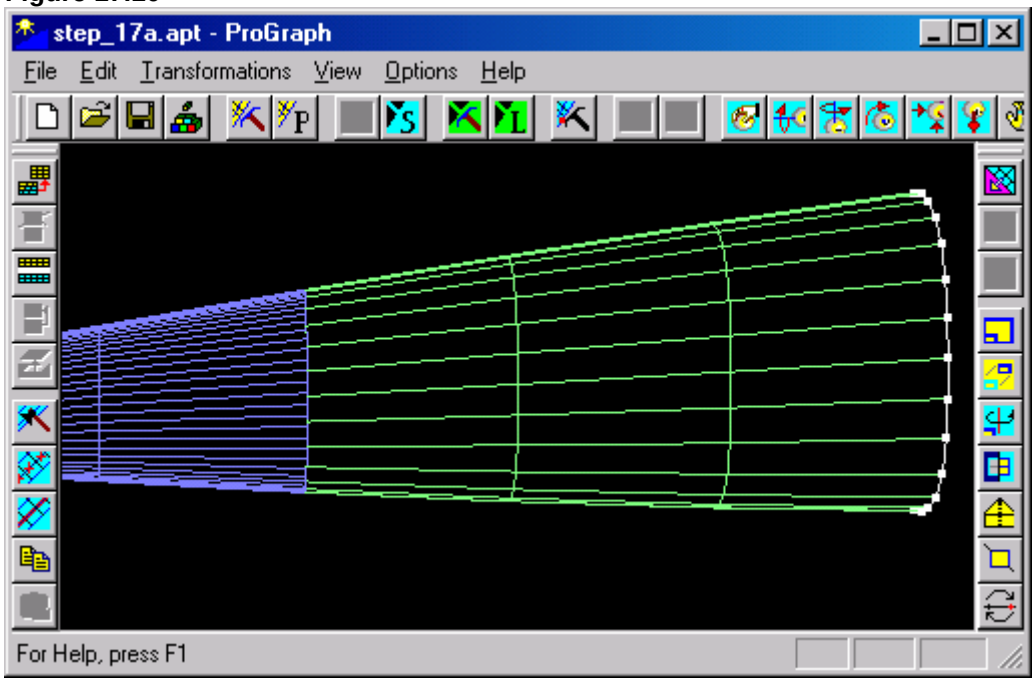
9. Click the **OK** control button. Then the fourth section will be rebroken. It will become the captured one.

Figure 17.9



10. To undo all changes choose the **Lines ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

Figure 17.10

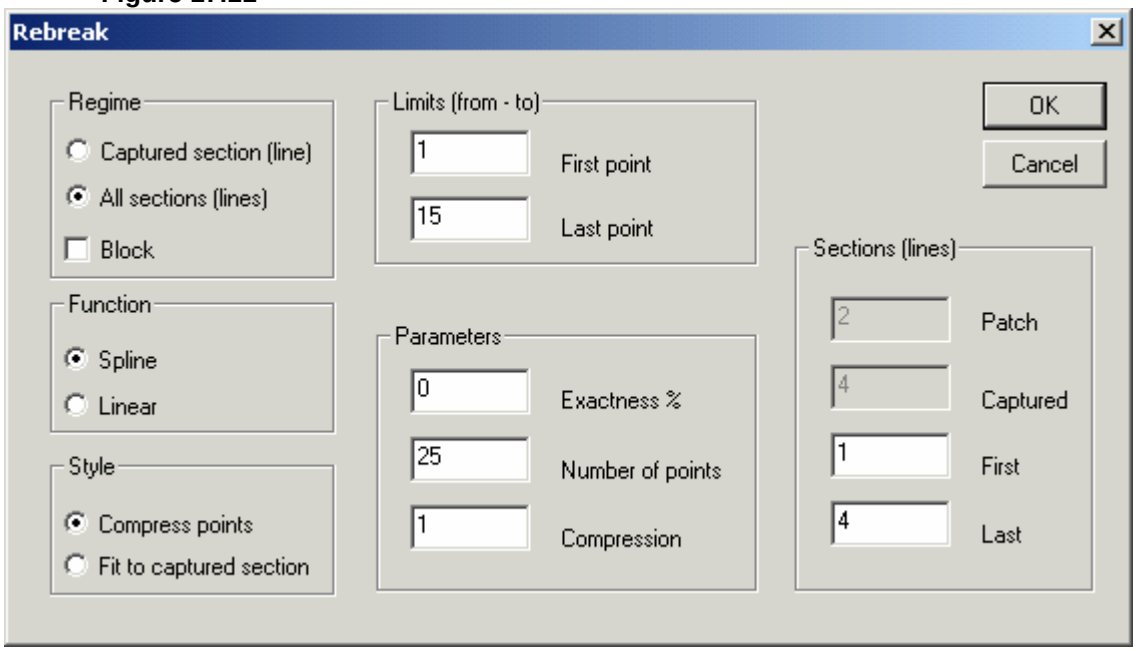


11. To rebreak all sections of the patch press right mouse button and choose the **Rebreak...** command from the

context menu again. Then the ***Rebreak Dialog Box*** will appear on your screen.

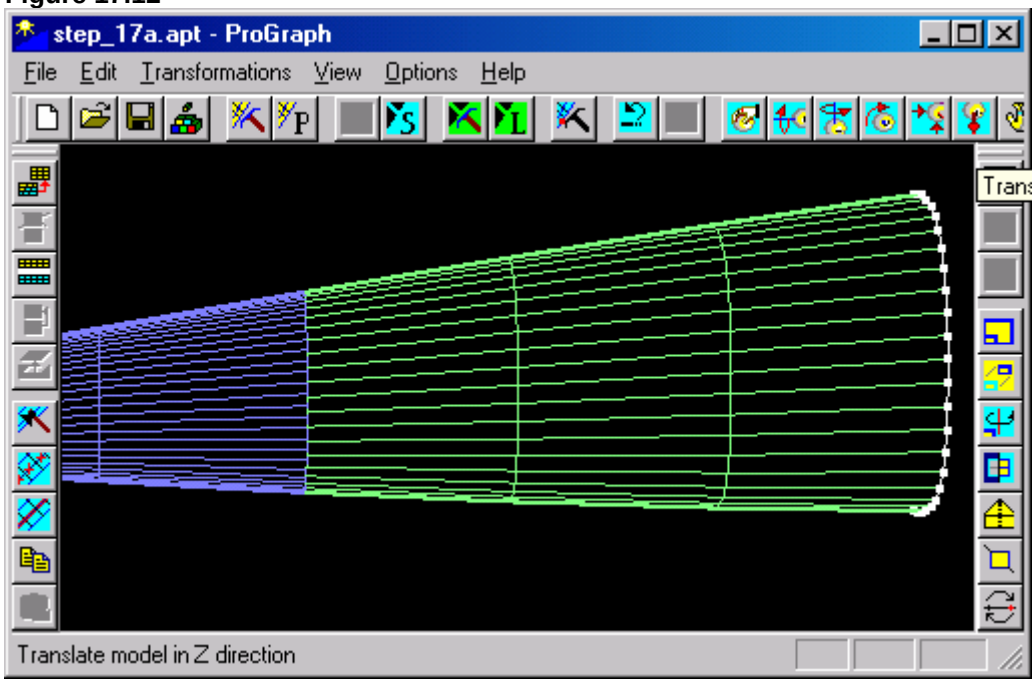
12. Choose all needed parameters in the ***Rebreak Dialog Box*** as shown below.

Figure 17.11



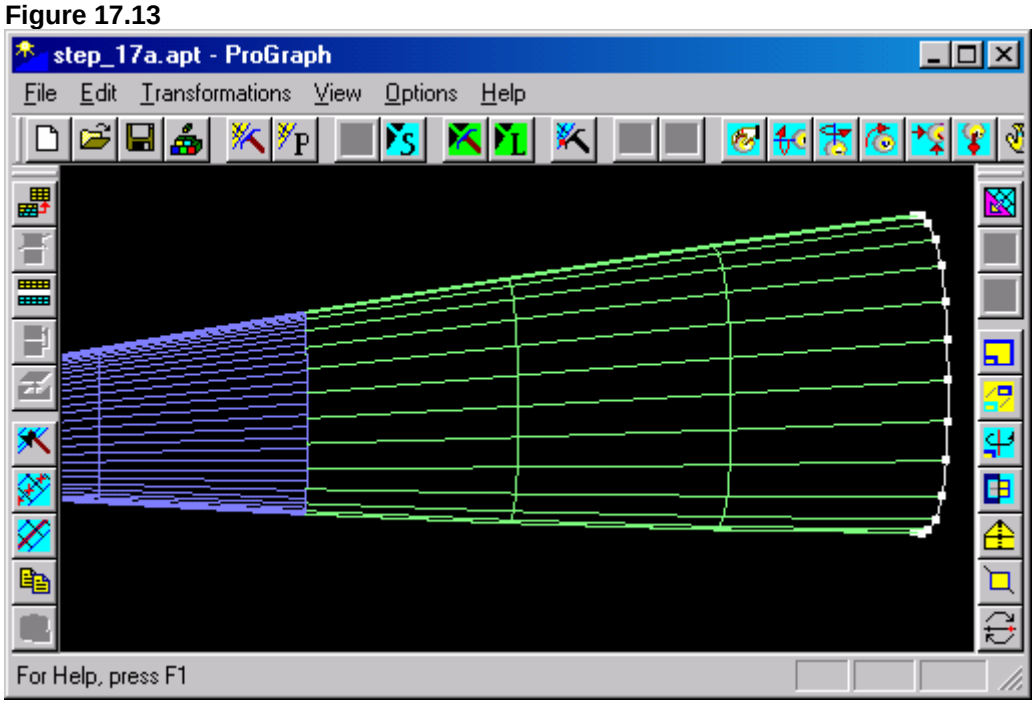
13. Click the **OK** control button. Then all the sections of green patch will be rebroken.

Figure 17.12



14. To undo all changes choose the **Lines ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

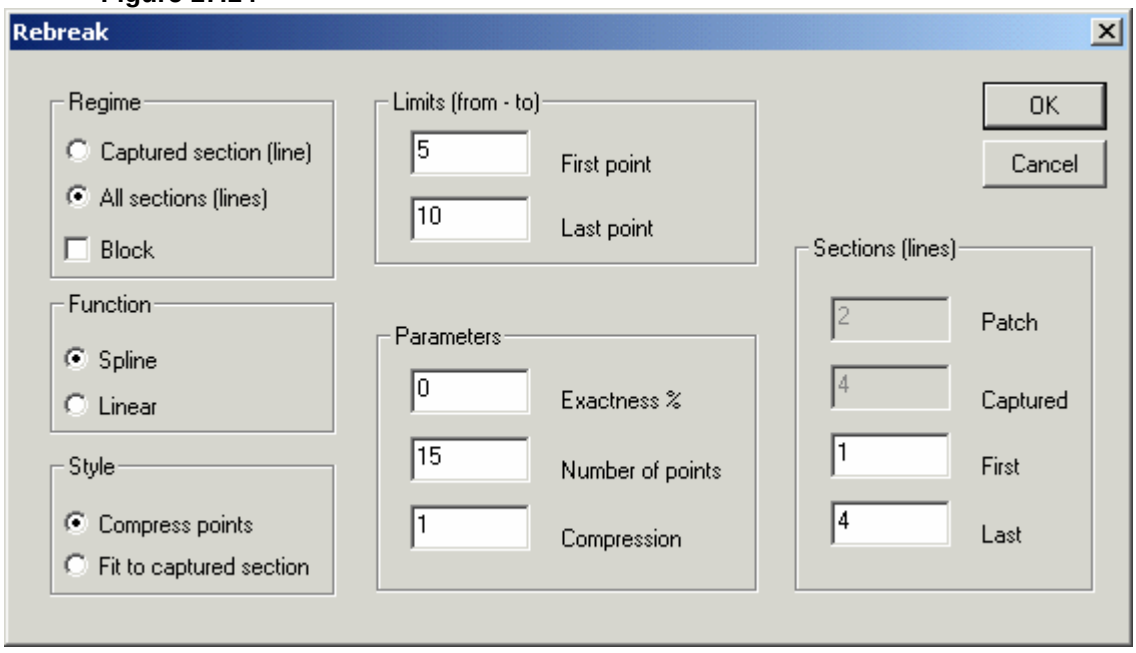
Figure 17.13



15. To rebreak the green patch in some range press right mouse button and choose the **Rebreak...** command from the context menu again. Then the ***Rebreak Dialog Box*** will appear on your screen.

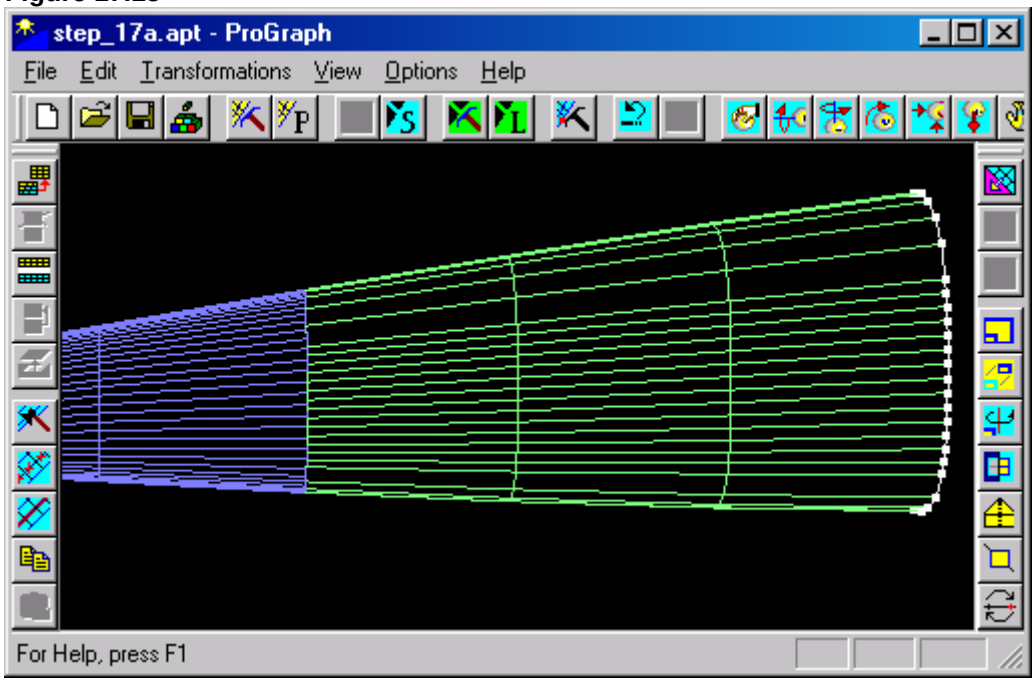
16. Choose all needed parameters in the ***Rebreak Dialog Box*** as shown below.

Figure 17.14



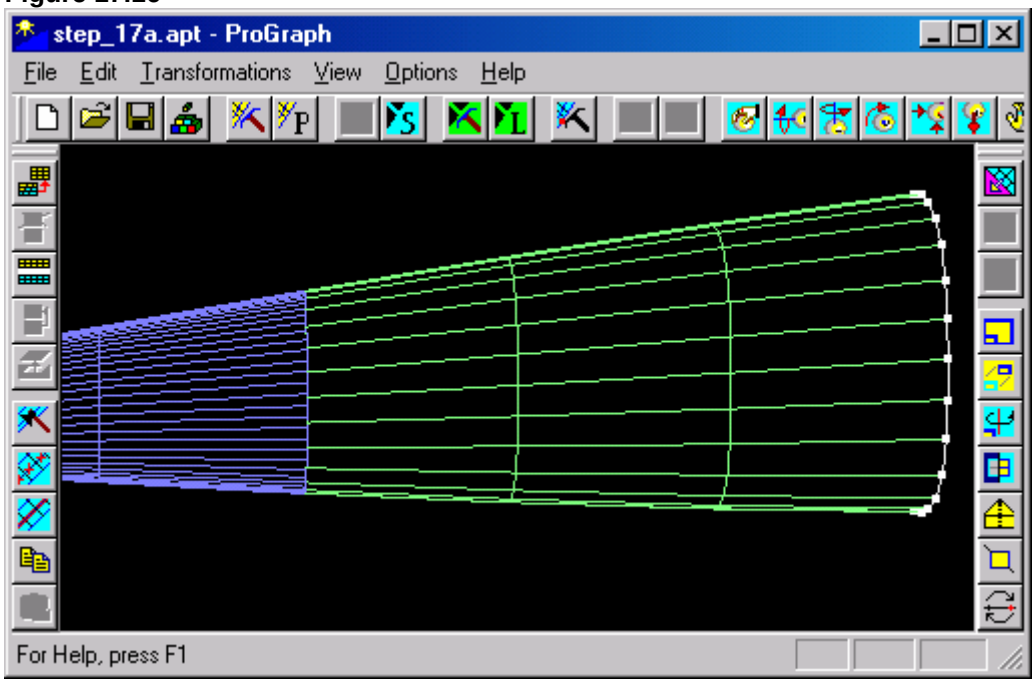
17. Click the **OK** control button. Then the green patch in the range from the fifth line to the tenth line will be rebroken.

Figure 17.15



18. To undo all changes choose the **Lines ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

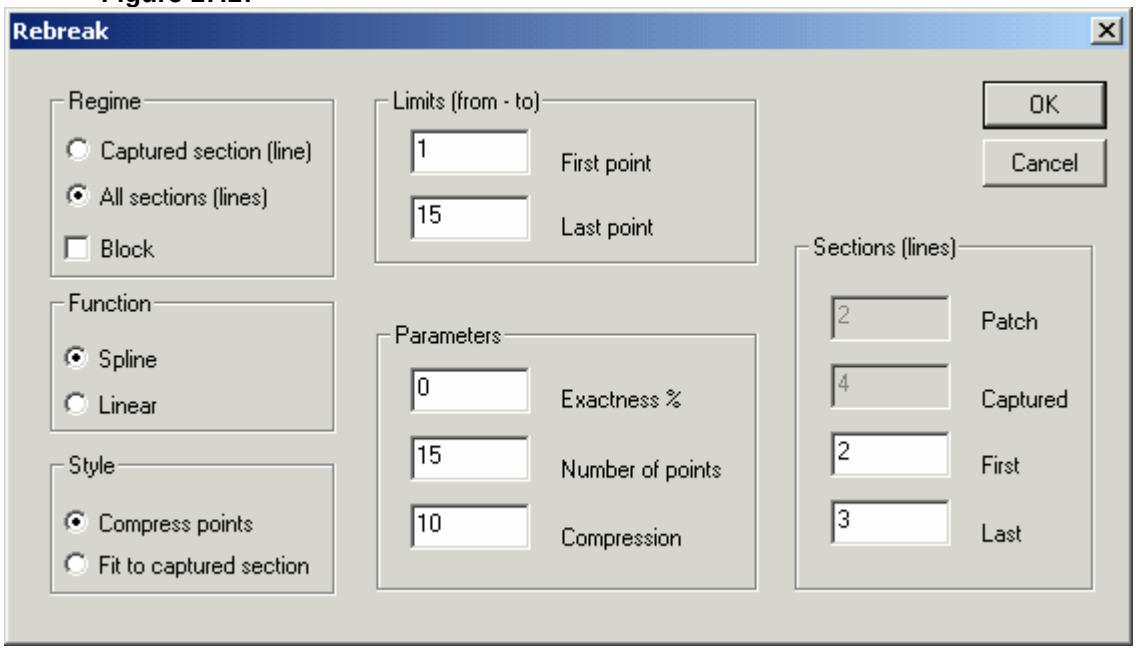
Figure 17.16



19. To rebreak the second and the third sections of green patch press right mouse button and choose the **Rebreak...** command from the context menu again. Then the ***Rebreak Dialog Box*** will appear on your screen.

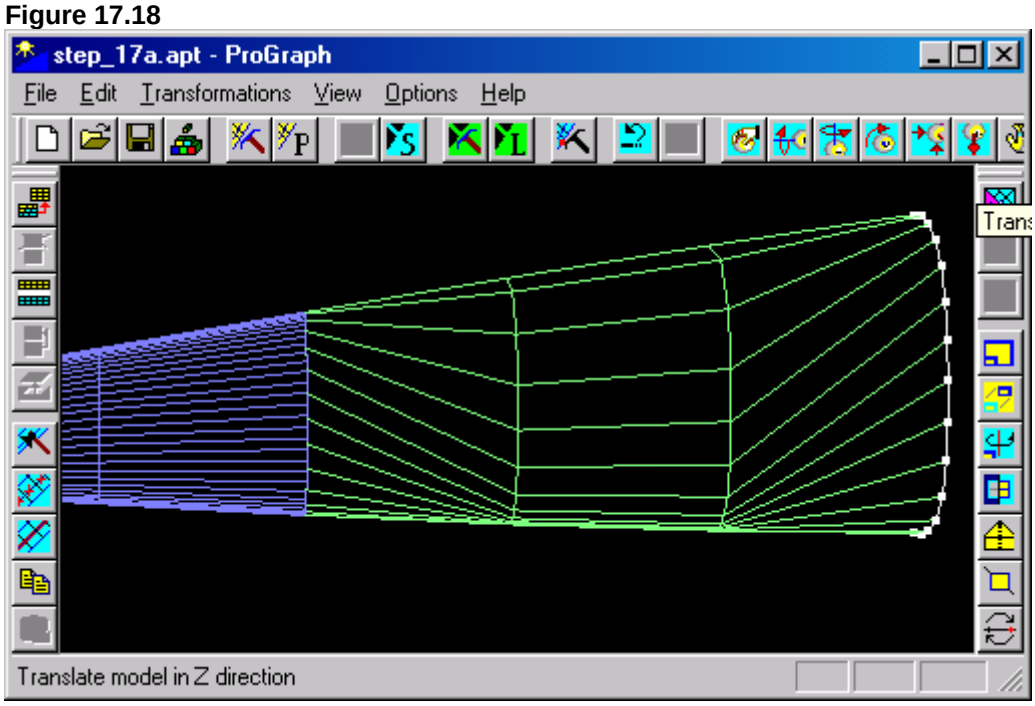
20. Choose all needed parameters in the ***Rebreak Dialog Box*** as shown below.

Figure 17.17



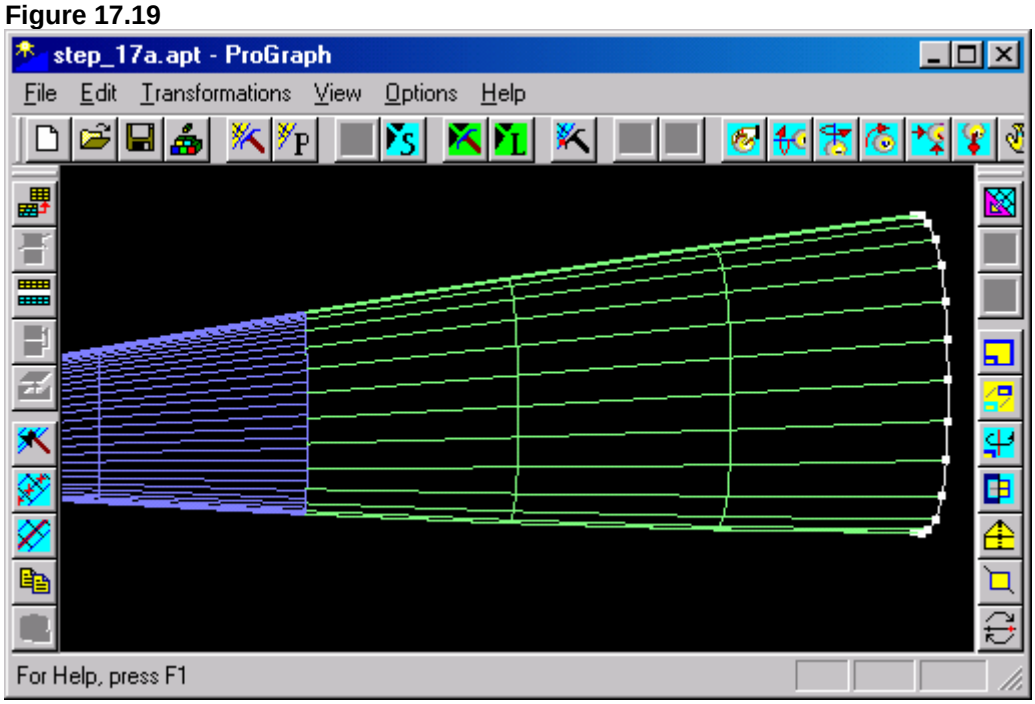
21. Click the **OK** control button. Then the second and the third sections of green patch will be rebroken.

Figure 17.18



22. To undo all changes choose the **Lines ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

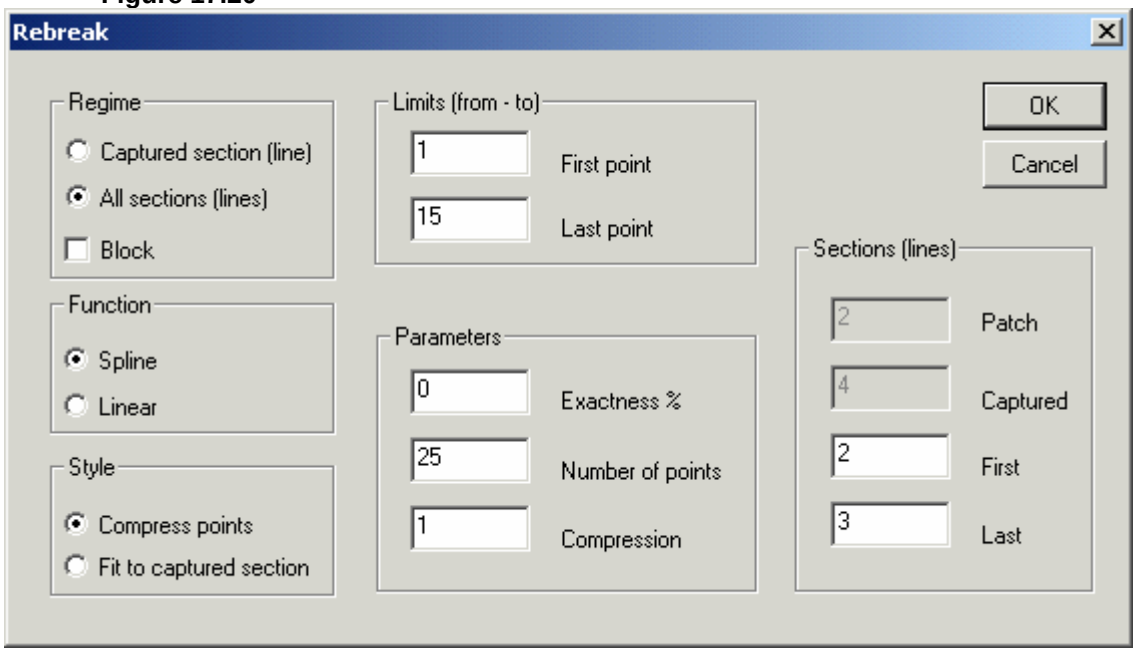
Figure 17.19



23. To rebreak the second and the third sections of green patch press right mouse button and choose the **Rebreak...** command from the context menu again. Then the ***Rebreak Dialog Box*** will appear on your screen.

24. Choose all needed parameters in the ***Rebreak Dialog Box*** as shown below.

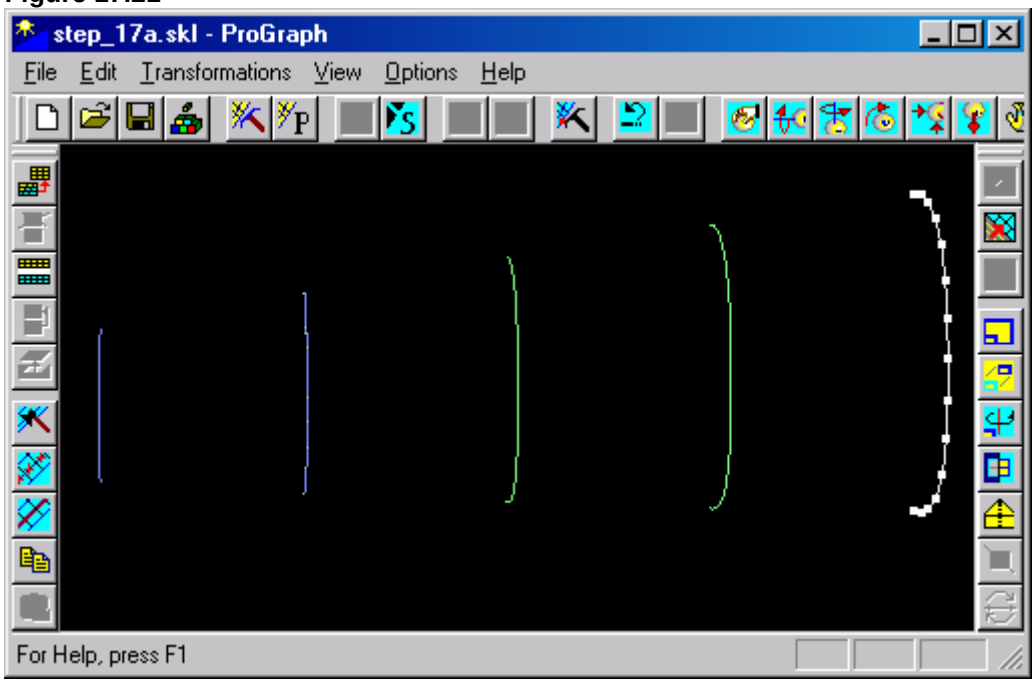
Figure 17.20



25. Click the **OK** control button. Then the second and the third sections of green patch will be rebroken with new number of points.

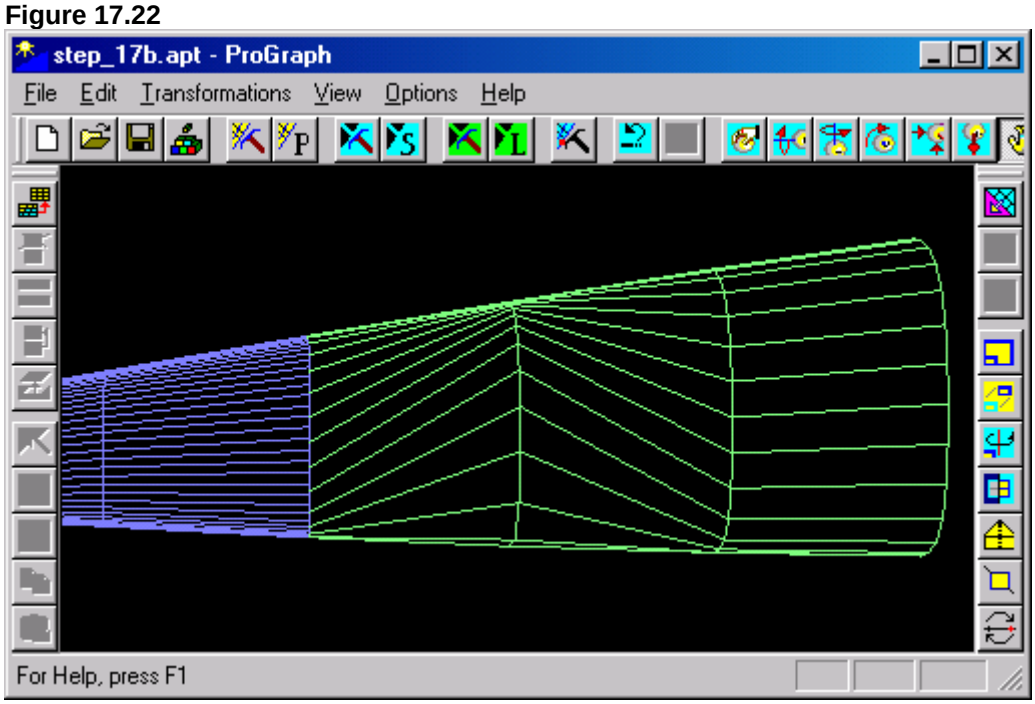
Note. APT format of opened file is violated.

Figure 17.21



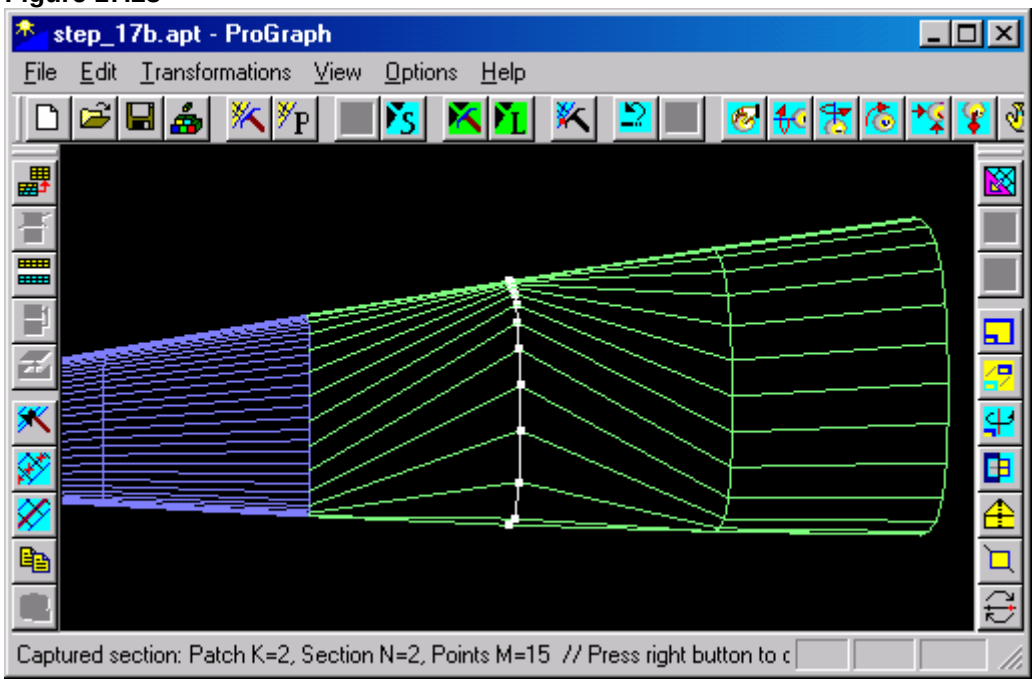
26. Open an existing file STEP_17b.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2.**) Then the Geometry will appear on your screen.

Figure 17.22



27. Capture the second section of a green patch. (For more information see steps 2-3 of **Step 11.**)

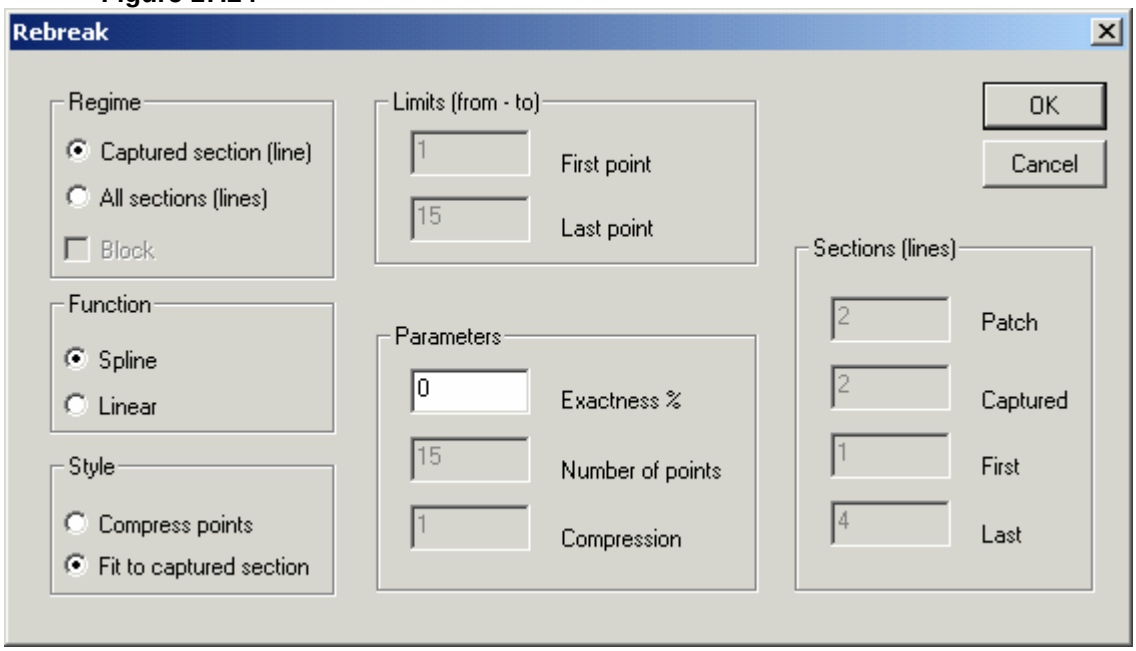
Figure 17.23



28. To rebreak all sections of green patch in accordance with the captured section press right mouse button and choose the **Rebreak...** command from the context menu. Then the ***Rebreak Dialog Box*** will appear on your screen.

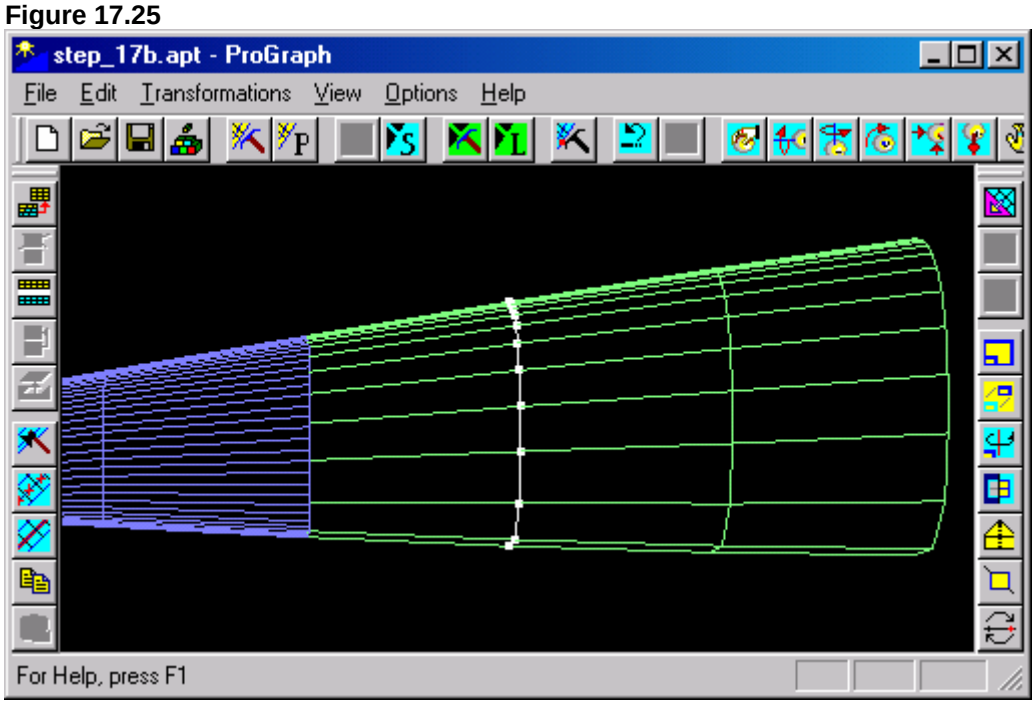
29. Choose all needed parameters in the ***Rebreak Dialog Box*** as shown below.

Figure 17.24



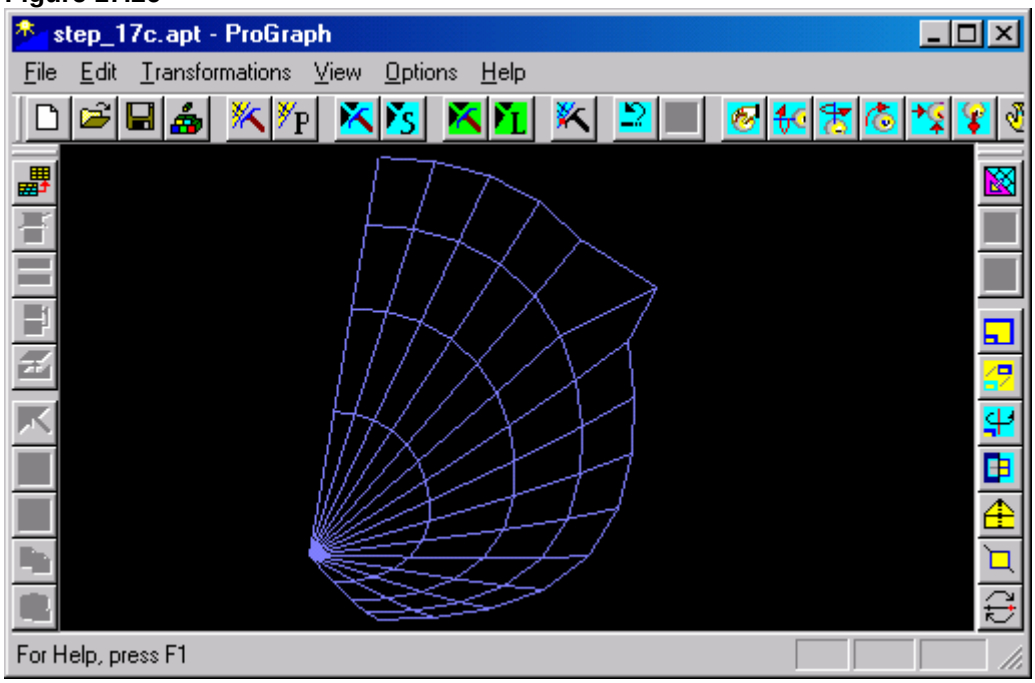
30. Click the **OK** control button. Then all sections of green patch will be rebroken in accordance with the captured section.

Figure 17.25



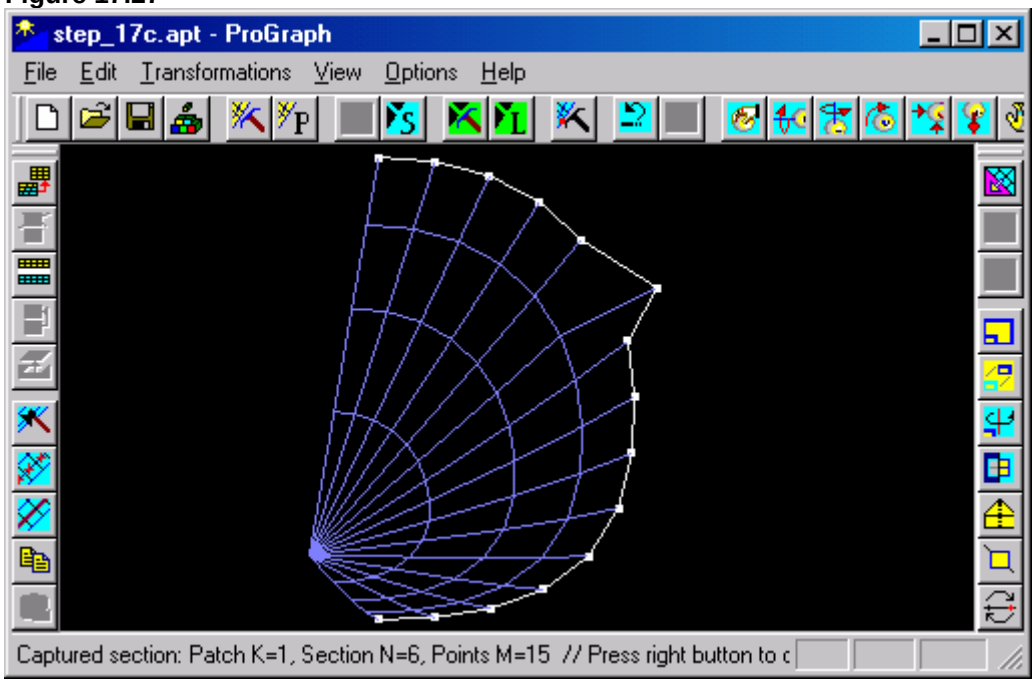
31. Open an existing file STEP_17c.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2.**) Then the Geometry will appear on your screen.

Figure 17.26



32. Capture the last section. (For more information see steps 2-3 of **Step 11.**)

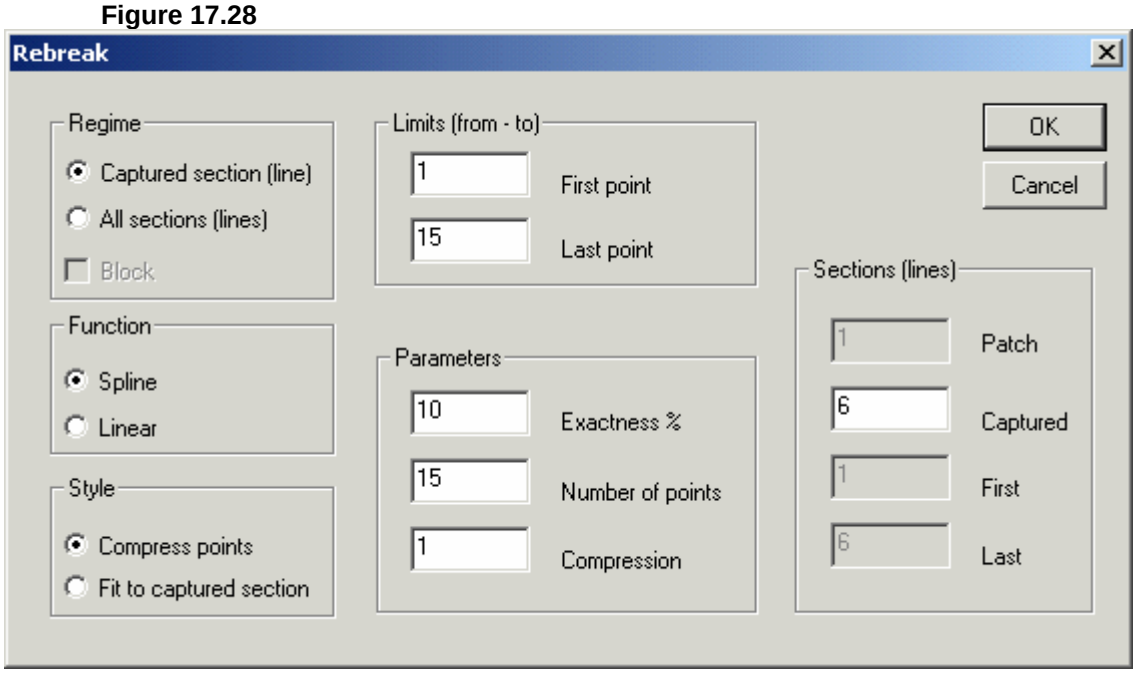
Figure 17.27



33. Press right mouse button and choose the **Rebreak...** command from the context menu. Then the ***Rebreak Dialog Box*** will appear on your screen.

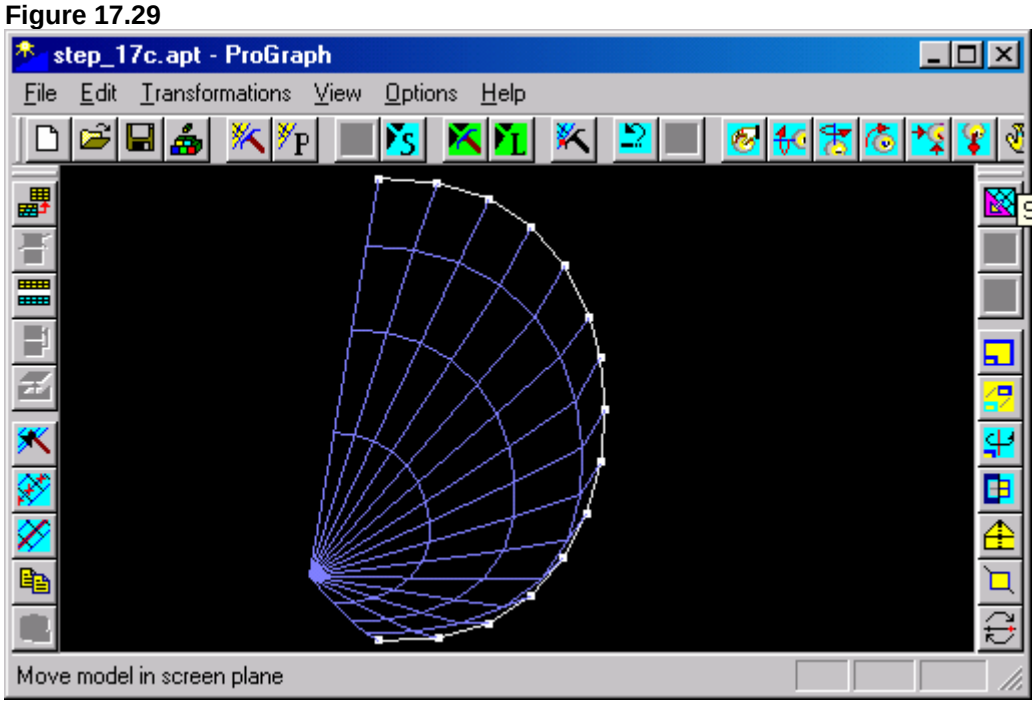
34. Choose all needed parameters in the ***Rebreak Dialog Box*** as shown below.

Figure 17.28



35. Click the **OK** control button. Then new Geometry will appear on your screen.

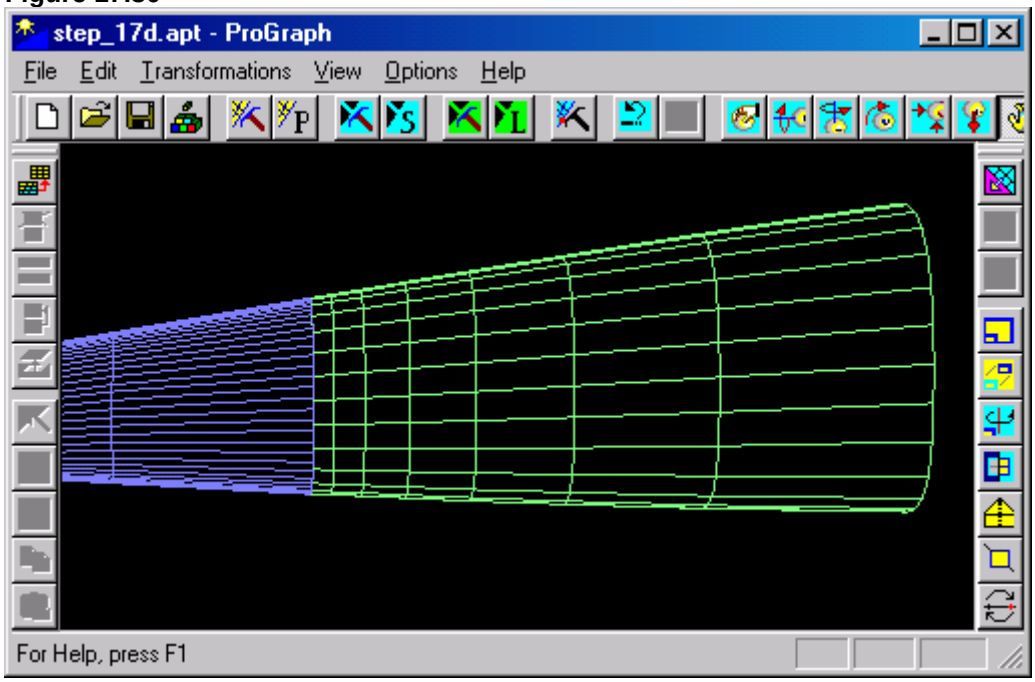
Figure 17.29



36. Open an existing file STEP_17d.APT that is presented in subfolder SAMPLES of the current folder. (For

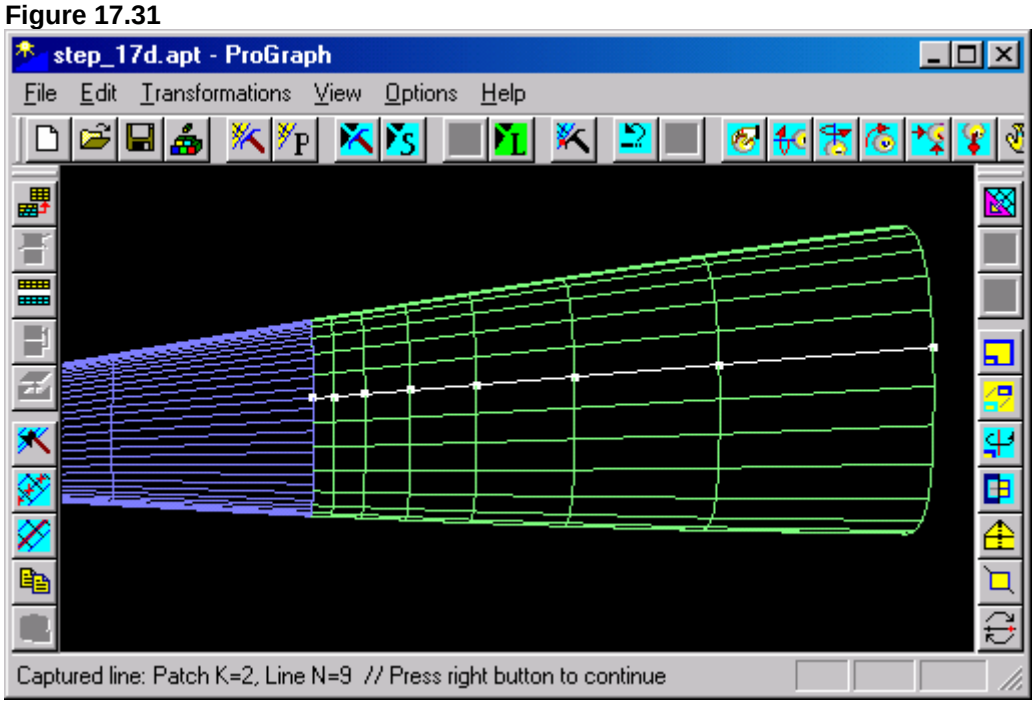
more information see steps 1-2 of **Step 2.**) Then the Geometry will appear on your screen.

Figure 17.30



37. Capture the ninth line of green patch. (For more information see steps 2-3 of **Step 13.**)

Figure 17.31

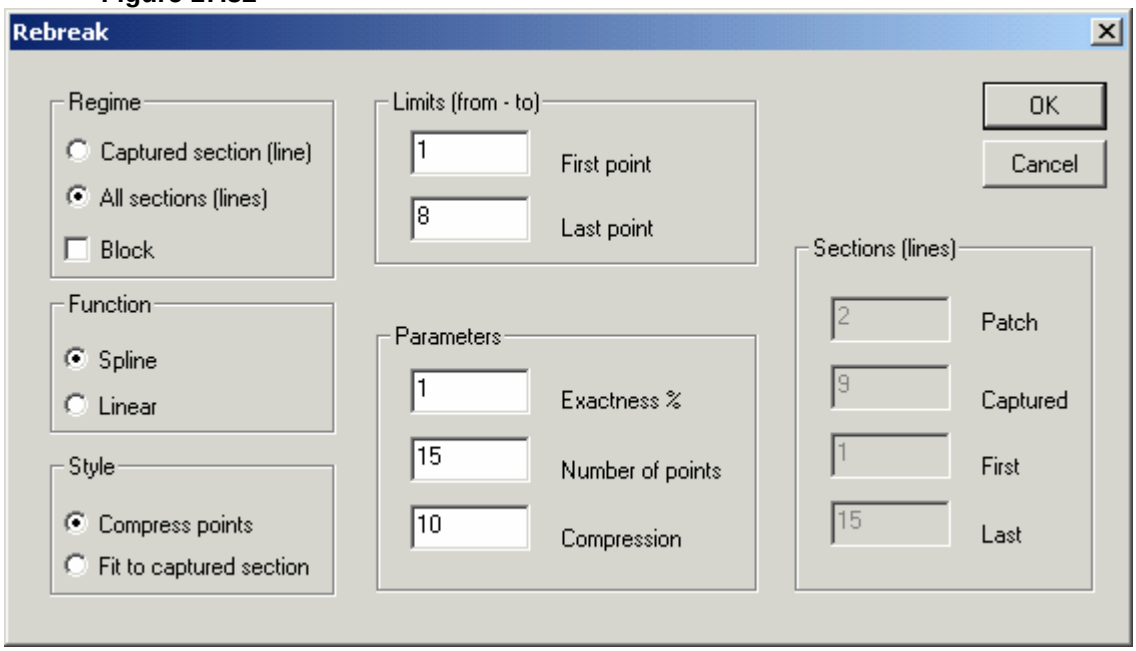


38. To change the number of sections in green patch press right mouse button and choose the **Rebreak...**

command from the context menu. Then the ***Rebreak Dialog Box*** will appear on your screen.

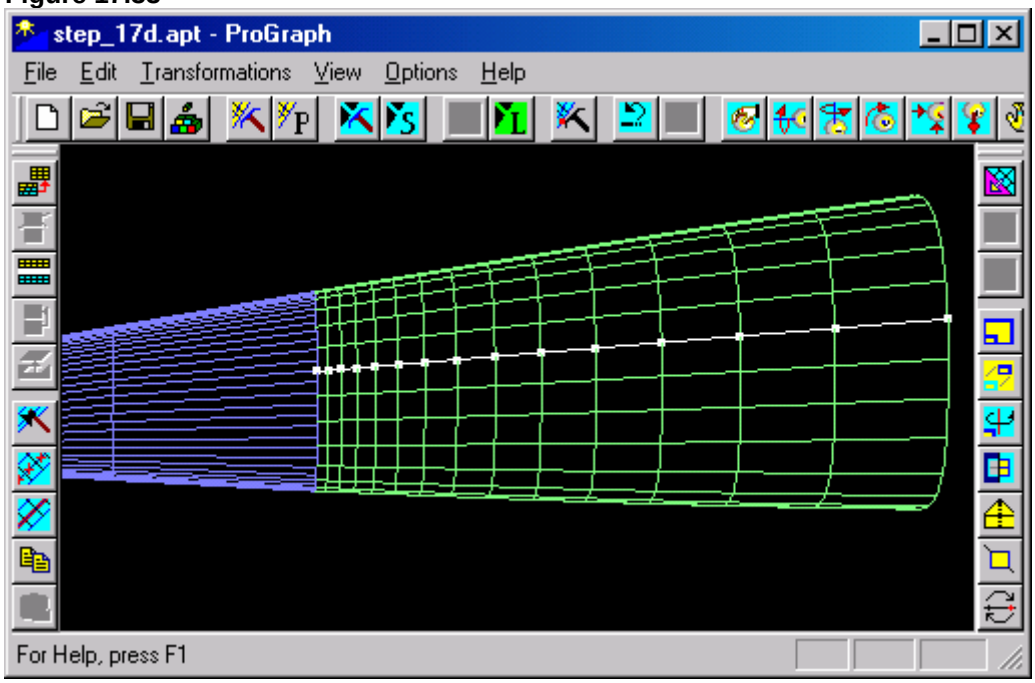
39. Choose all needed parameters in the ***Rebreak Dialog Box*** as shown below.

Figure 17.32



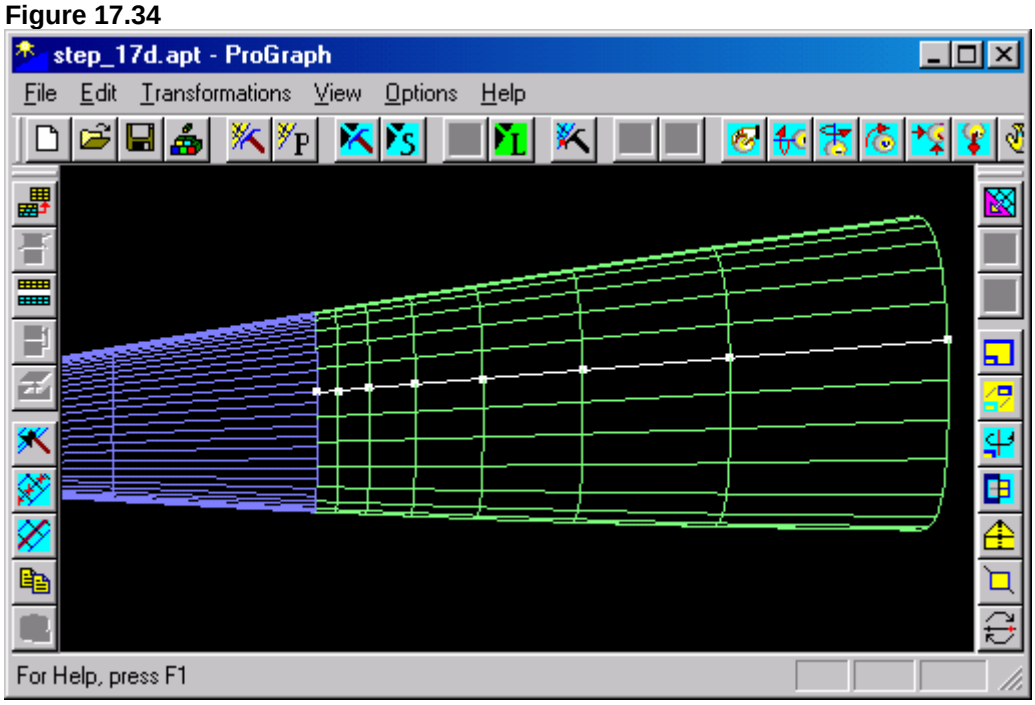
40. Click the **OK** control button. Then new Geometry will appear on your screen.

Figure 17.33



41. To undo all changes choose the **Lines ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

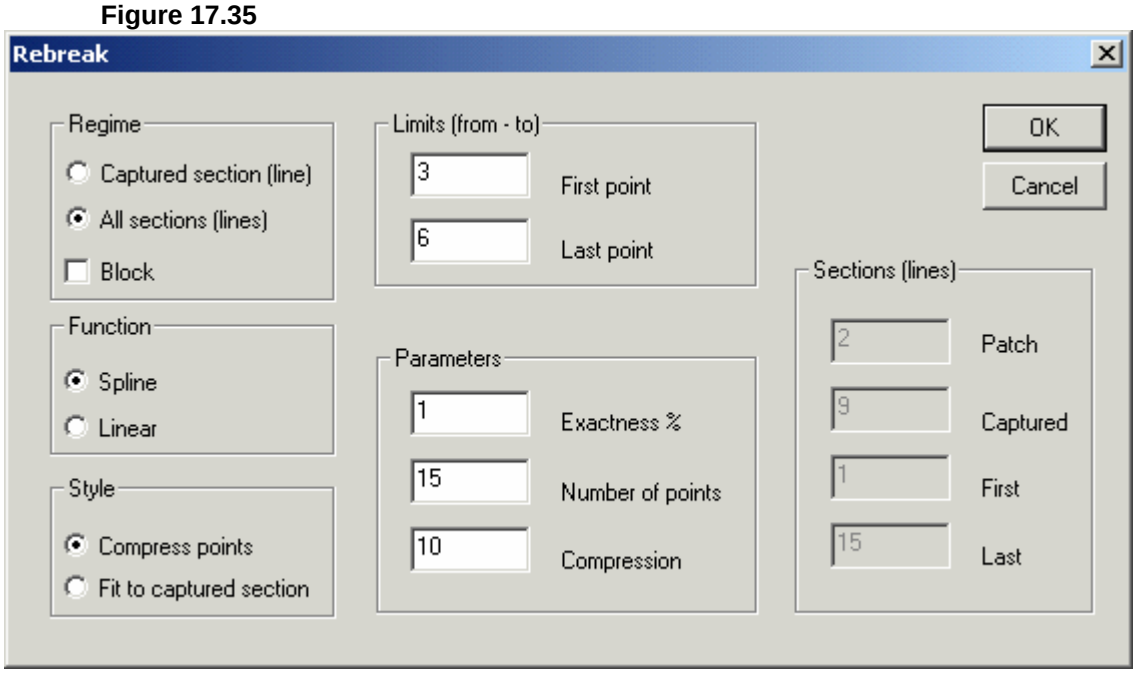
Figure 17.34



42. Press right mouse button and choose the **Rebreak...** command from the context menu. Then the ***Rebreak Dialog Box*** will appear on your screen.

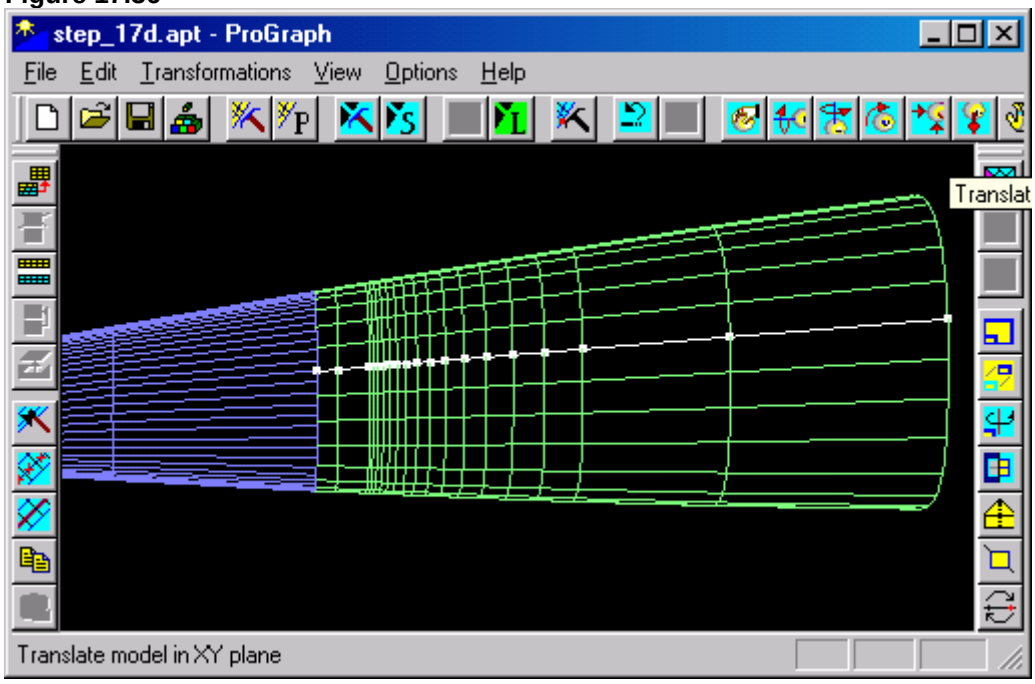
43. Choose all needed parameters in the ***Rebreak Dialog Box*** as shown below.

Figure 17.35



44.Click the **OK** control button. Then new Geometry will appear on your screen.

Figure 17.36



Step 18. How to capture a point

1. Open an existing file STEP_2.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

2. To capture the point:

   - Choose the **Point ~ Capture** command from the **Edit** menu.

   or

   - Click the following icon from the upper toolbar:

   Figure 18.1

   Then cursor shape will be changed to .

3. Then:

   - Press left mouse button and drag the mouse. The point under cursor will be distinguished as a white marker with red border and its number will appear in Status Bar. Releasing the mouse button captures the point.

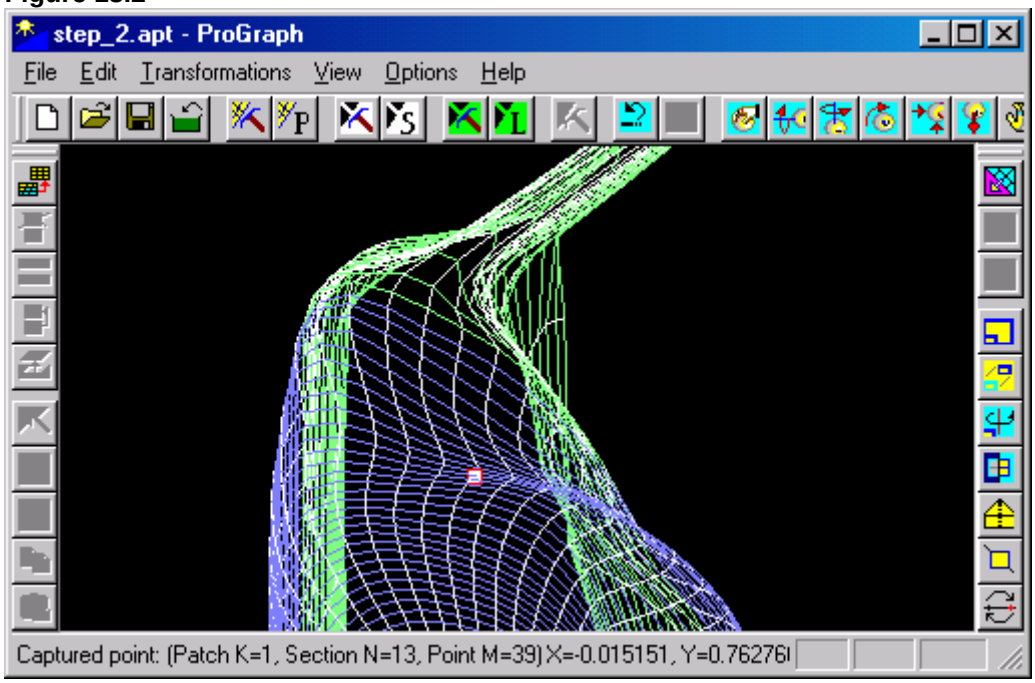
   or

   - Click the point.

   Then the captured point will be distinguished as a white marker with red border.

   When a block has been created, only a point belonging to this block may be captured. When a section or a line has been captured, only a point belonging to this section or line may be captured. When no patches, sections or lines have been captured, any point may be captured.

Figure 18.2


step_2.apt - ProGraph
File Edit Transformations View Options Help
Captured point: (Patch K=1, Section N=13, Point M=39) X=-0.015151, Y=0.76276

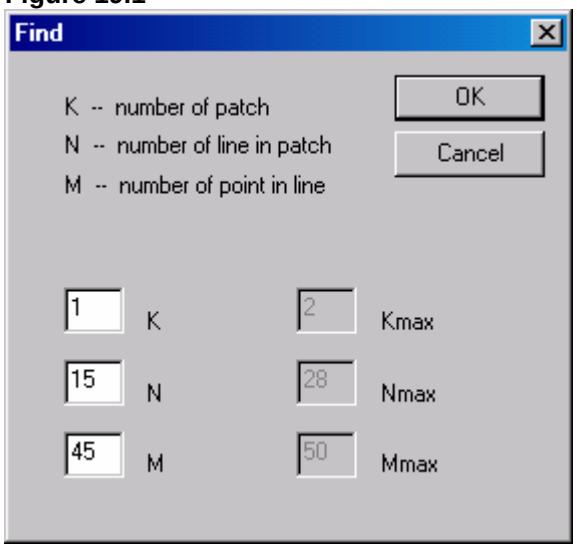
Step 19. How to capture a point with the use of *Input* command

1. Open an existing file STEP_2.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

2. To capture the section choose the **Point ~ Input...** command from the **Edit** menu. Then the ***Find Dialog Box*** will appear on your screen.

3. Choose all needed parameters in the ***Find Dialog Box*** as shown below.

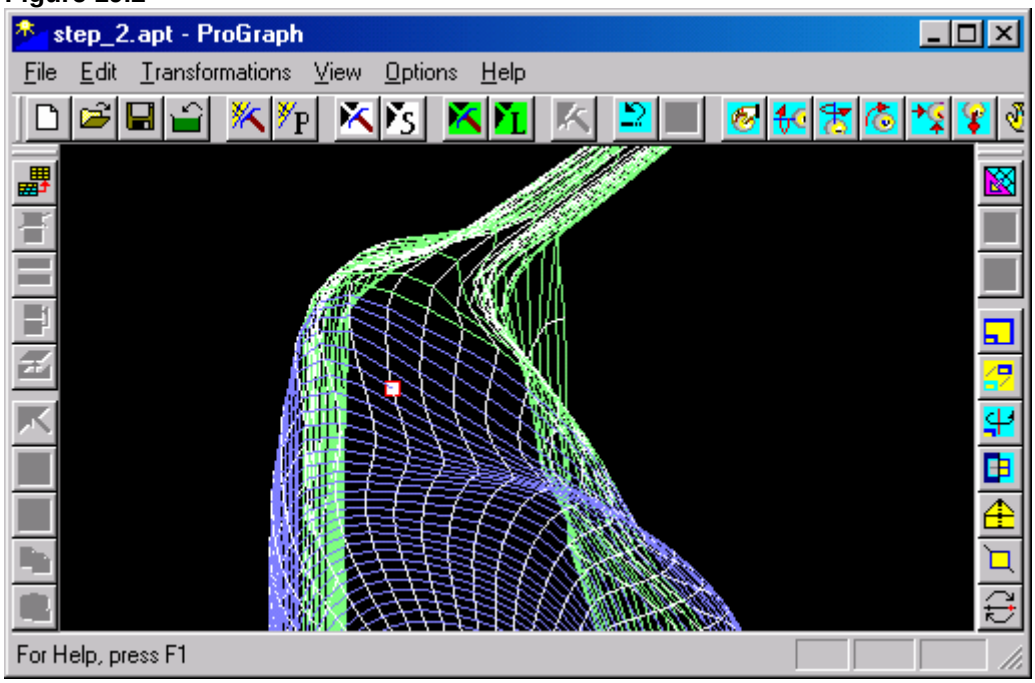
Figure 19.1



4. Click the **OK** control button. Then the captured point will be distinguished as a white marker with red border.

   When a block has been created, only a point belonging to this block may be captured. When a section or a line has been captured, only a point belonging to this section or line may be captured. When no patches, sections or lines have been captured, any point may be captured.

Figure 19.2

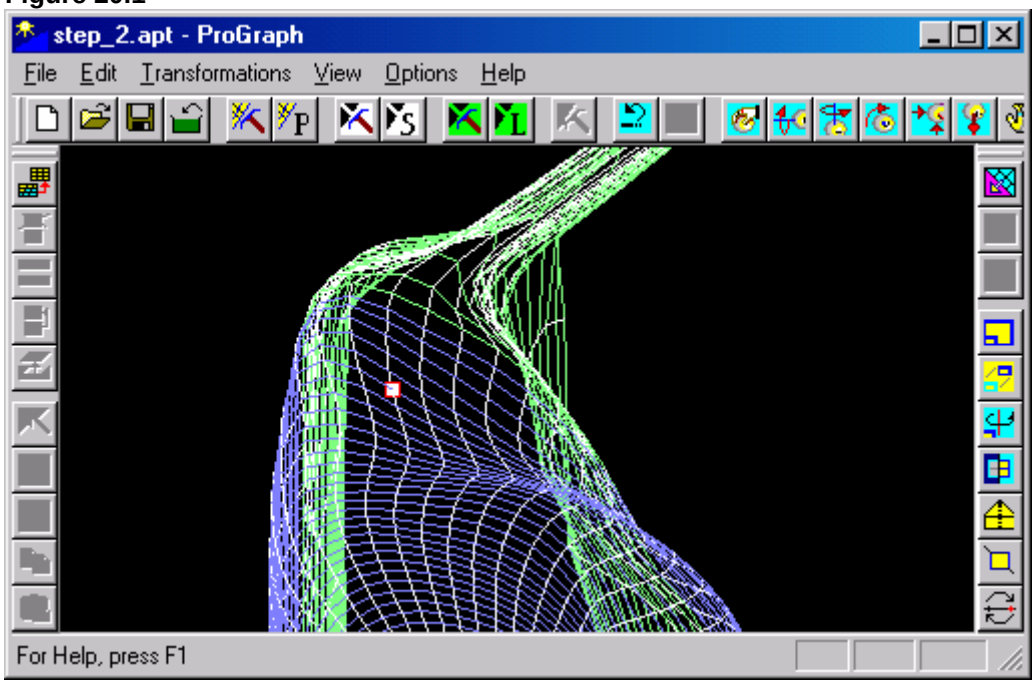

step_2.apt - ProGraph
File Edit Transformations View Options Help
For Help, press F1

Step 20. A set of one-action operations with points

1. Open an existing file STEP_2.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

2. Capture a point. (For more information see steps 2-3 of **Step 18**.)

Figure 20.1



3. To delete the captured point:

- Choose the **Point ~ Delete** command from the **Edit** menu.

or

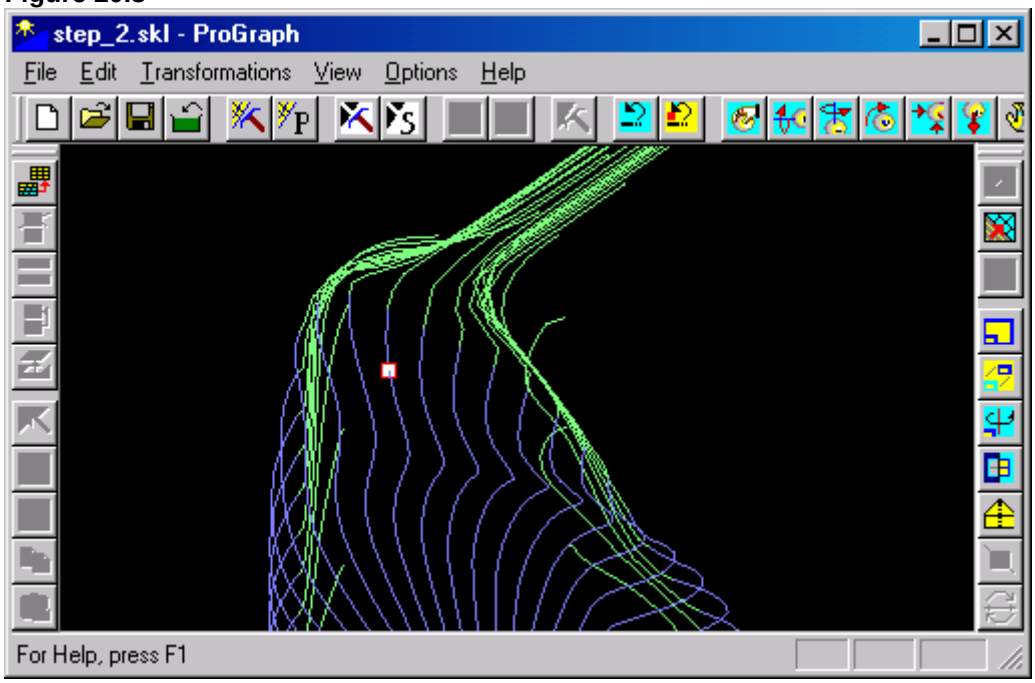
- Click the following icon from the left toolbar:

Figure 20.2

Then the captured point will be deleted. The next point will become the captured one.

Note. APT format of opened file is violated.

Figure 20.3



4. To undo all changes:

   - Choose the **Point ~ Undo** command from the **Edit** menu.

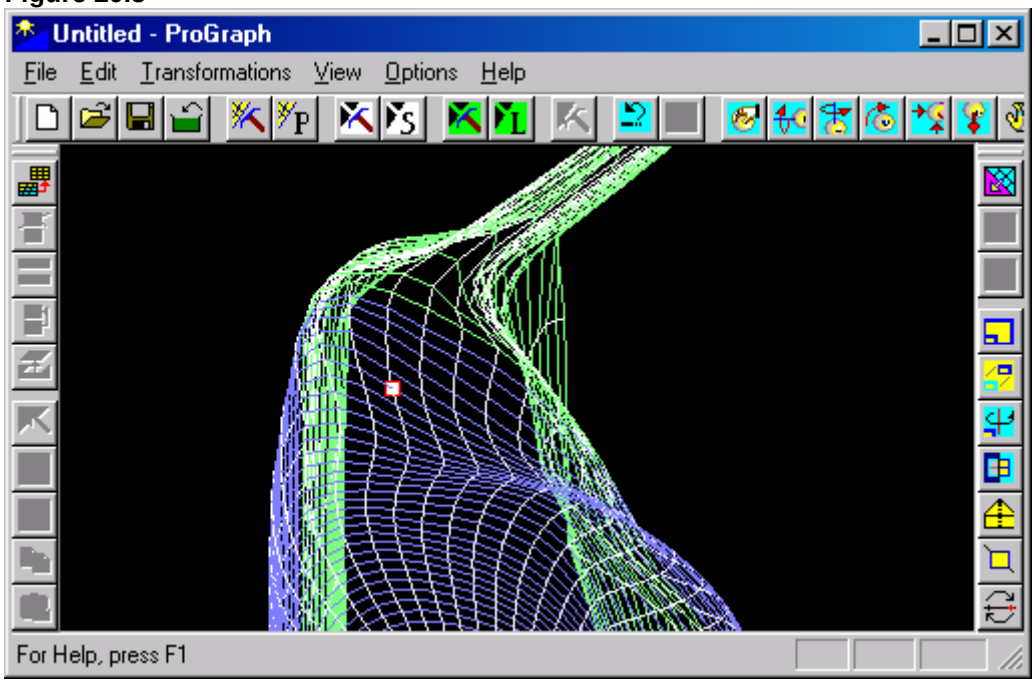
     or

   - Click the following icon from the upper toolbar:

Figure 20.4

Then old Geometry will appear on your screen again.

Figure 20.5



5. To copy the captured point:

   - Choose the **Point ~ Duplicate...** command from the **Edit** menu.

   or

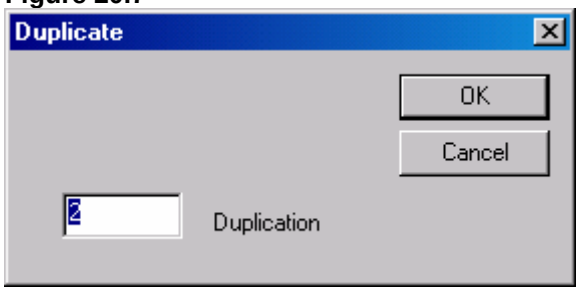
   - Click the following icon from the left toolbar:

Figure 20.6

Then the ***Duplicate Dialog Box*** will appear on your screen.

6. Choose all needed parameters in the ***Duplicate Dialog Box*** as shown below.

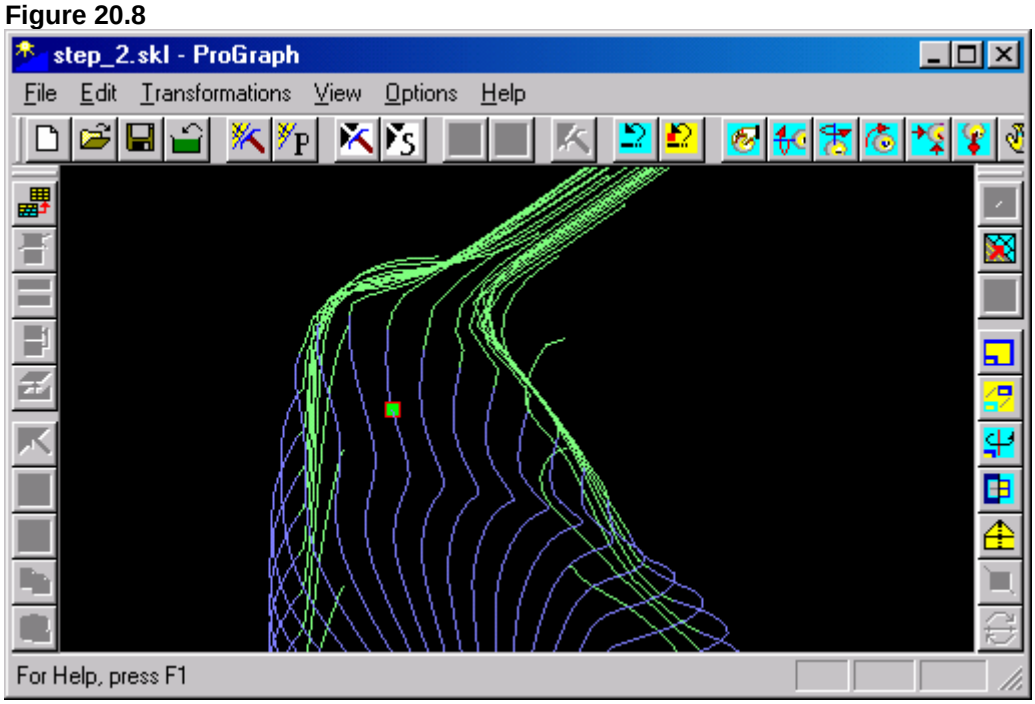
Figure 20.7



7. Click the **OK** control button. Then the captured point will be duplicated and distinguished as a green markers with red border.

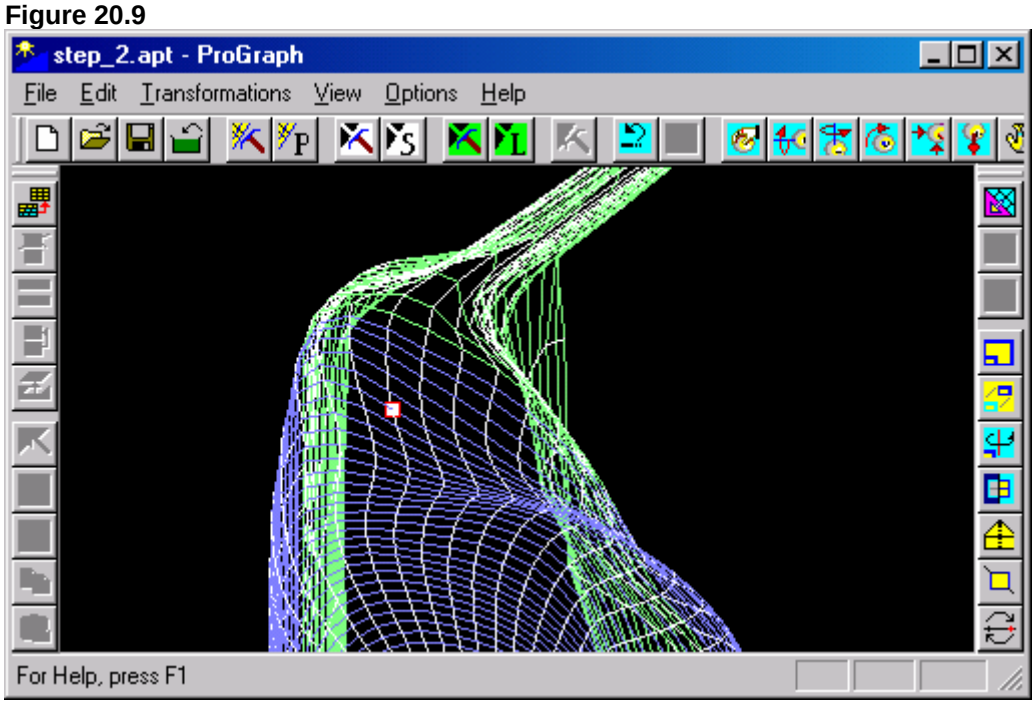
Note. APT format of opened file is violated.

Figure 20.8



8. To undo all changes choose the **Point ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

Figure 20.9



9. To copy the captured point to Clipboard:

- Choose the **Point ~ Copy** command from the **Edit** menu.

or

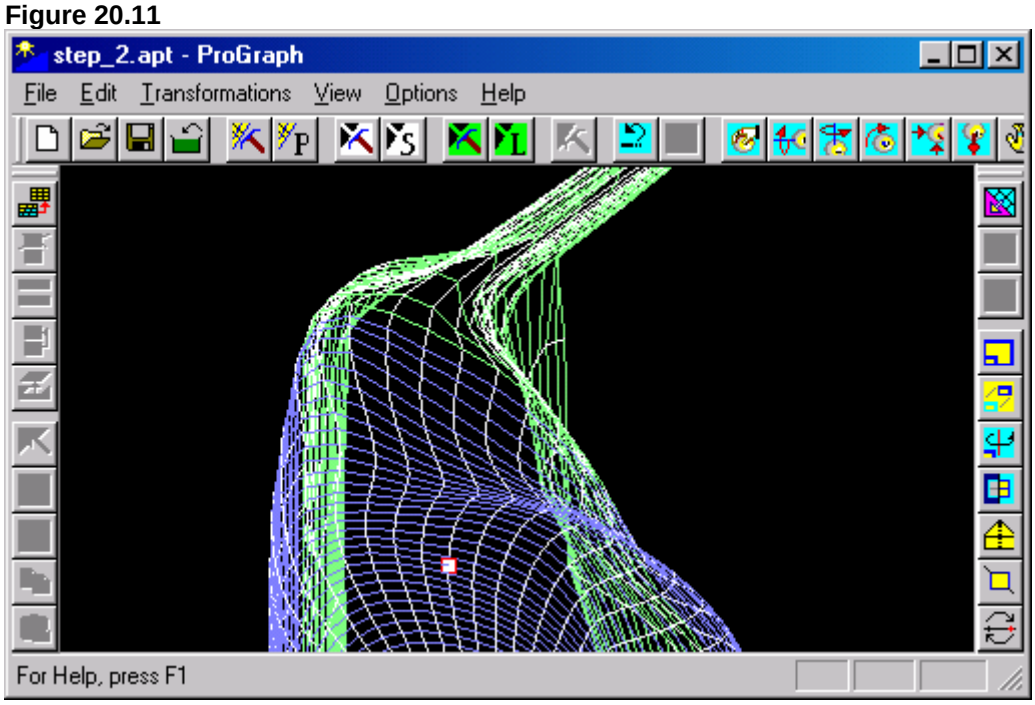
- Click the following icon from the left toolbar:

Figure 20.10

Then the captured point will be copied to Clipboard. It may be placed at any position.

10. To capture another point press right mouse button, choose the **Next point** command from the context menu and capture necessary section. (For more information see steps 2-3 of **Step 18.**)

Figure 20.11



11. To place the Clipboard content instead of the captured point:

- Choose the **Point ~ Paste** command from the **Edit** menu.

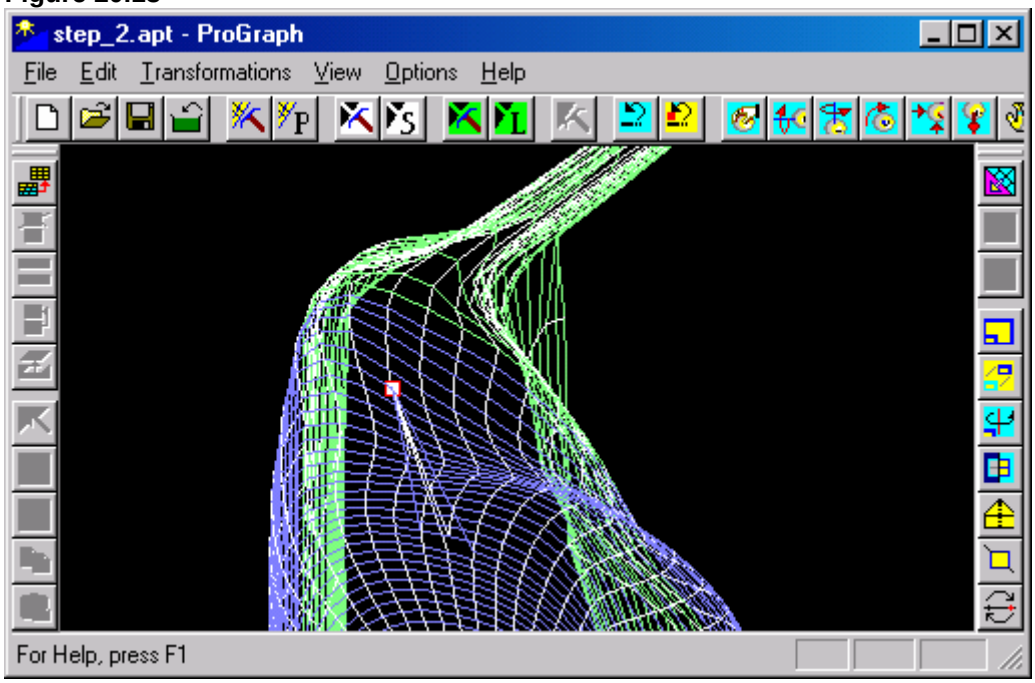
or

- Click the following icon from the left toolbar:

Figure 20.12

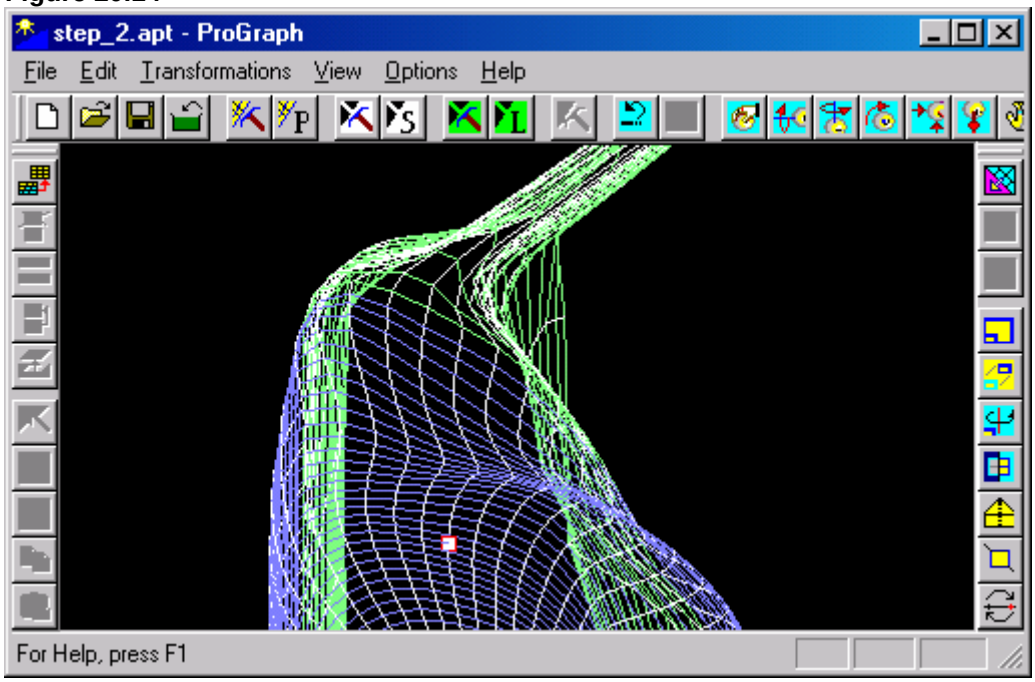
Then the Clipboard content will replace the captured point.

Figure 20.13



12. To undo all changes choose the **Point ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

Figure 20.14



13. To edit the coordinates of the captured point:

- Choose the **Point ~ Edit...** command from the **Edit** menu.

or

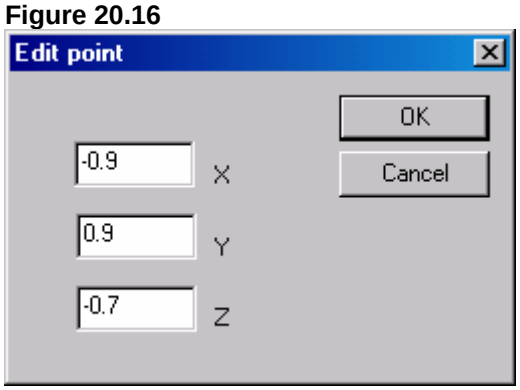
- Click the following icon from the left toolbar:

Figure 20.15

Then the ***Edit point Dialog Box*** will appear on your screen.

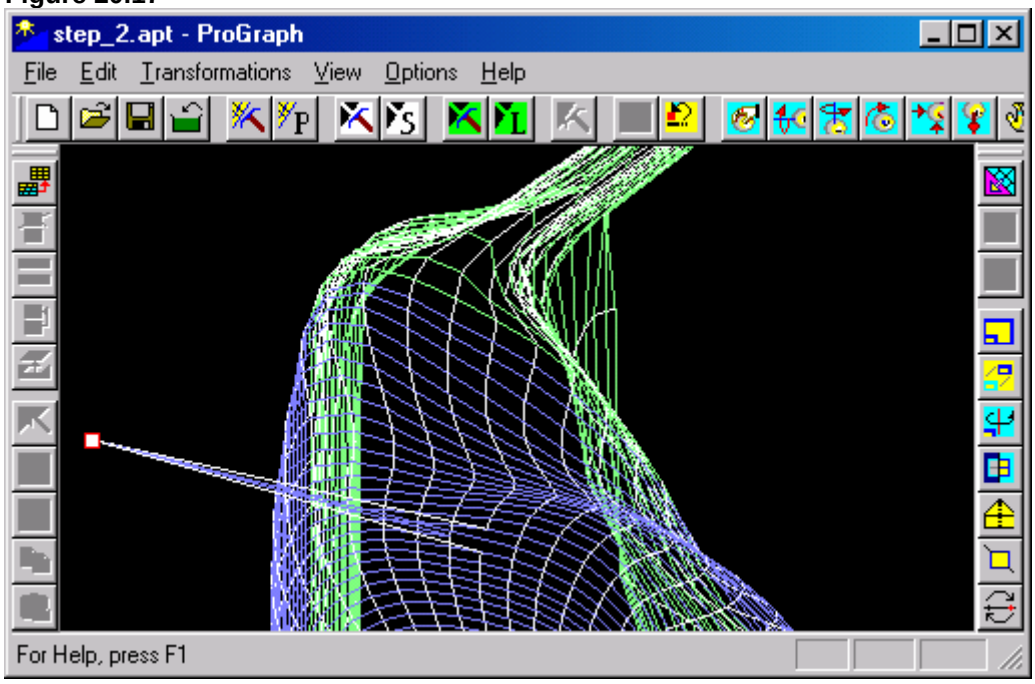
14. Choose all needed parameters in the ***Edit point Dialog Box*** as shown below.

Figure 20.16



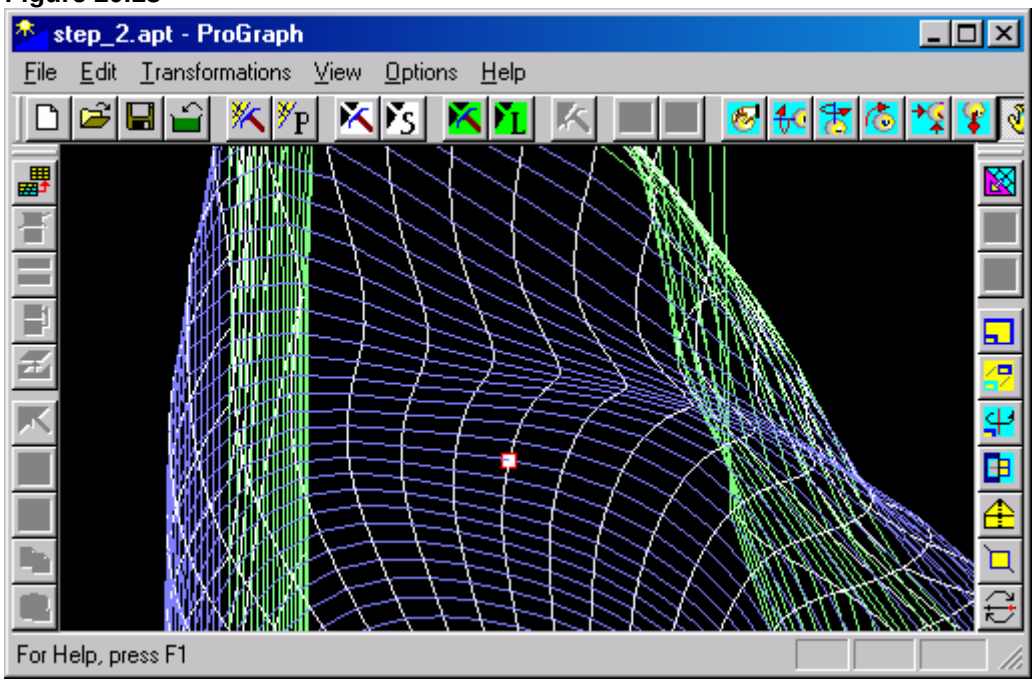
15. Click the **OK** control button. Then the captured point will be moved.

Figure 20.17



16. To undo all changes choose the **Point ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

Figure 20.18



17. To drag the captured point:

- Choose the **Point ~ Drag** command from the **Edit** menu.

or

- Click the following icon from the left toolbar:

Figure 20.19

18. Then:

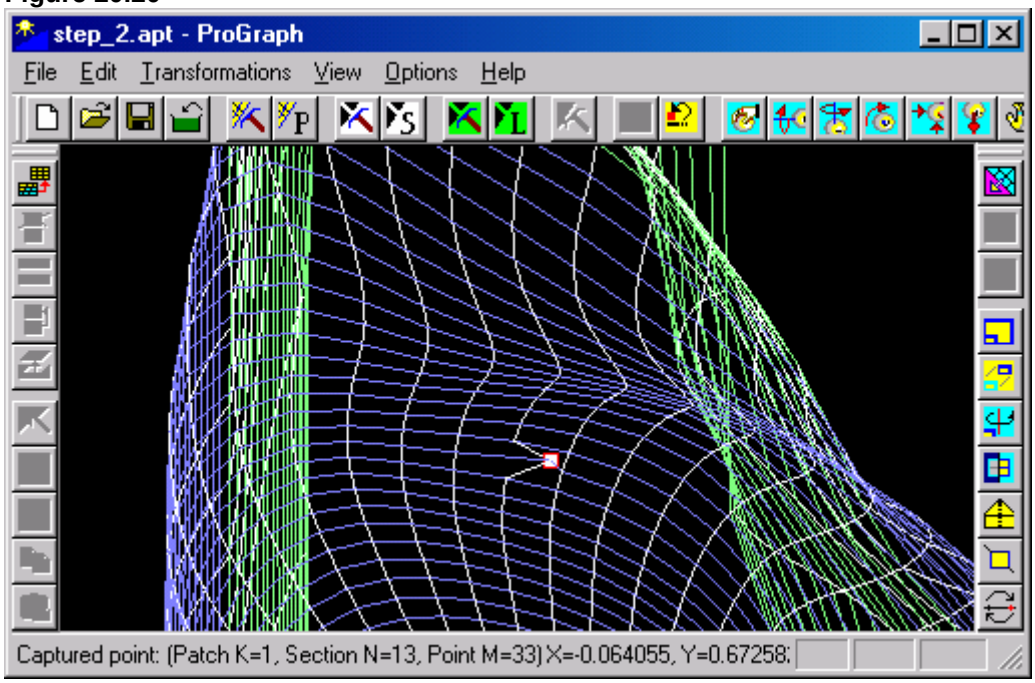
- Press left mouse button and drag the mouse. The captured point will be moved and its new coordinates will appear in Status Bar. Releasing the mouse button drops the captured point at the last position.

or

- Click a new position of the captured point.

Then the captured point is moved in the plane of curvilinear quadrangle that is formed by neighboring sections and lines. This curvilinear quadrangle is covered by a grid that has 100x100 cells. The point can be placed in the points of this grid only. The point can't be dragged outside the quadrangle.

Figure 20.20


step_2.apt - ProGraph
File Edit Transformations View Options Help
Captured point: (Patch K=1, Section N=13, Point M=33) X=-0.064055, Y=0.67258;

Chapter 3. Block transforming (using Transformations menu)

Step 21. How to create a block projection on other patches

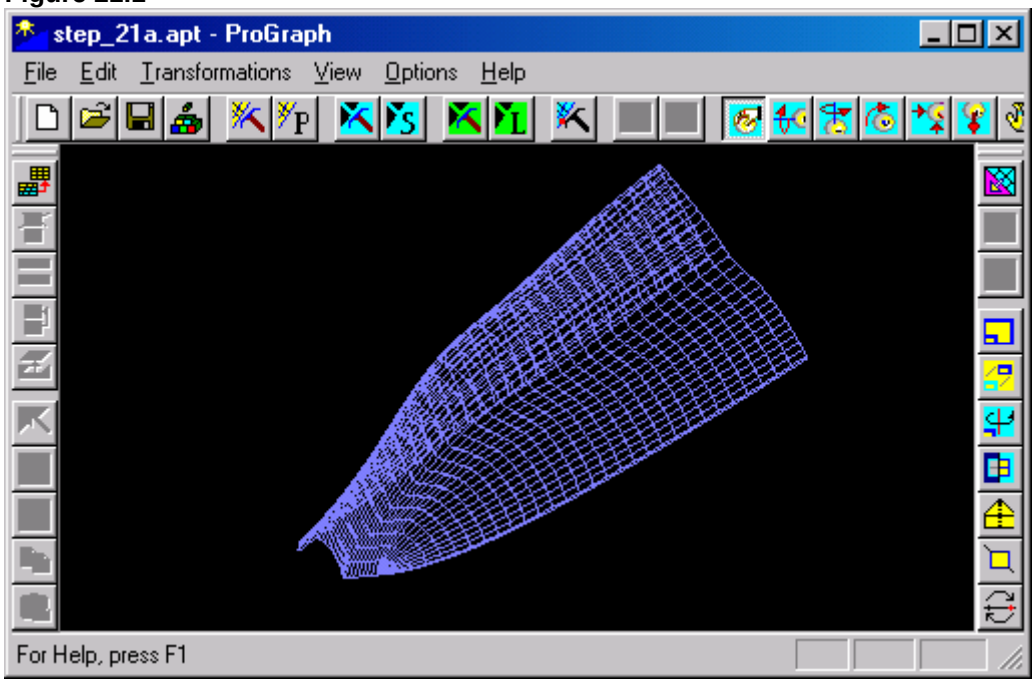
Introduction. In many cases, it is convenient to work with files that contain structured grid prepared by a special way. Nevertheless, the main constructor systems (for example, AutoCAD) create structured files using automatic procedures for meshing. For more suitable work in these cases, a simple procedure that permits to obtain grid on the model surface in the necessary form has been developed.

ProGraph permits to convert one structured grid into another one.

Such possibility is described in this **Step**. To its realization an algorithm of one-to-another grid reflection has been used. A normal is calculated at each node of the template grid and coordinates of point where normal intersects the target grid surface are determined. As a result, we can receive the surface grid that is similar to template but contains all the points placed on the target surface. In fact, if template contains compression of grid nodes, then result of projection contains similar compression too. The template may be created by any methods, but it is desirable to create it as close to target surface as possible.

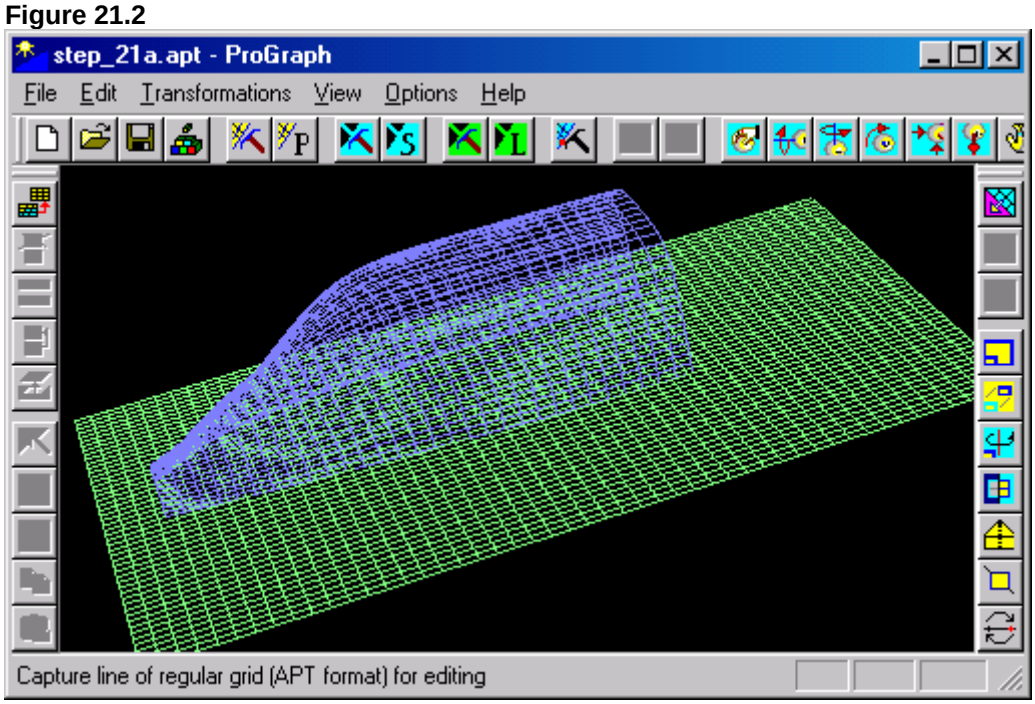
1. Open an existing file STEP_21a.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

Figure 21.1



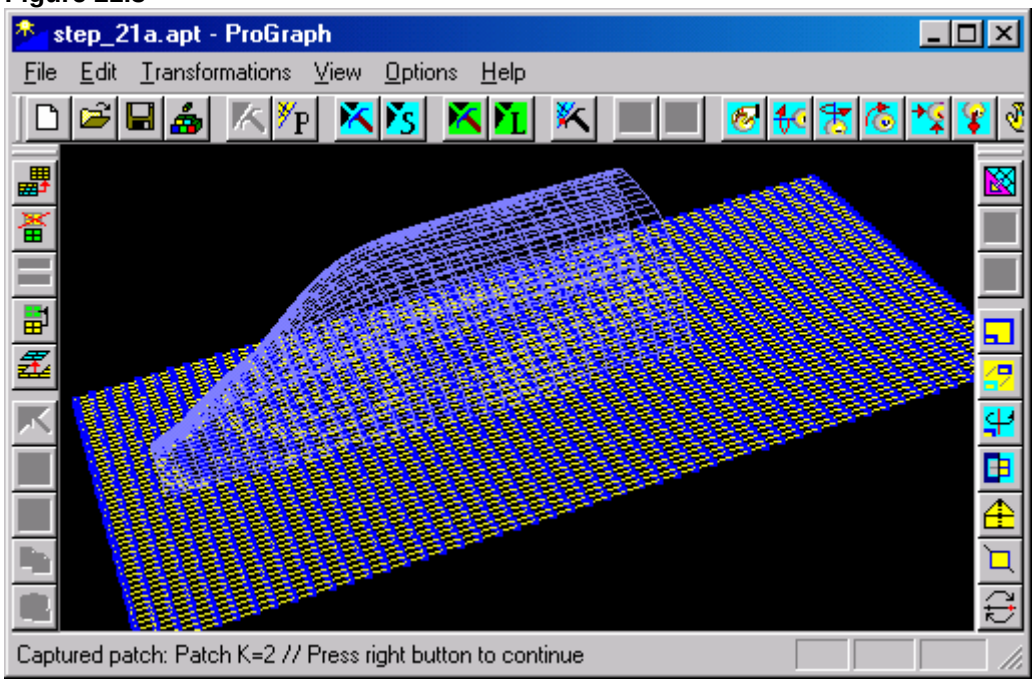
2. Append an existing file STEP_21b.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 3**.)

Figure 21.2



3. Capture the green patch. (For more information see steps 2-3 of **Step 5**.)

Figure 21.3



4. To create a projection of block on the other patch:

   - Choose the **Projection to APT** command from the **Transformations** menu.

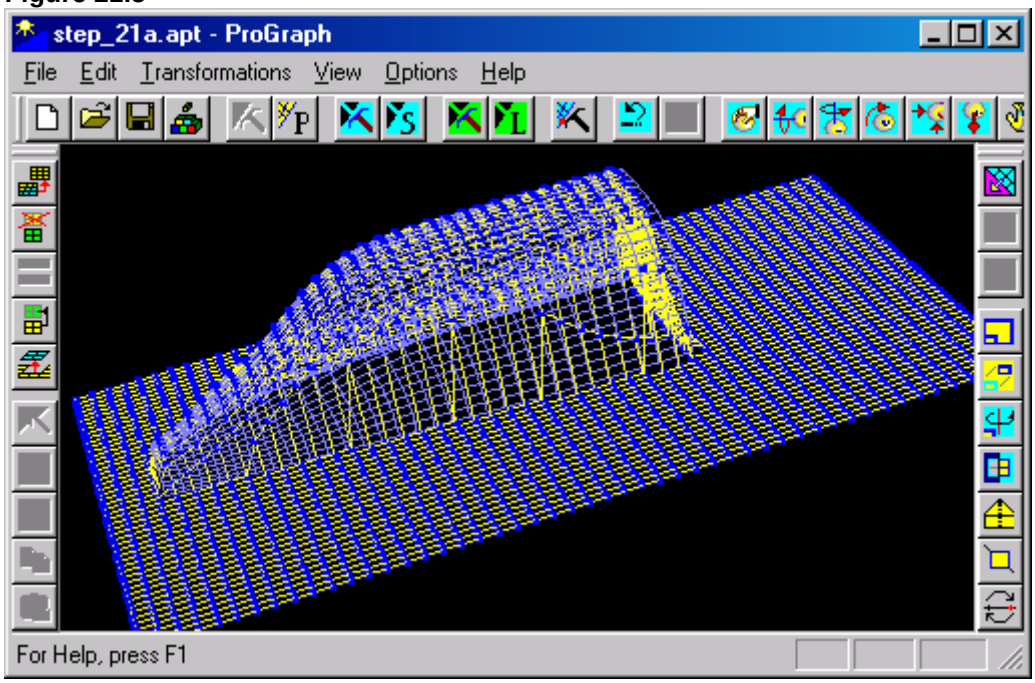
     or

   - Click the following icon from the right toolbar:

Figure 21.4

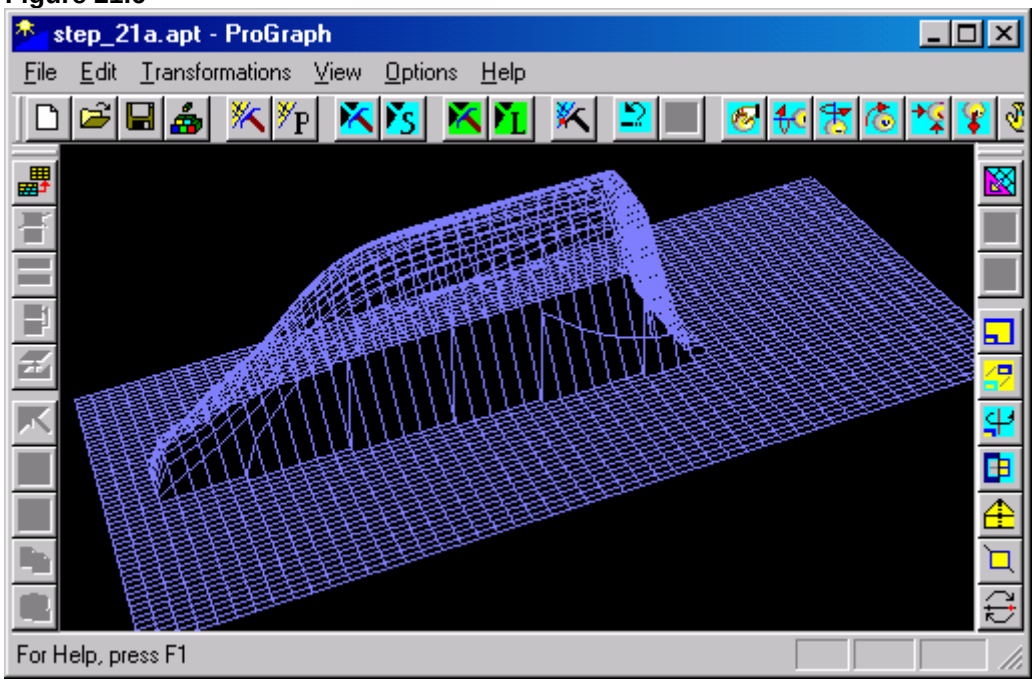
Then the Geometry will appear on your screen.

Figure 21.5



5. Keep all the patches included in the block. (For more information see step 4 of **Step 9.**) Only the patches included in the block remain on your screen. Their colors are changed. (For more information about colors see **Step 2.**)

Figure 21.6



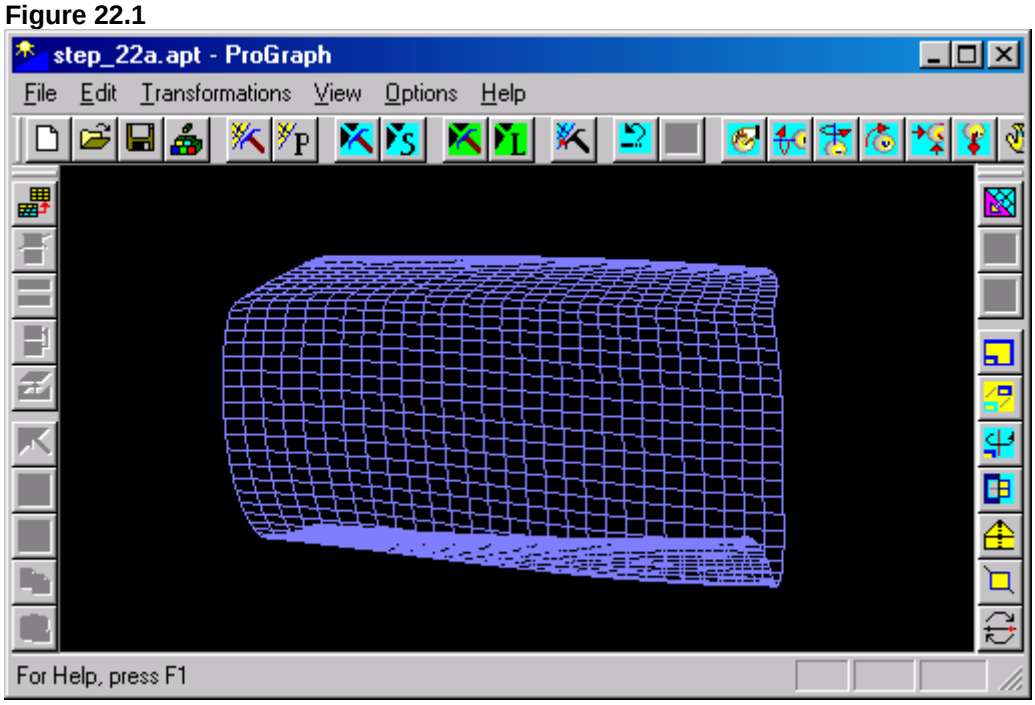
Step 22. How to create an intersection of two patches

Introduction. Quite often, Geometry grids developed with the use of constructor systems (UniGraphics, for example) aren't agreed each other. For example, mathematical models of fuselage and wing usually are developed separately. In this case, it is necessary to perform an additional procedure named as "inset of wing into fuselage".

This **Step** describes how to do it.

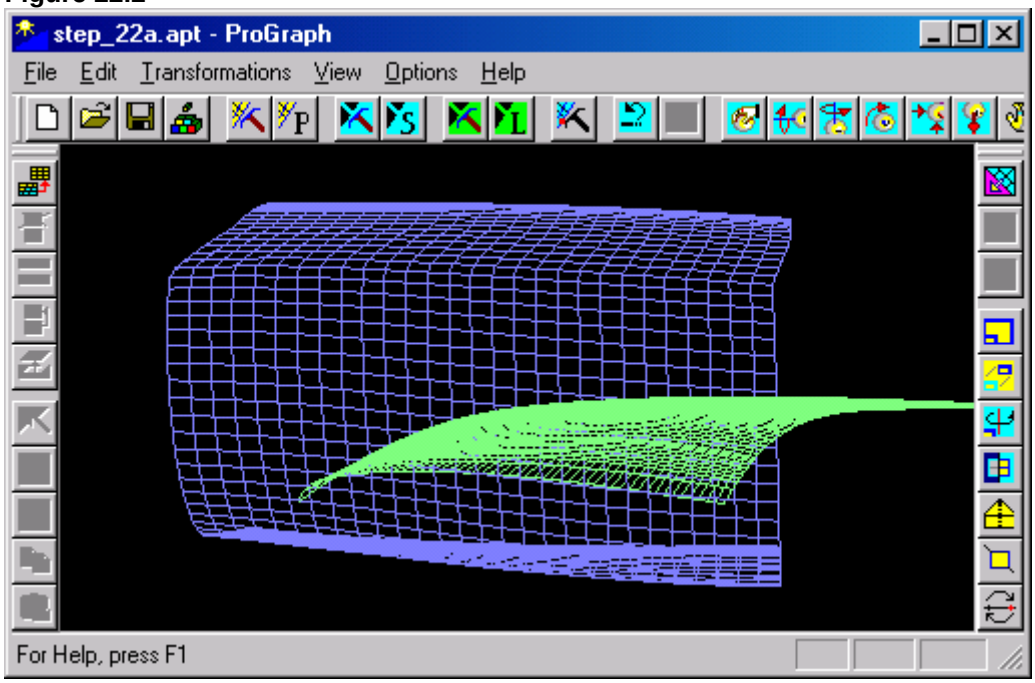
1. Open an existing file STEP_22a.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

Figure 22.1



2. Append an existing file STEP_22b.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 3**.)

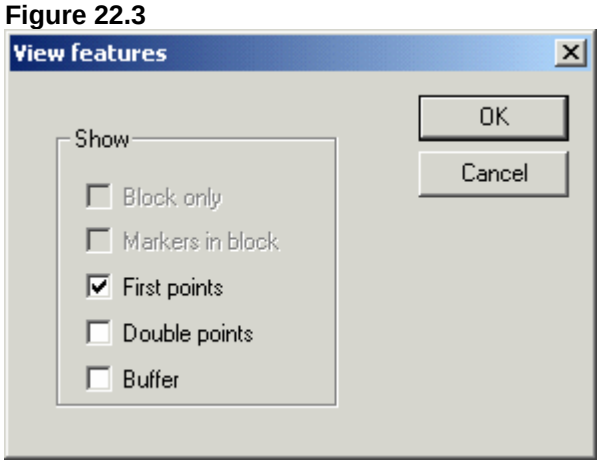
Figure 22.2



3. To show first points and sections choose the **View features** command from the **Options** menu. Then the ***View features Dialog Box*** will appear on your screen.

4. Choose all needed parameters in the ***View features Dialog Box*** as shown below.

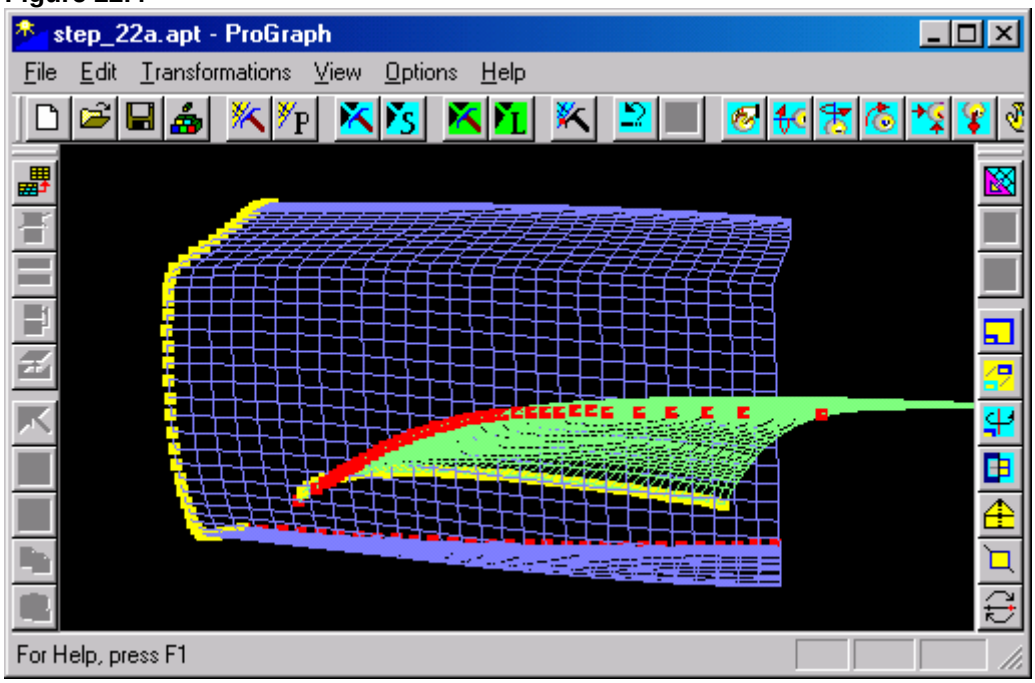
Figure 22.3



5. Click the **OK** control button. Then first sections will be represented with big yellow markers and first point at each section will be represented as big red markers.

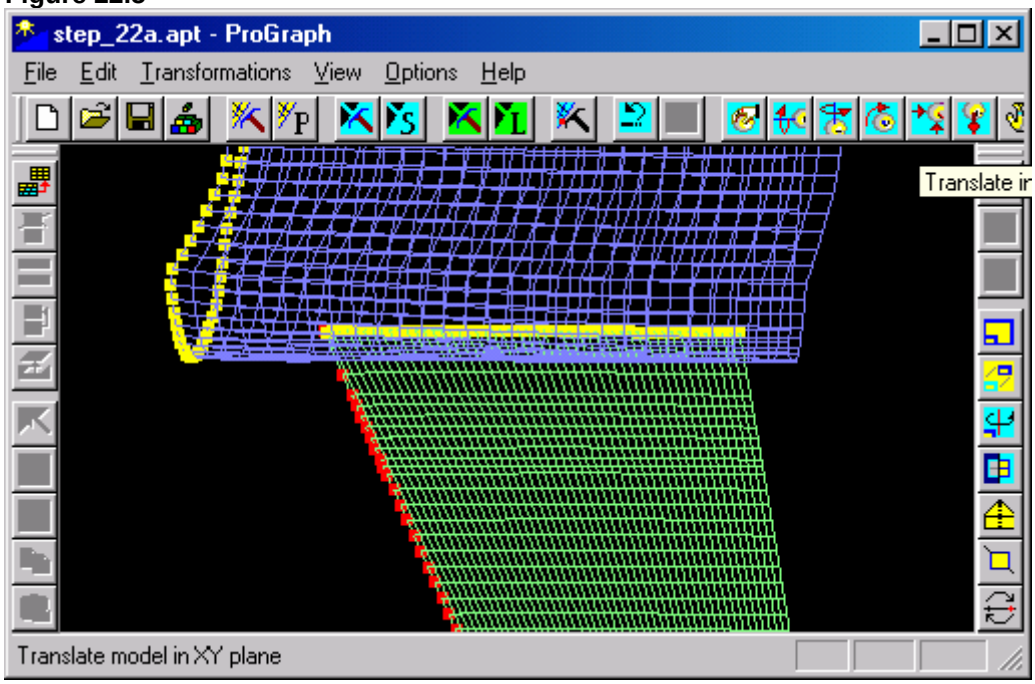
Note. Patches must be crossed.

Figure 22.4



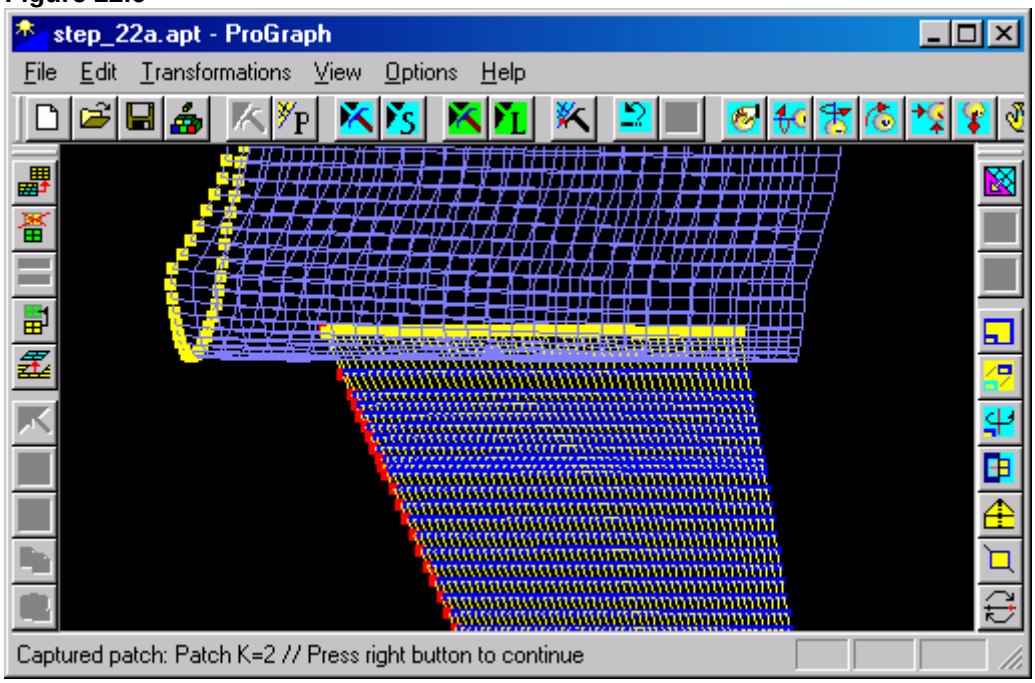
6. To set the plane view $Y = const$ click the following icon from the upper toolbar . Then a new projection of Geometry will appear on your screen.

Figure 22.5



7. Capture the green patch. (For more information see steps 2-3 of **Step 5**.)

Figure 22.6



8. To intersect these patches and to create smooth conjugation of intersecting area:

   - Choose the **Intersection...** command from the **Transformations** menu.

   or

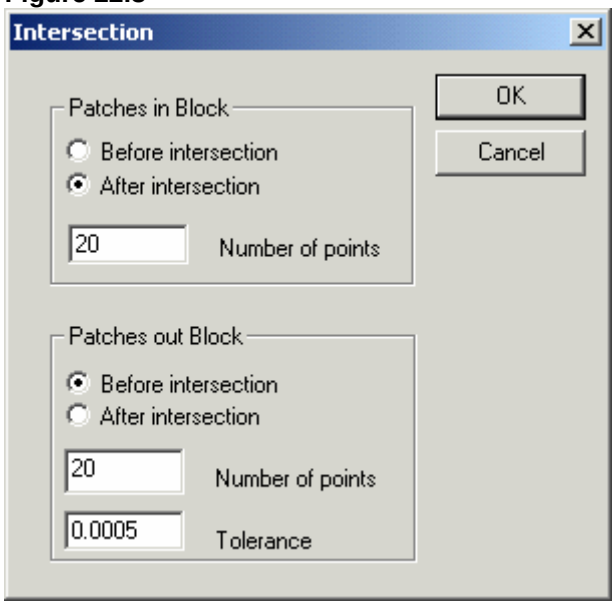
   - Click the following icon from the right toolbar:

   Figure 22.7

   Then the ***Intersection Dialog Box*** will appear on your screen.

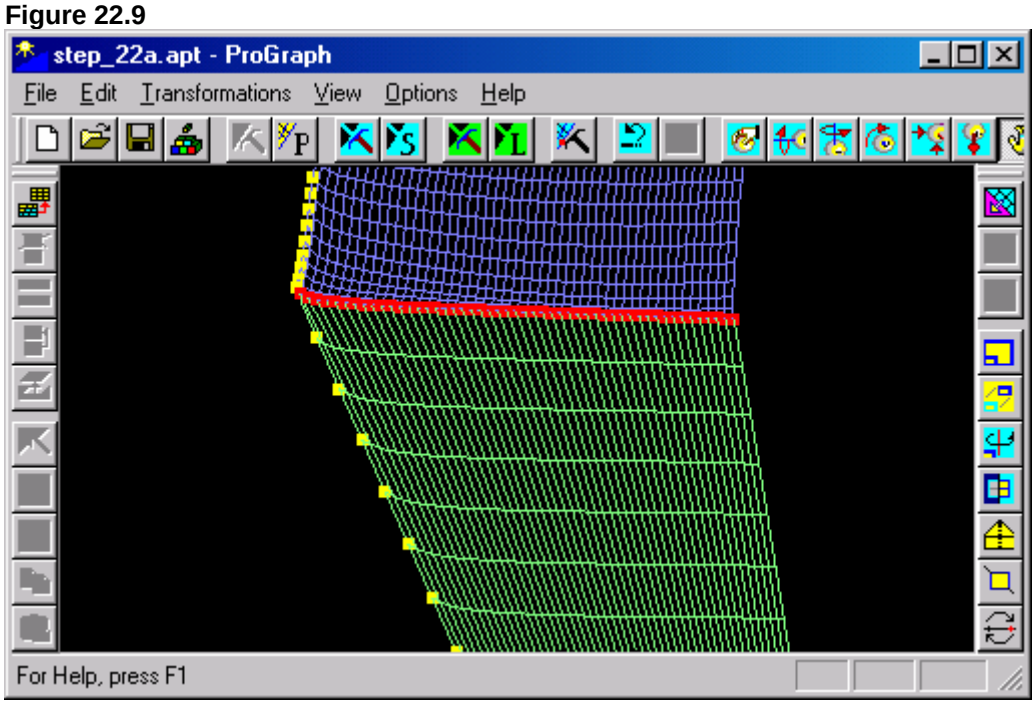
9. Choose all needed parameters in the ***Intersection Dialog Box*** as shown below.

Figure 22.8



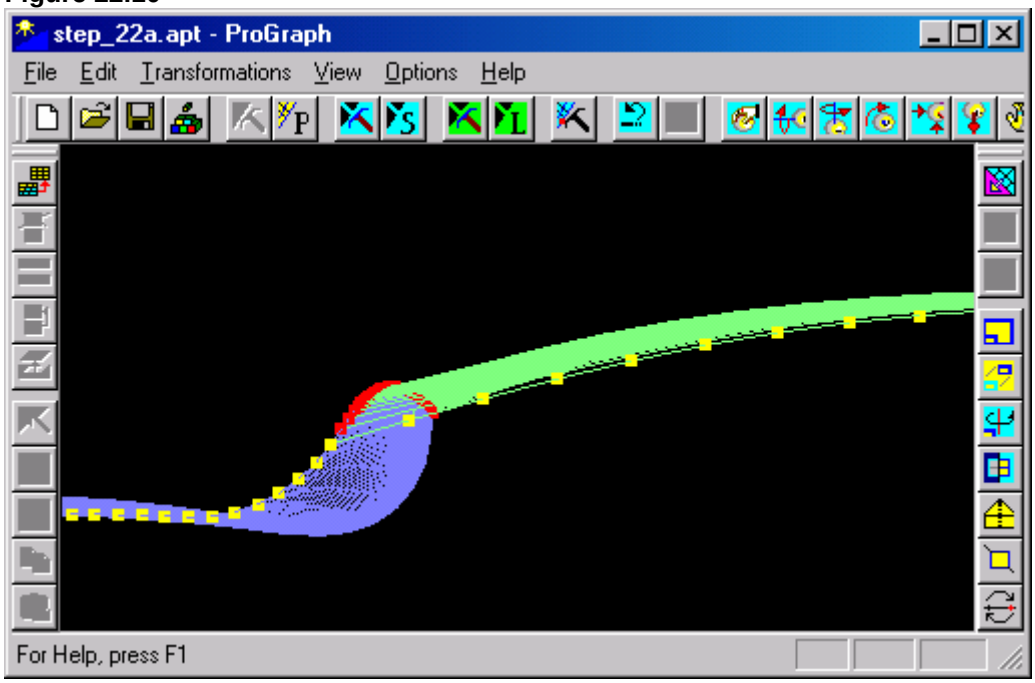
10. Click the **OK** control button. Then the Geometry will appear on your screen.

Figure 22.9



11. To set the plane view $X = \text{const}$ click the following icon from the upper toolbar . Then a new projection of Geometry will appear on your screen.

Figure 22.10


step_22a.apt - ProGraph
File Edit Transformations View Options Help
For Help, press F1

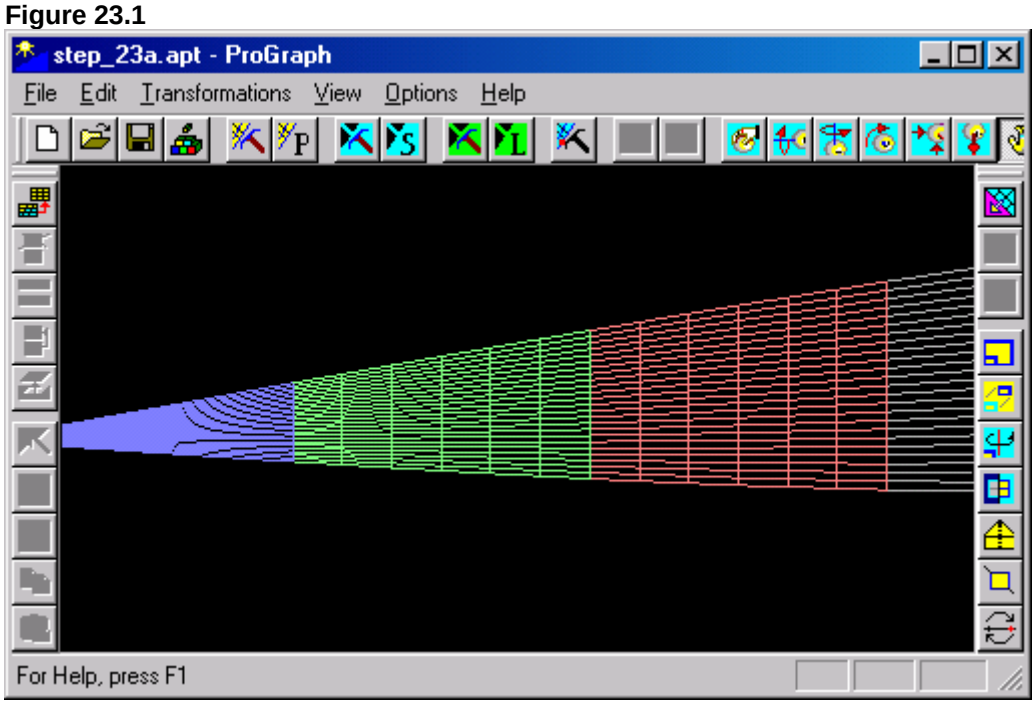
Step 23. How to merge patches included in the block

Introduction. In **Step 15** it has been mentioned that during the work it may be necessary to create additional patches. The reverse process of creating a united patch from several patches is important too.

This **Step** describes how to do it.

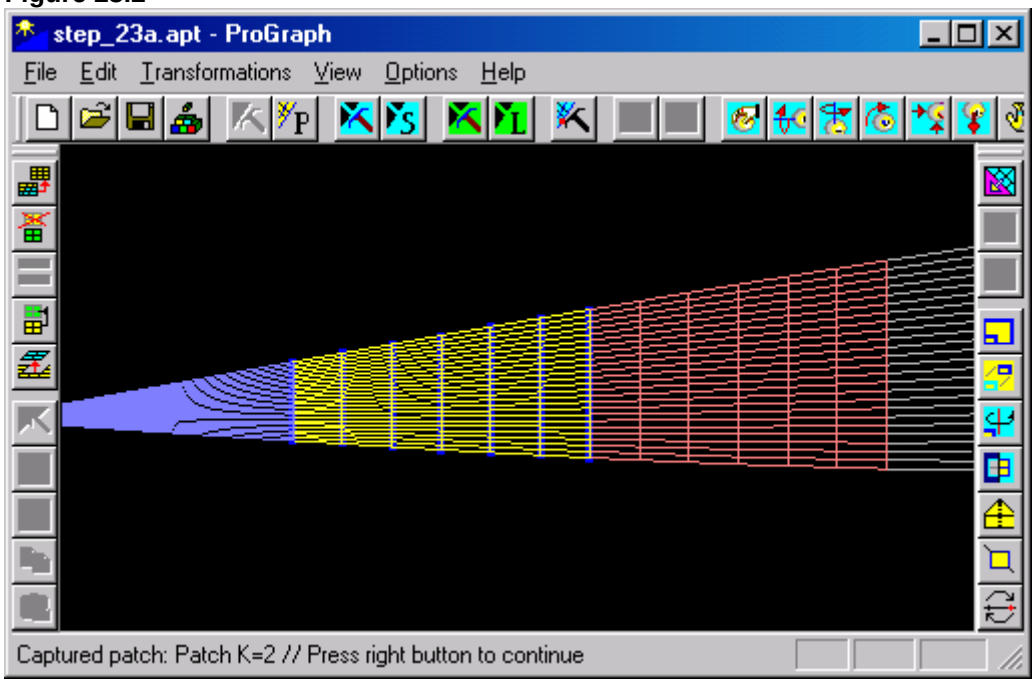
1. Open an existing file STEP_23a.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

Figure 23.1



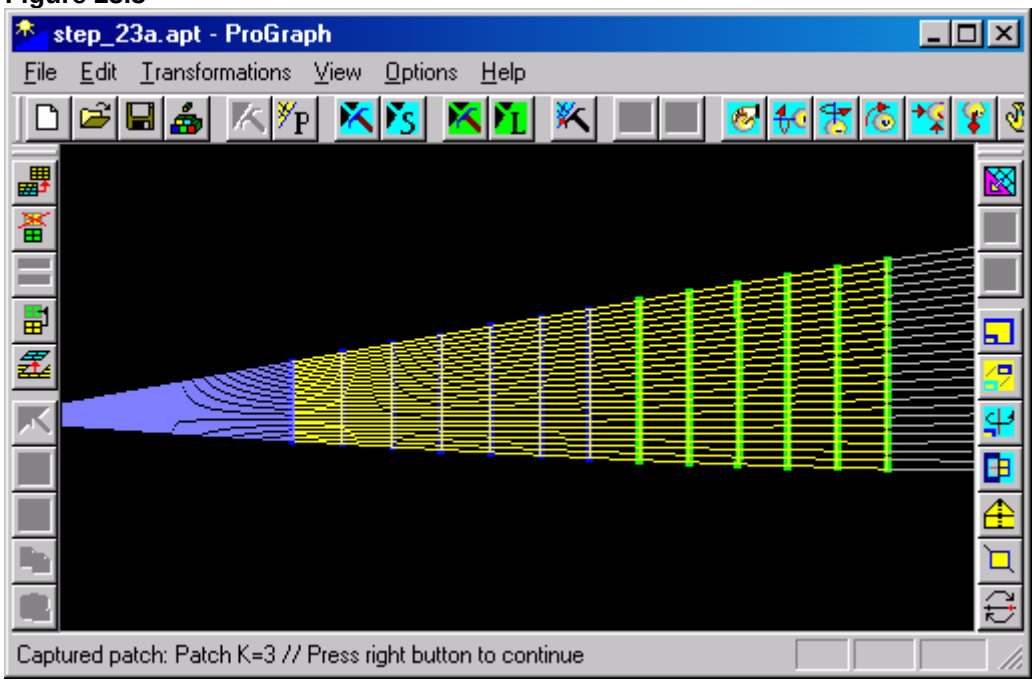
2. Capture the green patch. (For more information see steps 2-3 of **Step 5**.)

Figure 23.2



3. Capture the red patch. (For more information see steps 1-2 of **Step 7**.)

Figure 23.3



4. To merge this patches:

   - Choose the **Merge...** command from the **Transformations** menu.

or

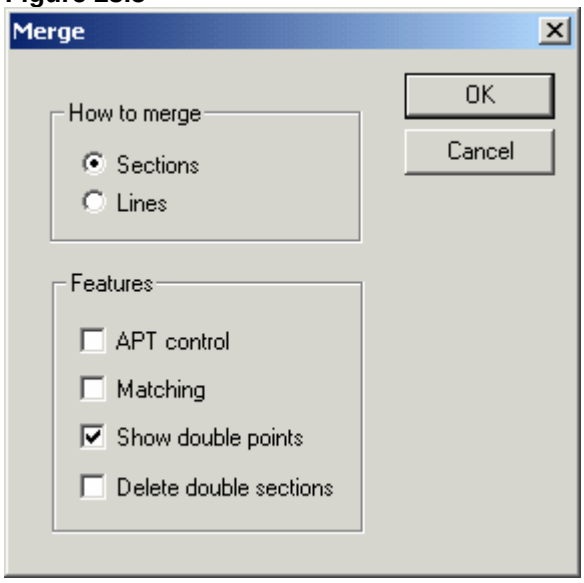
- Click the following icon from the upper toolbar:

Figure 23.5

Then the ***Merge Dialog Box*** will appear on your screen.

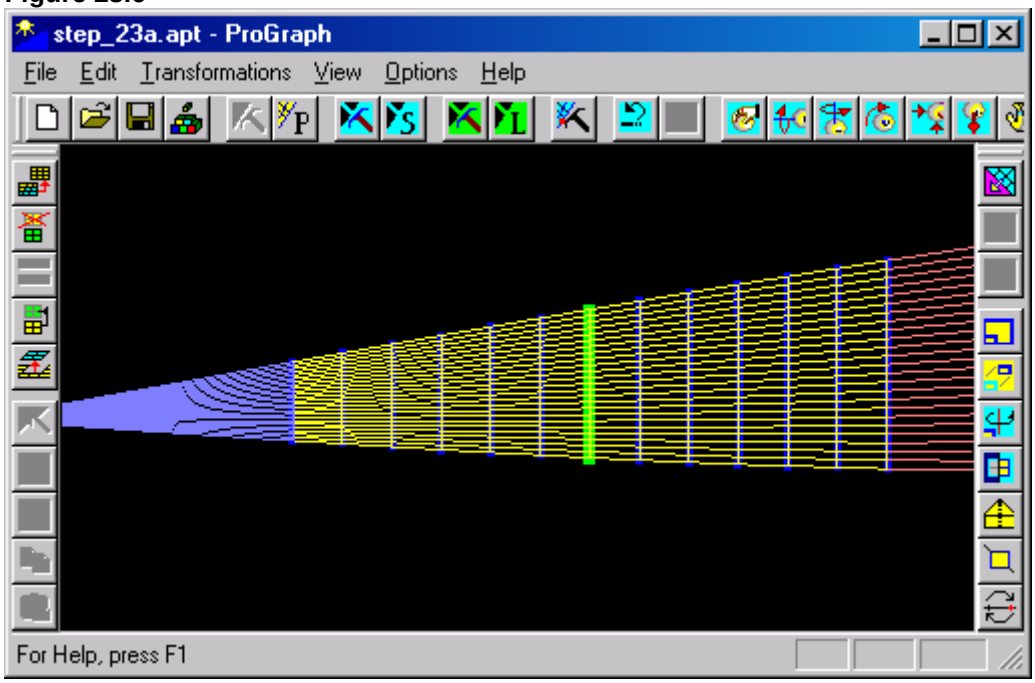
5. Choose all needed parameters in the ***Merge Dialog Box*** as shown below.

Figure 23.5



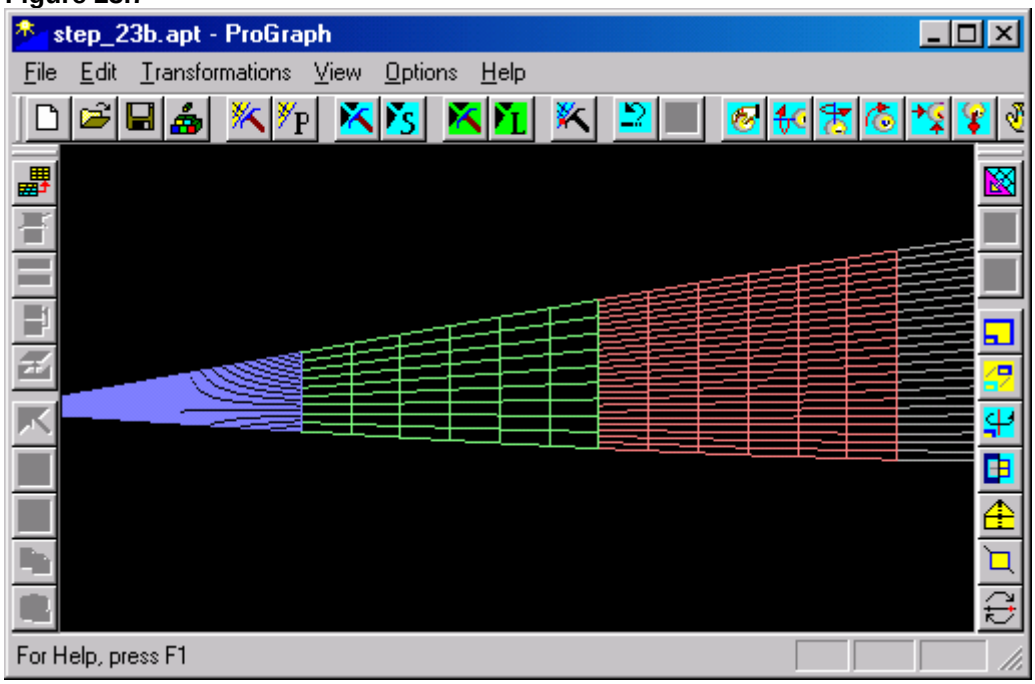
6. Click the **OK** control button. Then the number of lines will remain the same and the number of sections will increase. Double points will be represented with big green markers. The colors of patches will be changed. (For more information about colors see **Step 2**.)

Figure 23.6



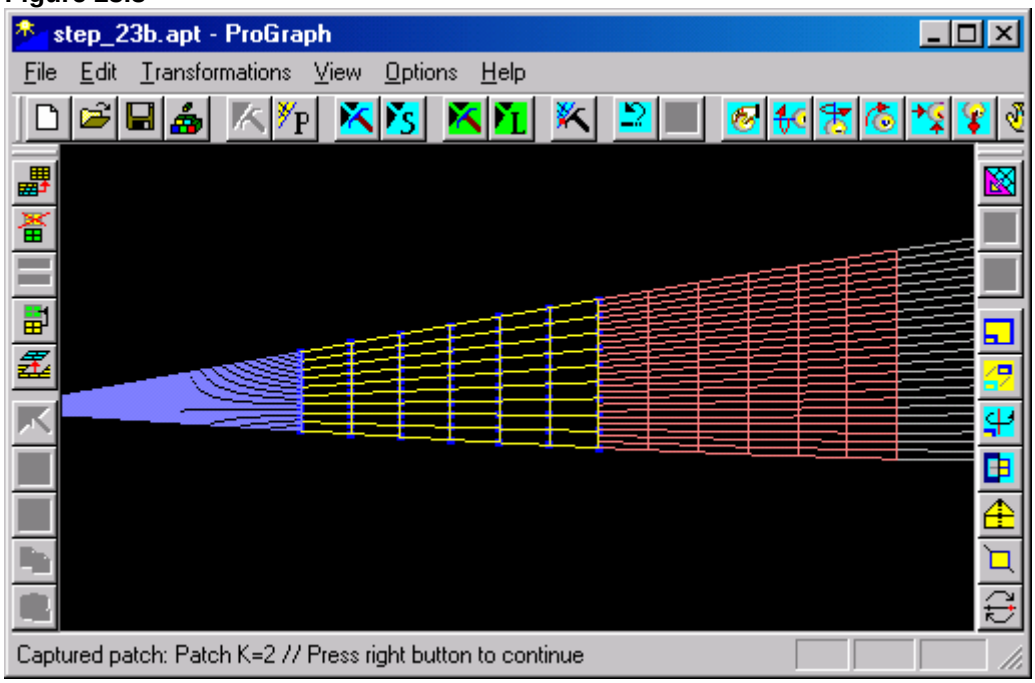
7. Open an existing file STEP_23b.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

Figure 23.7



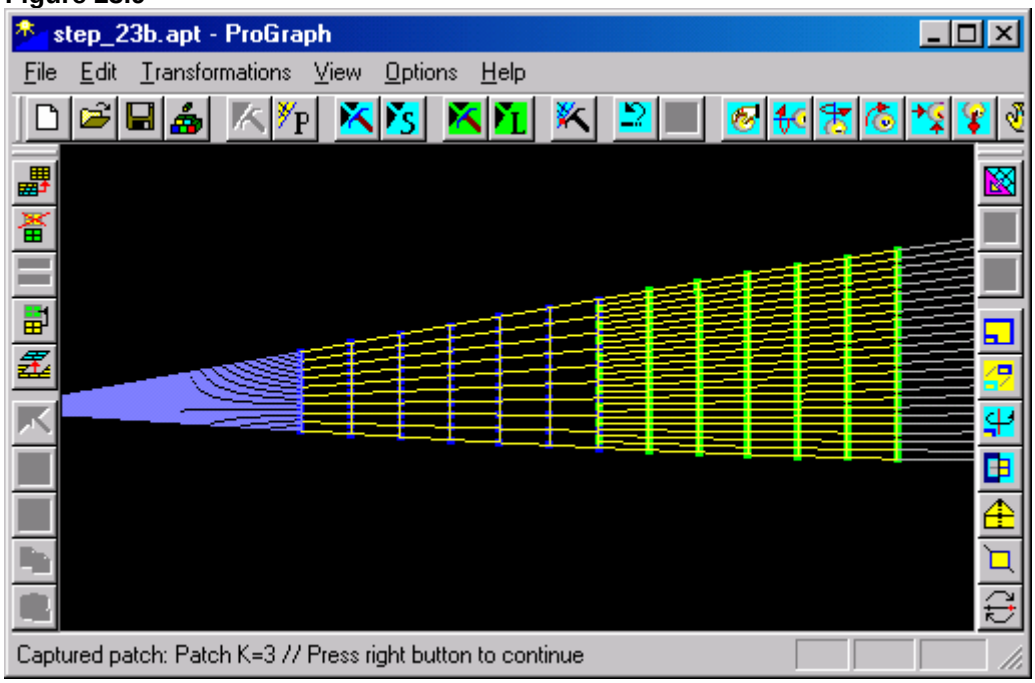
8. Capture the green patch. (For more information see steps 2-3 of **Step 5**.)

Figure 23.8



9. Capture the red patch. (For more information see steps 1-2 of **Step 7**.)

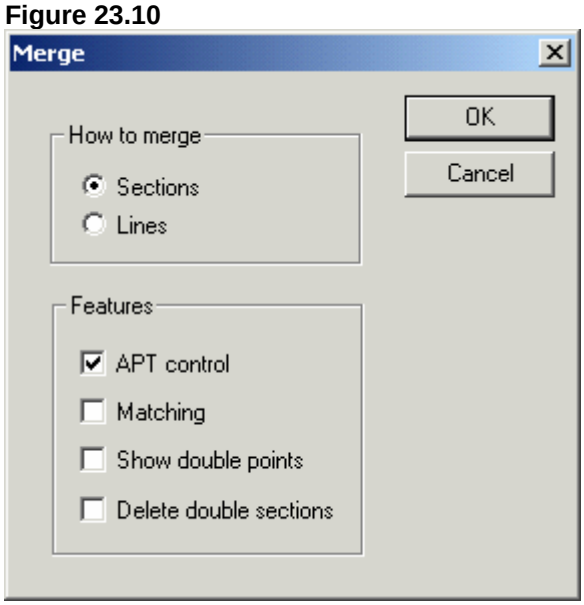
Figure 23.9



10. Choose the **Merge...** command from the **Transformations** menu again. Then the ***Merge Dialog Box*** will appear on your screen.

11. Choose all needed parameters in the ***Merge Dialog Box*** as shown below.

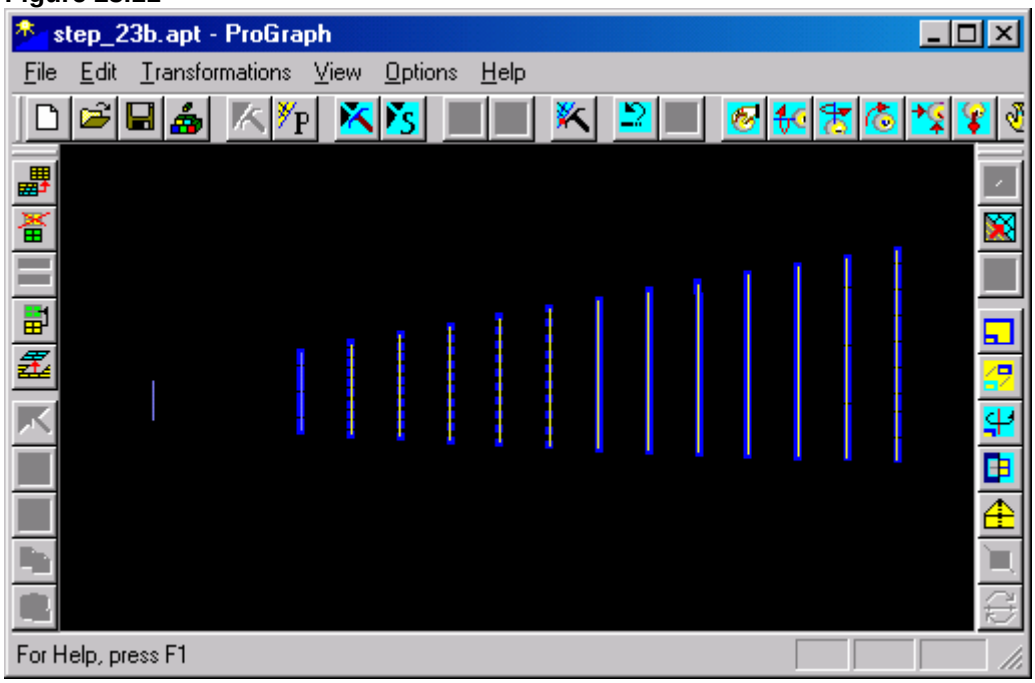
Figure 23.10



12. Click the **OK** control button. The patches in block have different numbers of lines. After merging APT format will be violated. Then a warning about APT format violation will appear on your screen.

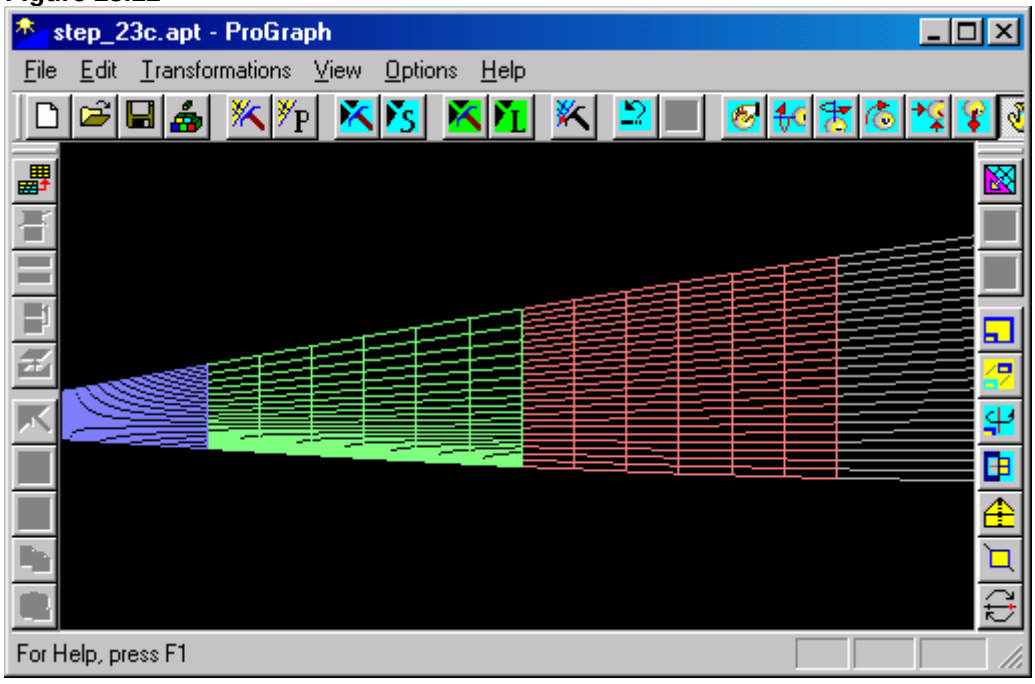
13. Click the **Yes** control button or press Enter. Then a new Geometry of SKL format will appear on your screen. The sections of block belong to one patch now. The colors of patches will be changed. (For more information about colors see **Step 2**.)

Figure 23.11



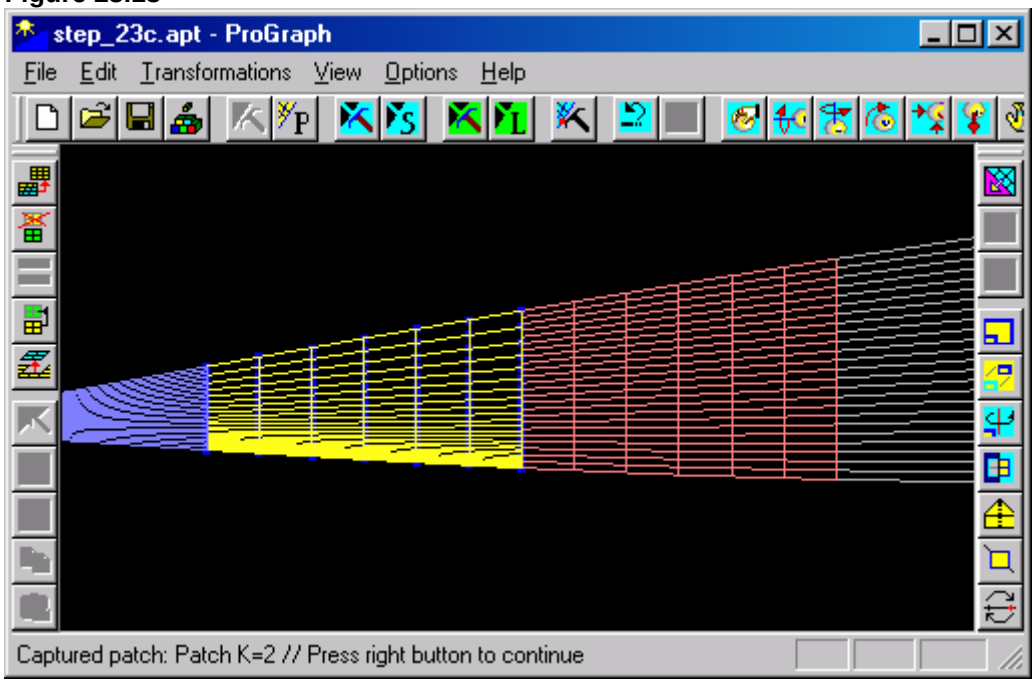
14. Open an existing file STEP_23c.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

Figure 23.12



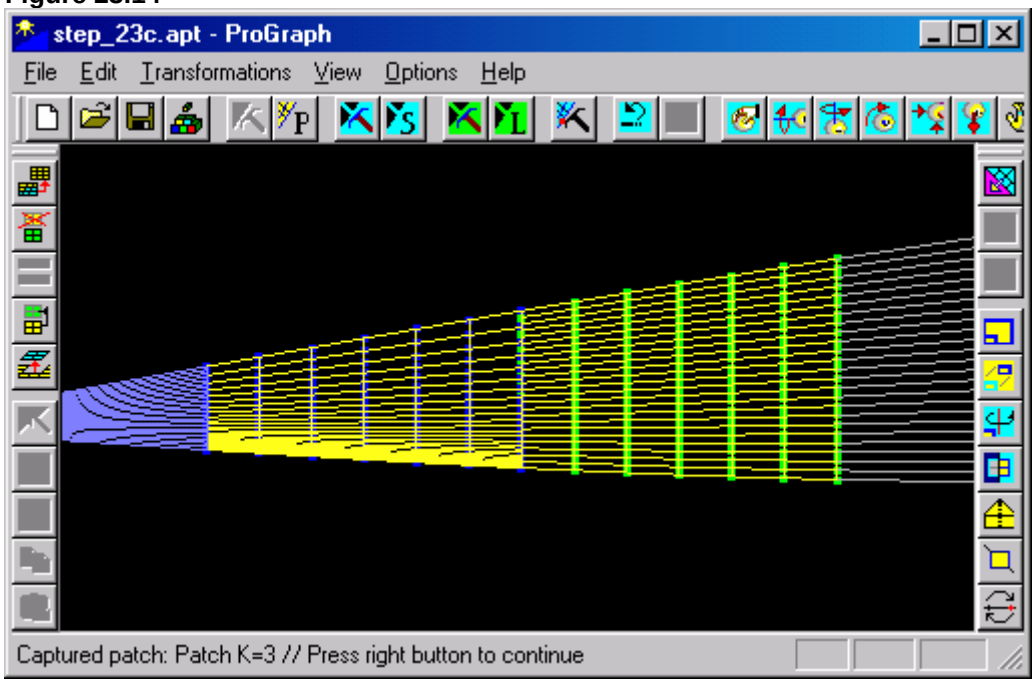
15. Capture the green patch. (For more information see steps 2-3 of **Step 5**.)

Figure 23.13



16. Capture the red patch. (For more information see steps 1-2 of **Step 7**.)

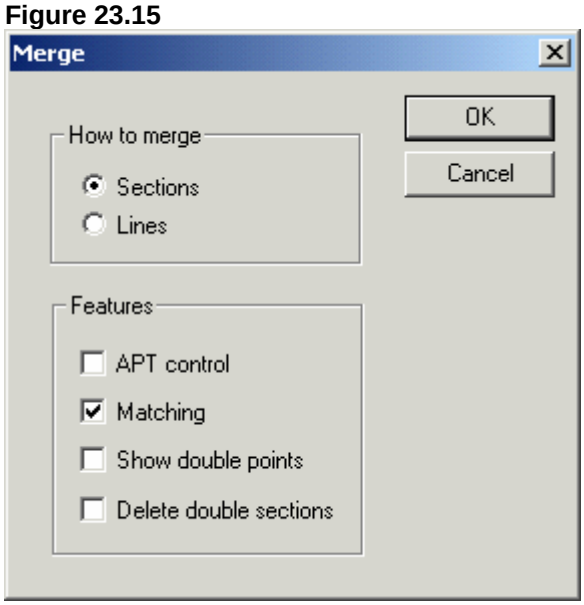
Figure 23.14



17. Choose the **Merge...** command from the **Transformations** menu again. Then the ***Merge Dialog Box*** will appear on your screen.

18. Choose all needed parameters in the ***Merge Dialog Box*** as shown below.

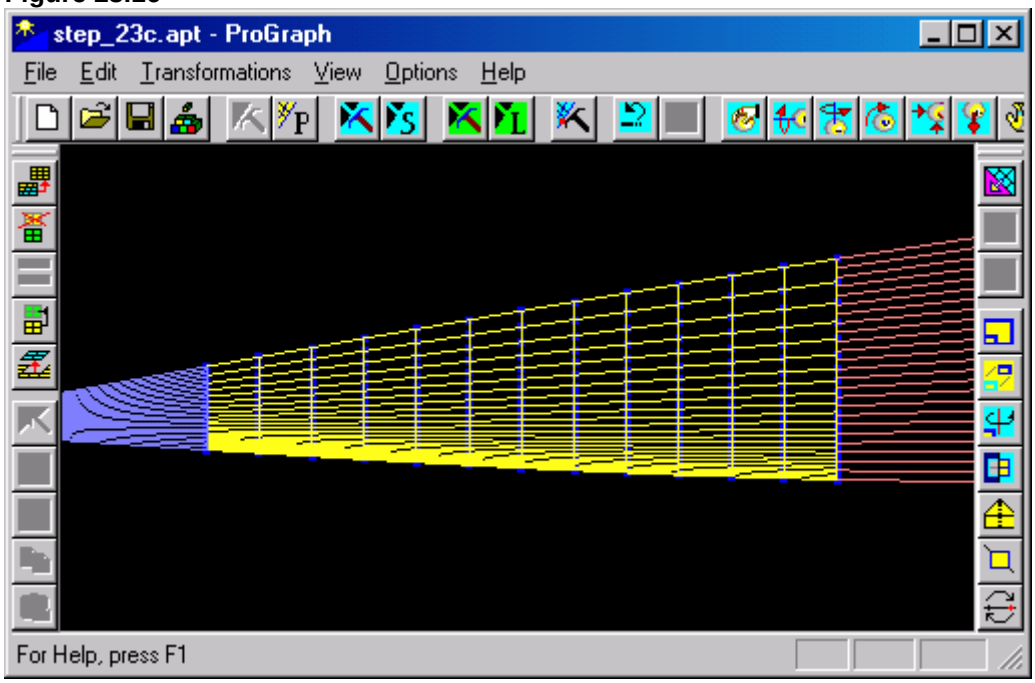
Figure 23.15



19. Click the **OK** control button. The points of sections in the first and the second patches have different distributions.

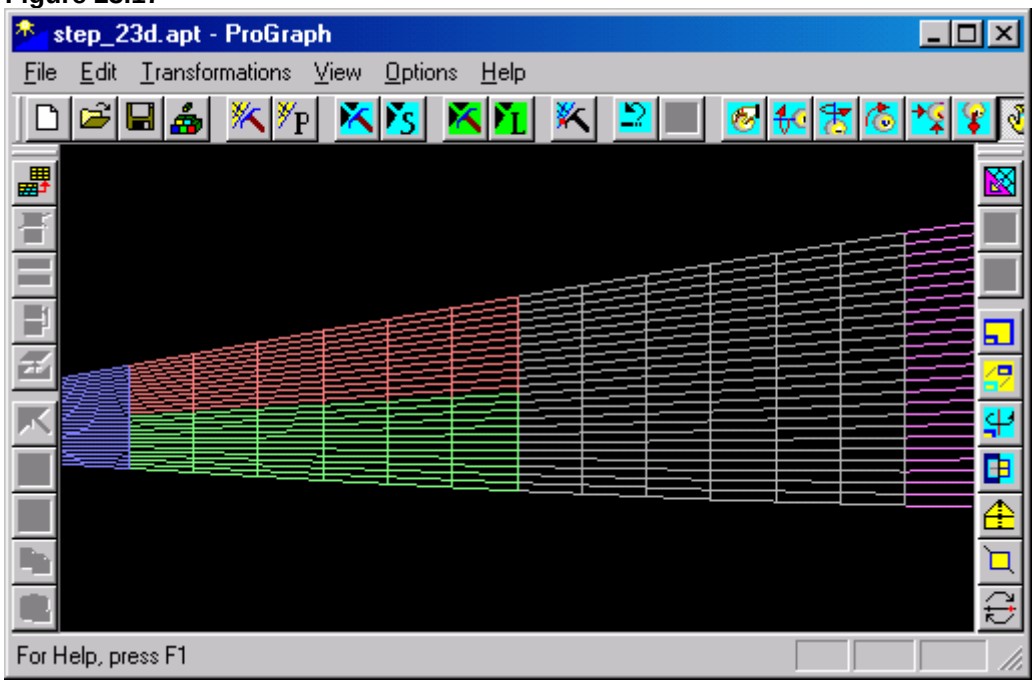
    A new Geometry appears on your screen. The sections of block belong to one patch now. The second patch is rebroken in accordance with the first one. The colors of patches are changed. (For more information about colors see **Step 2**.)

Figure 23.16



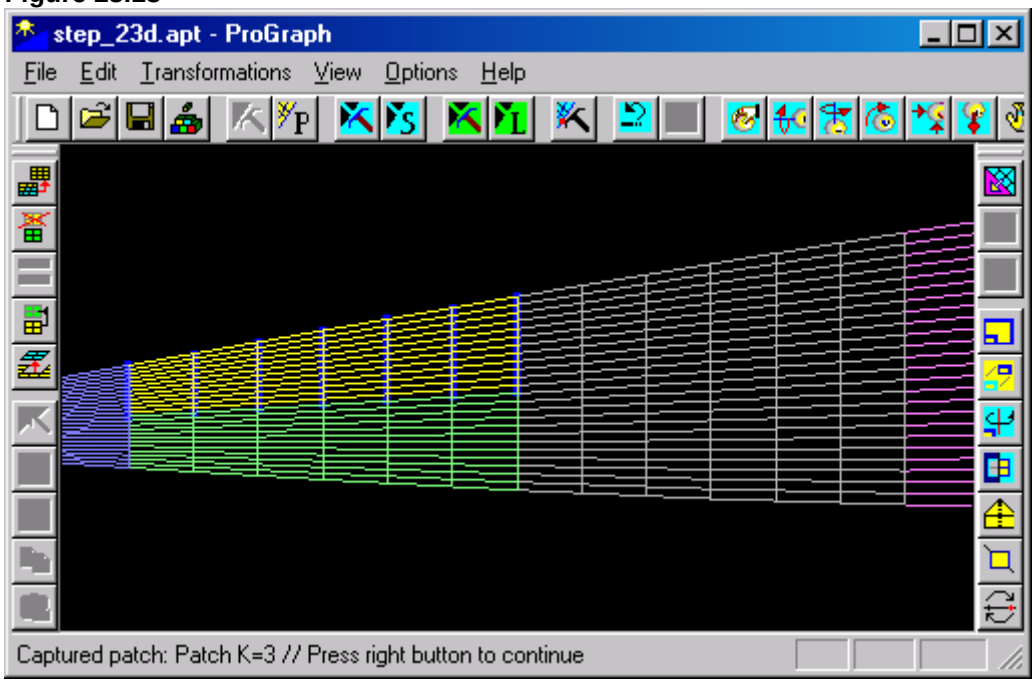
20. Open an existing file STEP_23d.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

Figure 23.17



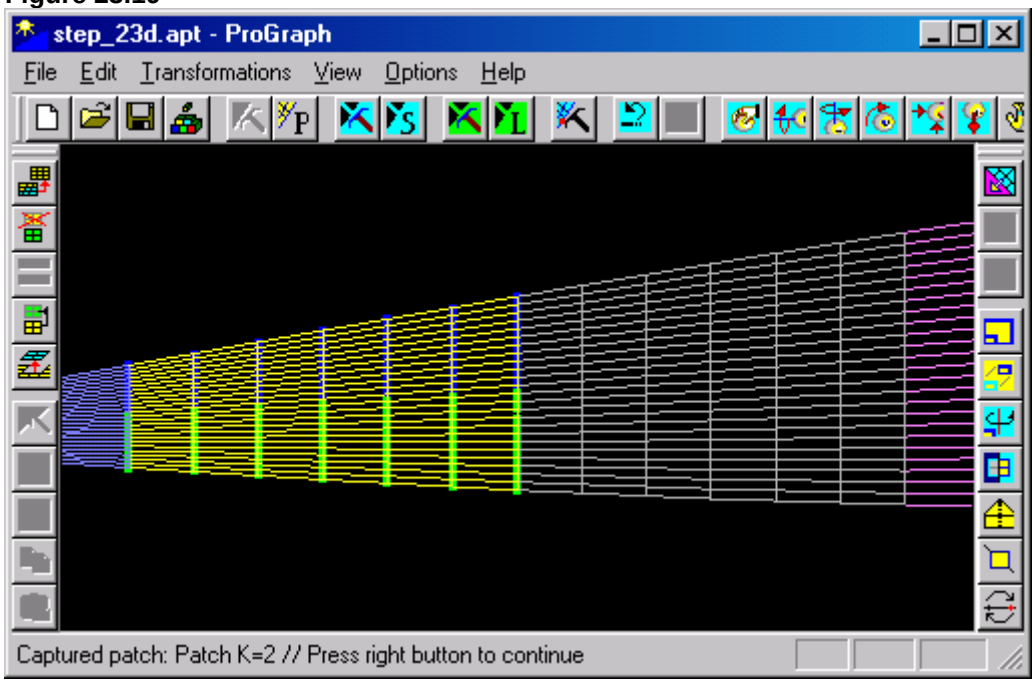
21. Capture the red patch. (For more information see steps 2-3 of **Step 5**.)

Figure 23.18



22. Capture the green patch. (For more information see steps 1-2 of **Step 7**.)

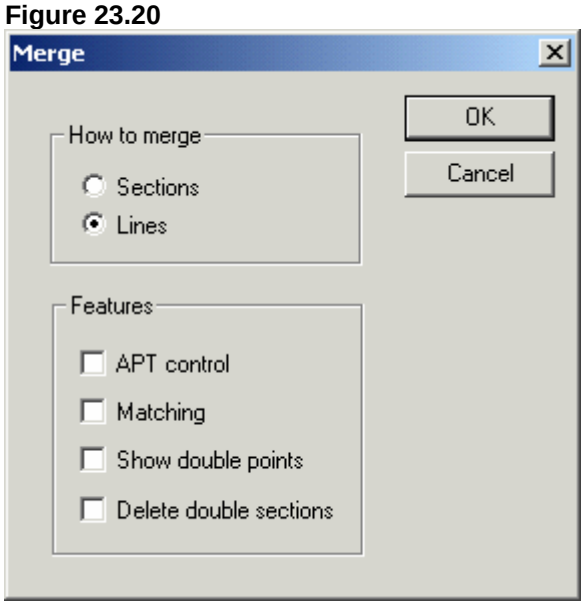
Figure 23.19



23. Choose the **Merge...** command from the **Transformations** menu again. Then the ***Merge Dialog Box*** will appear on your screen.

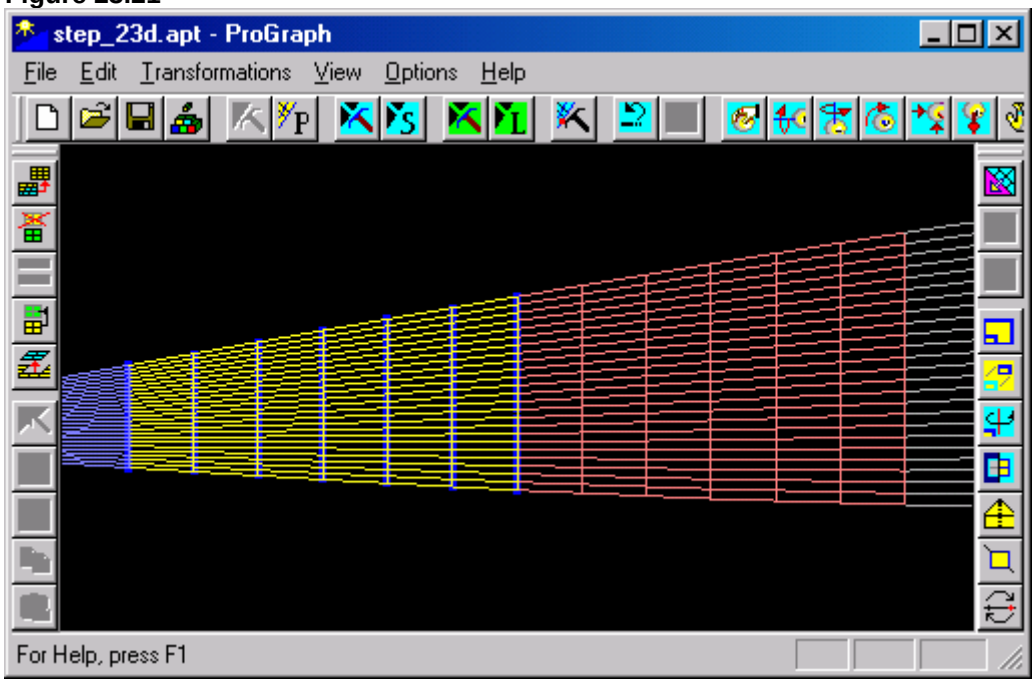
24. Choose all needed parameters in the ***Merge Dialog Box*** as shown below.

Figure 23.20



25. Click the **OK** control button. Then the number of sections will remain the same and the number of lines will increase. The colors of patches will be changed. (For more information about colors see **Step 2**.)

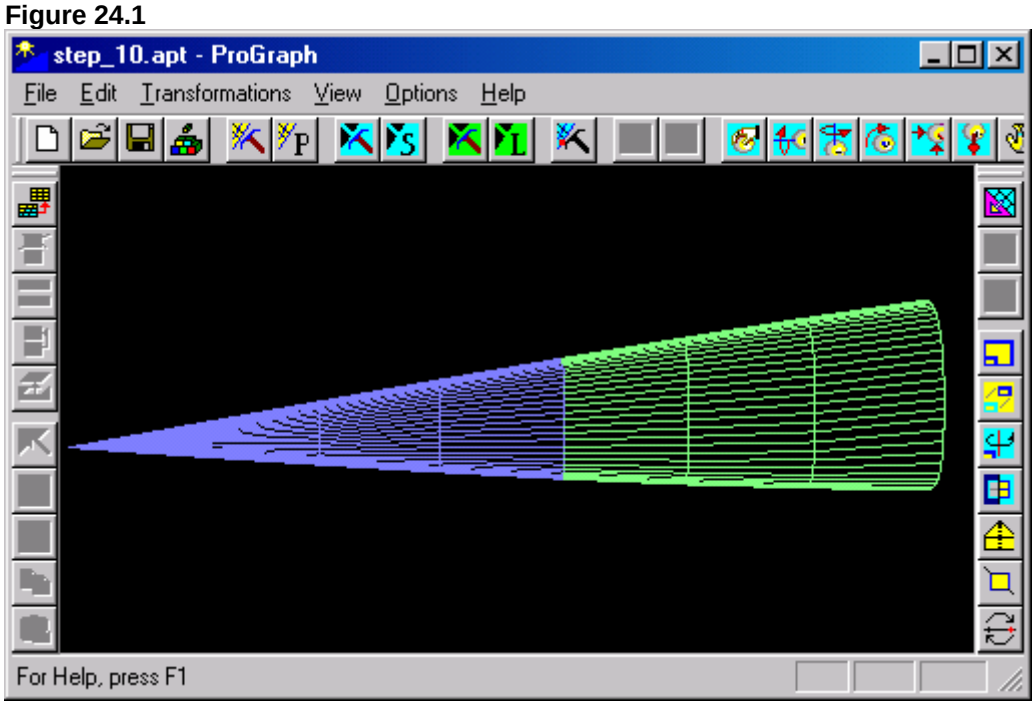
Figure 23.21



Step 24. A set of one-action transformations of block

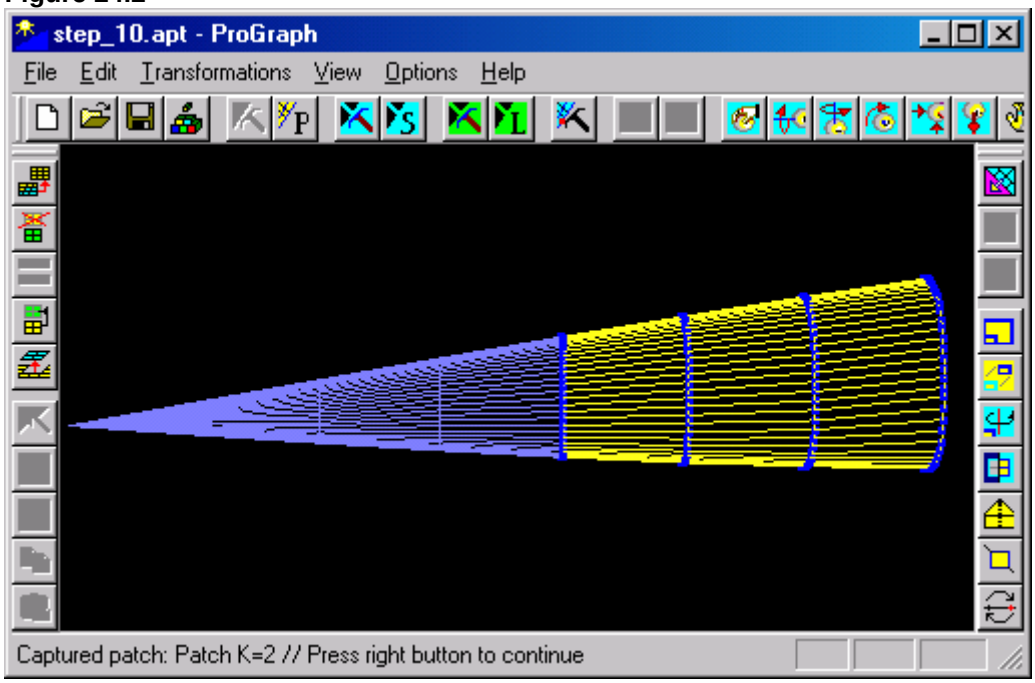
1. Open an existing file STEP_10.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

Figure 24.1



2. Capture the green patch. (For more information see steps 2-3 of **Step 5**.)

Figure 24.2



3. To scale the block:

   - Choose the **Scaling...** command from the **Transformations** menu.

   or

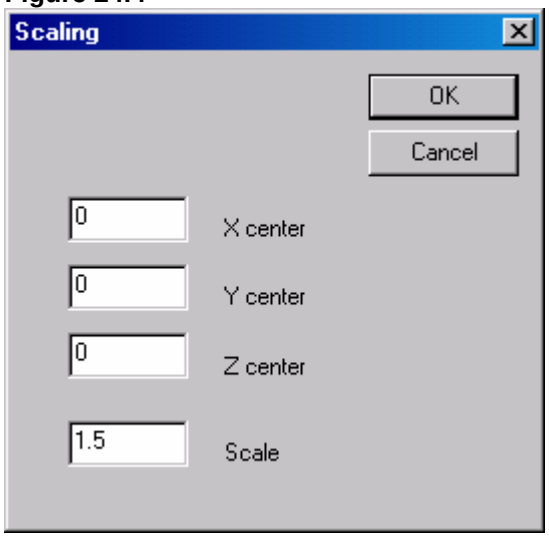
   - Click the following icon from the right toolbar:

   Figure 24.3

   Then the ***Scaling Dialog Box*** will appear on your screen.

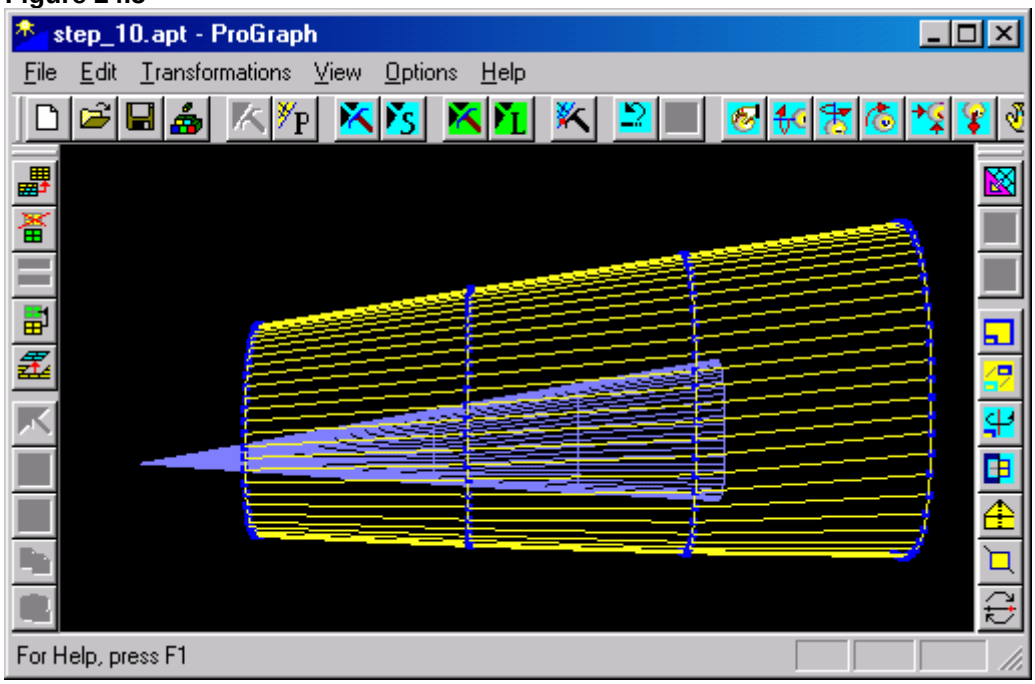
4. Choose all needed parameters in the ***Scaling Dialog Box*** as shown below.

Figure 24.4



5. Click the **OK** control button. Then the block will be scaled and a new Geometry will appear on your screen.

Figure 24.5



6. To undo all changes:

   - Choose the **Patches ~ Undo** command from the **Edit** menu.

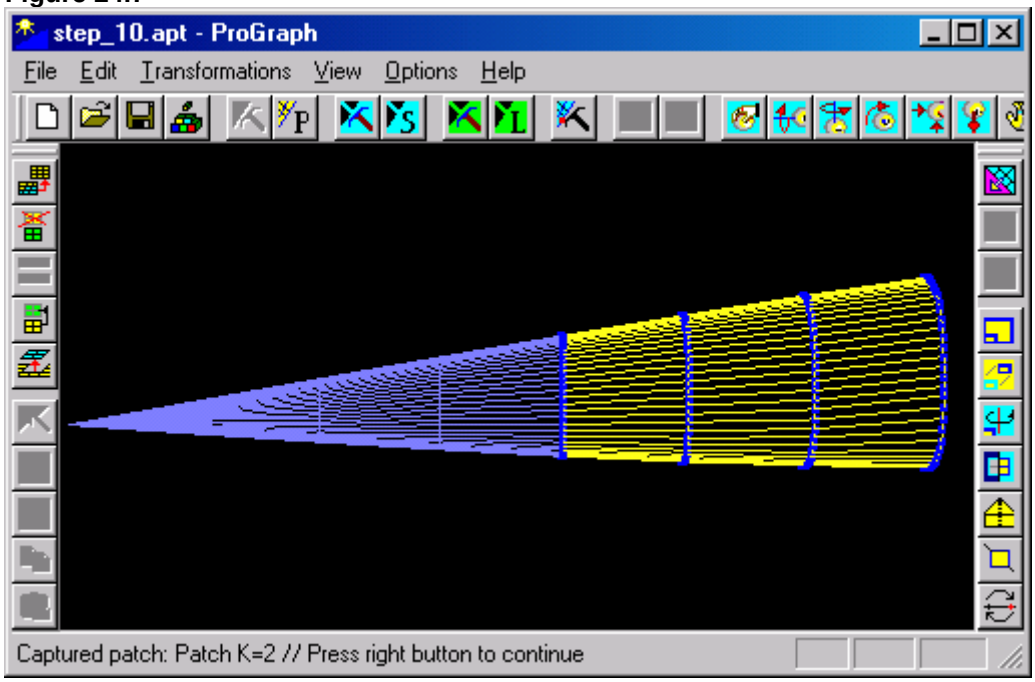
     or

   - Click the following icon from the upper toolbar:

Figure 24.6

Then old Geometry will appear on your screen again.

Figure 24.7



7. To move the block:

   - Choose the **Move...** command from the **Transformations** menu.

   or

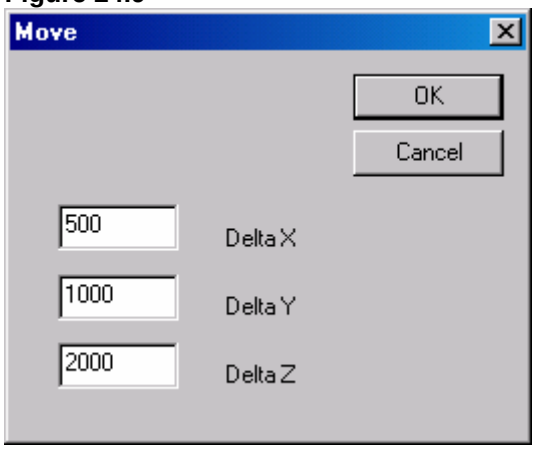
   - Click the following icon from the right toolbar:

Figure 24.8

Then the ***Move Dialog Box*** will appear on your screen.

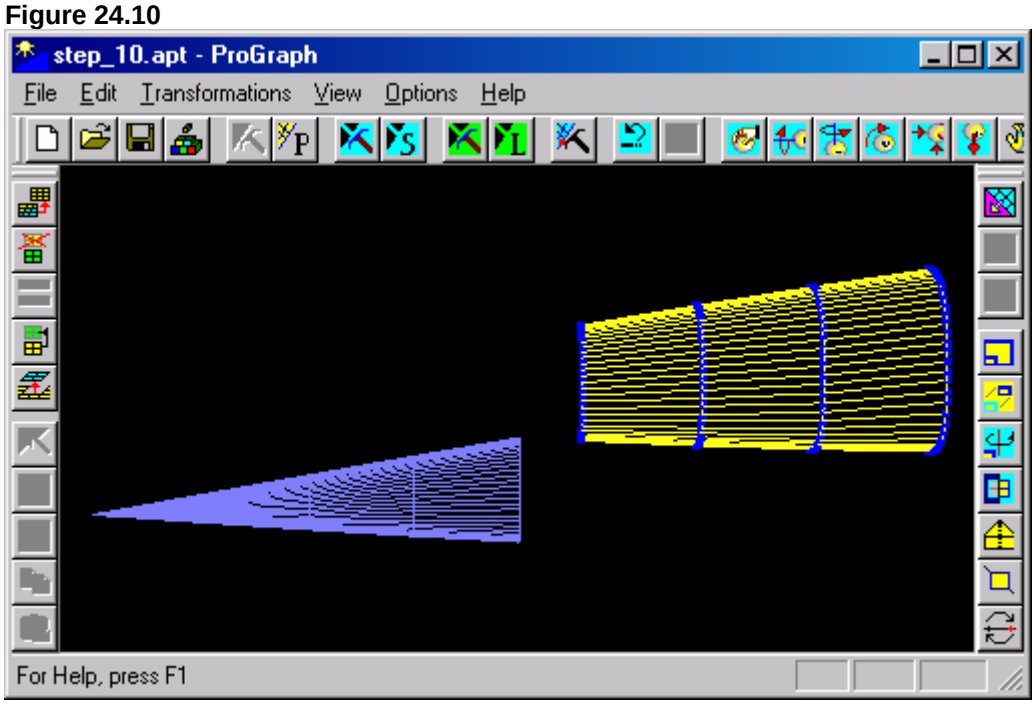
8. Choose all needed parameters in the ***Move Dialog Box*** as shown below.

Figure 24.9



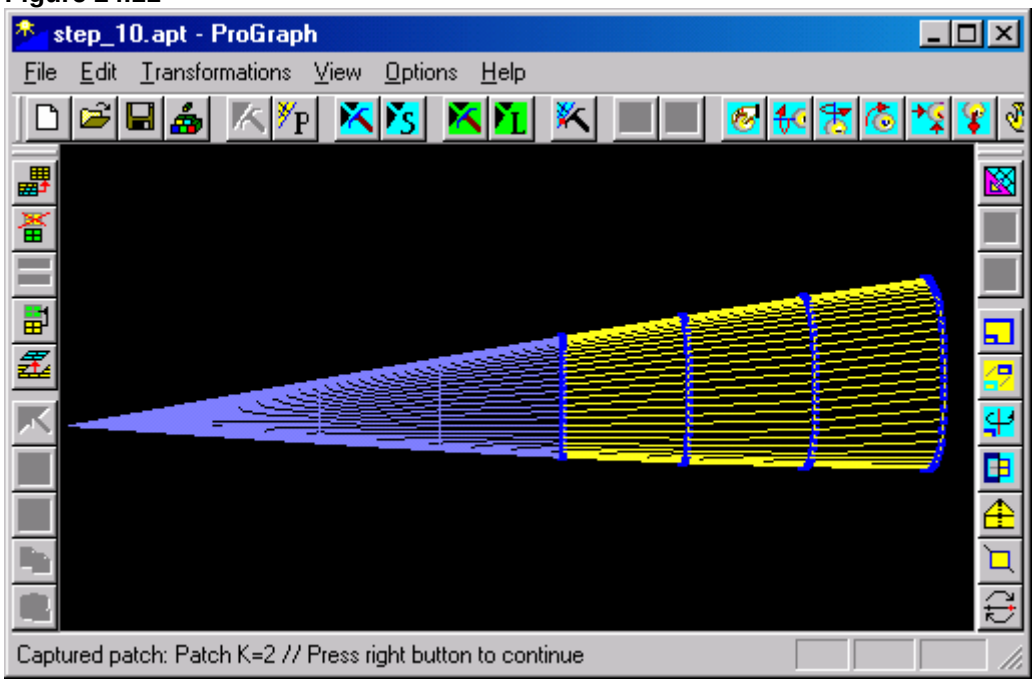
9. Click the **OK** control button. Then the block will be moved and a new Geometry will appear on your screen.

Figure 24.10



10. To undo all changes choose the **Patches ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

Figure 24.11



11. To rotate the block:

- Choose the **Rotation...** command from the **Transformations** menu.

or

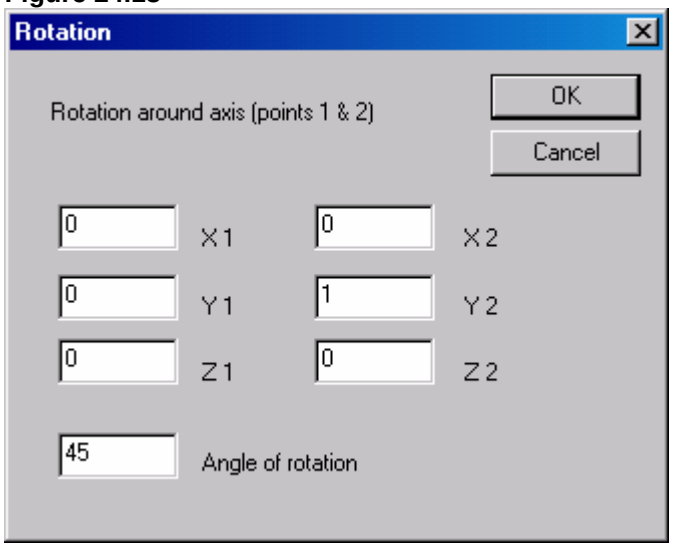
- Click the following icon from the right toolbar:

Figure 24.12

Then the ***Rotation Dialog Box*** will appear on your screen.

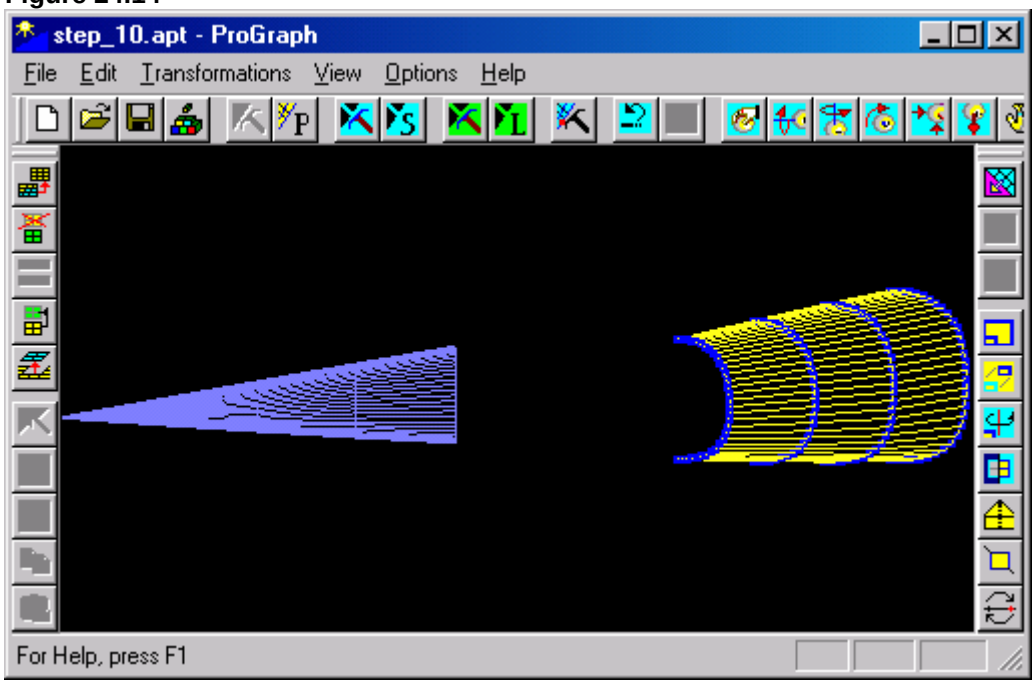
12. Choose all needed parameters in the ***Rotation Dialog Box*** as shown below.

Figure 24.13



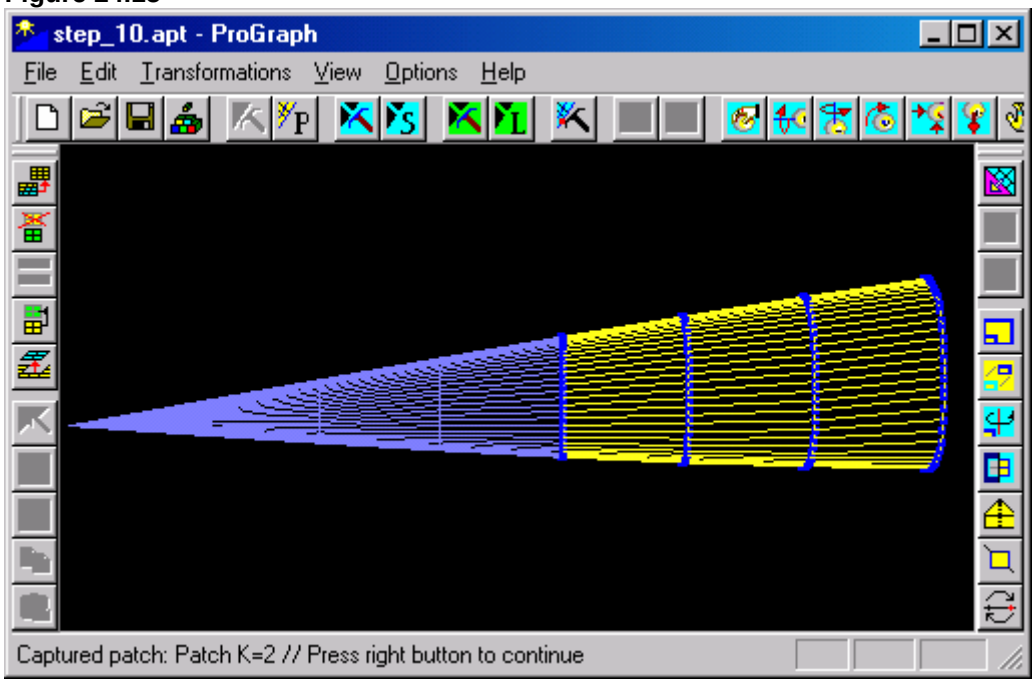
13. Click the **OK** control button. Then the block will be rotated and a new Geometry will appear on your screen.

Figure 24.14



14. To undo all changes choose the **Patches ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

Figure 24.15



15. To mirror the block:

- Choose the **Flip...** command from the **Transformations** menu.

or

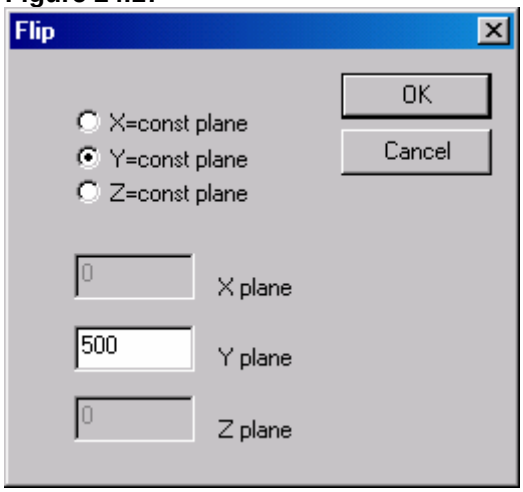
- Click the following icon from the right toolbar:

Figure 24.16

Then the ***Flip Dialog Box*** will appear on your screen.

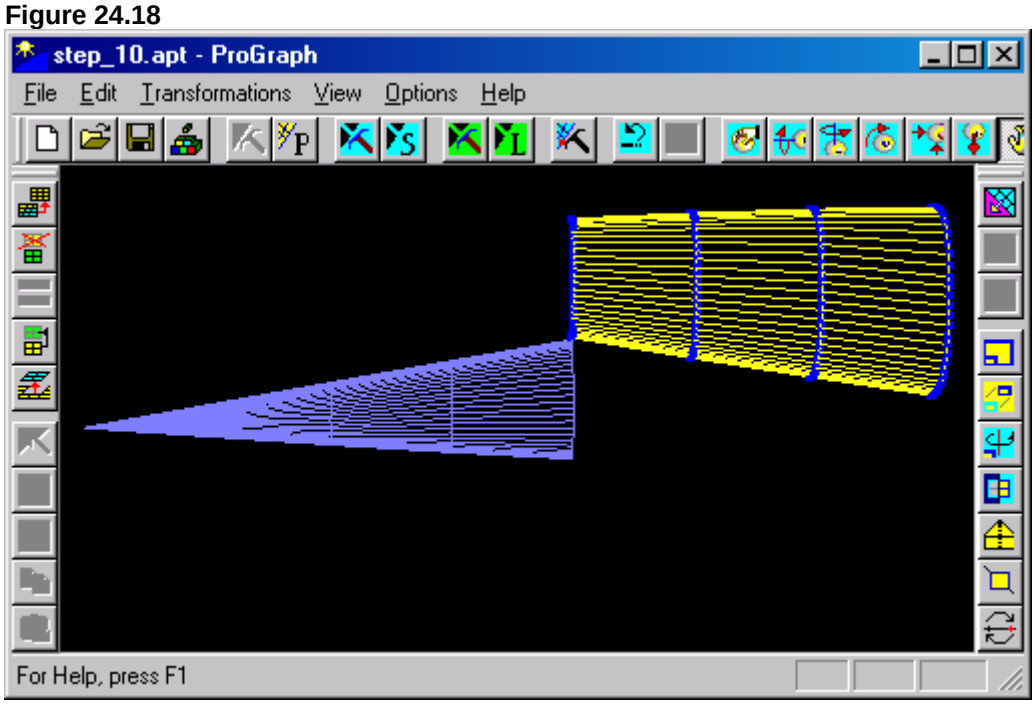
16. Choose all needed parameters in the ***Flip Dialog Box*** as shown below.

Figure 24.17



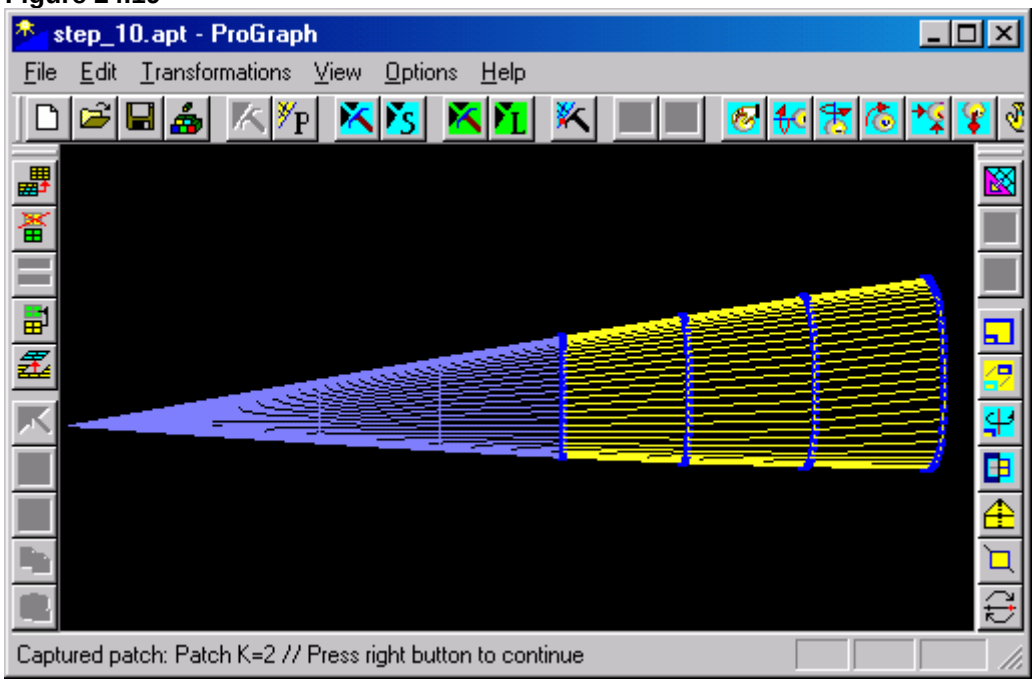
17. Click the **OK** control button. Then the block will be mirrored and a new Geometry will appear on your screen.

Figure 24.18



18. To undo all changes choose the **Patches ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

Figure 24.19



19. To add symmetrical block to the present one:

- Choose the **Symmetric...** command from the **Transformations** menu.

or

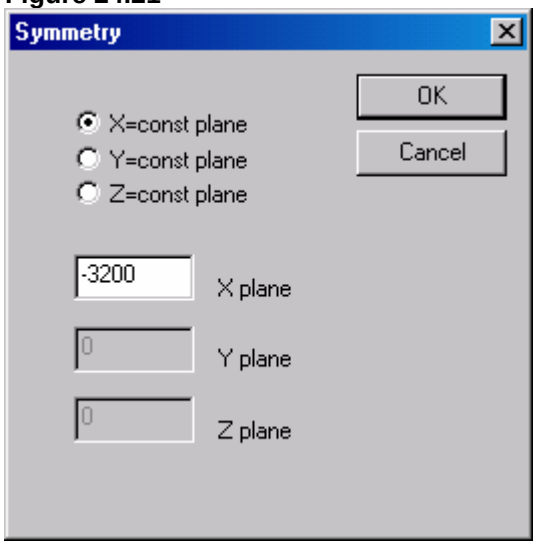
- Click the following icon from the right toolbar:

Figure 24.20

Then the ***Symmetry Dialog Box*** will appear on your screen.

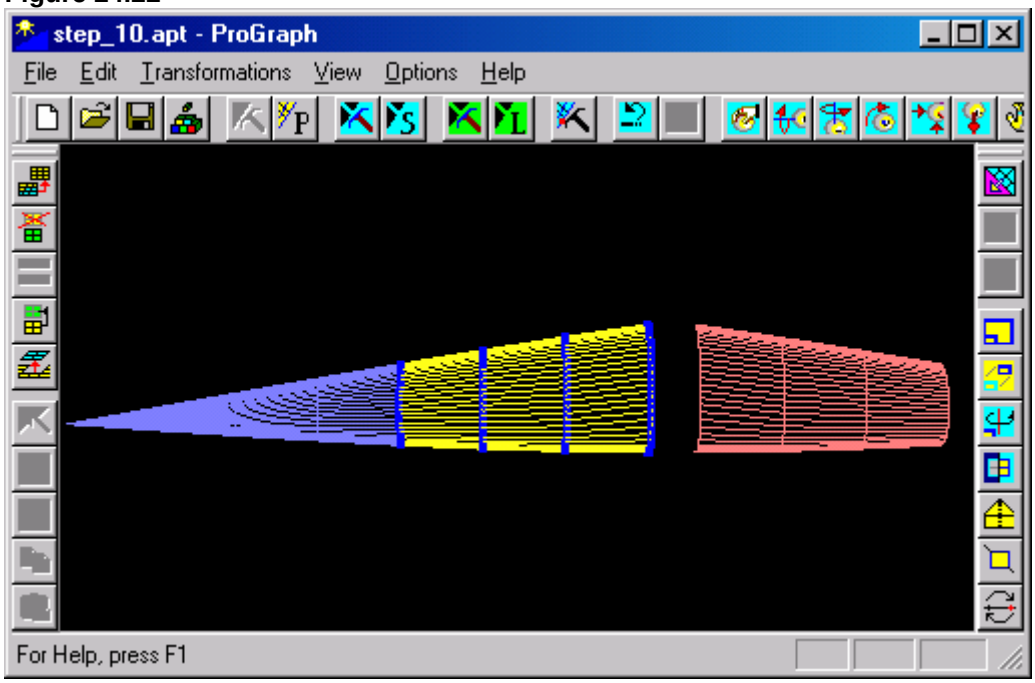
20. Choose all needed parameters in the ***Symmetry Dialog Box*** as shown below.

Figure 24.21



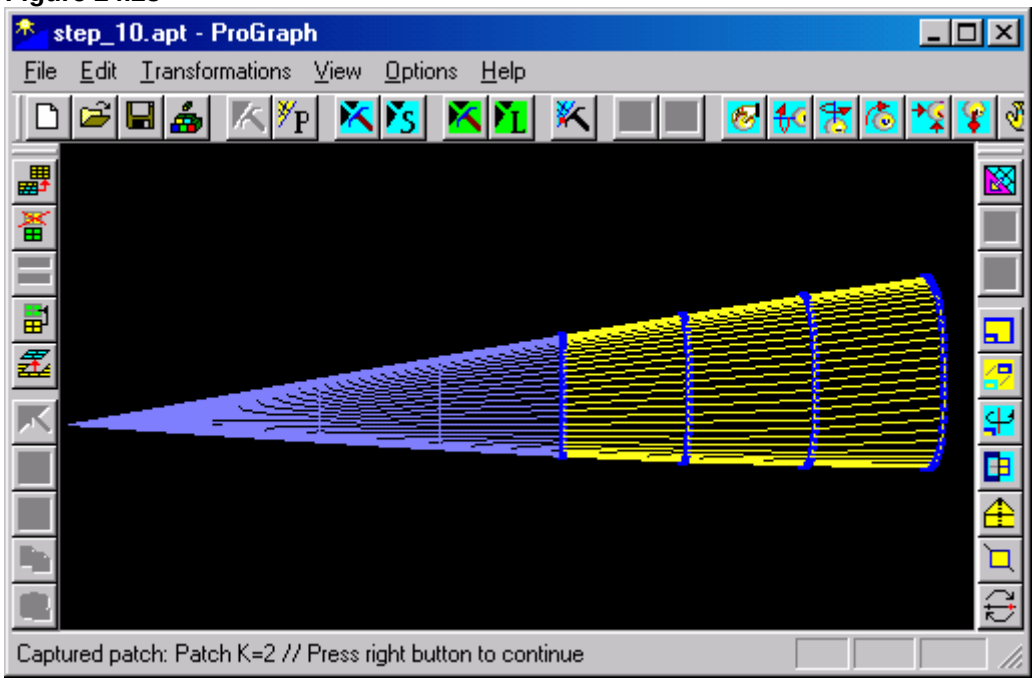
21. Click the **OK** control button. Then a new Geometry will appear on your screen.

Figure 24.22



22. To undo all changes choose the **Patches ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

Figure 24.23



23. To halve the number of points in every section of block:

- Choose the **Knife...** command from the **Transformations** menu.

or

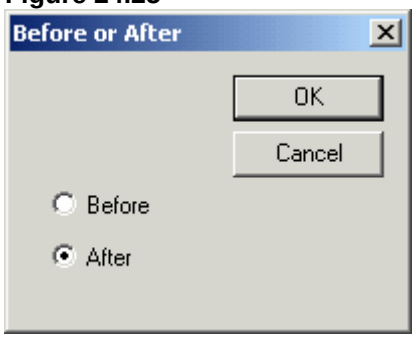
- Click the following icon from the right toolbar:

Figure 24.24

Then the ***Before or After Dialog Box*** will appear on your screen.

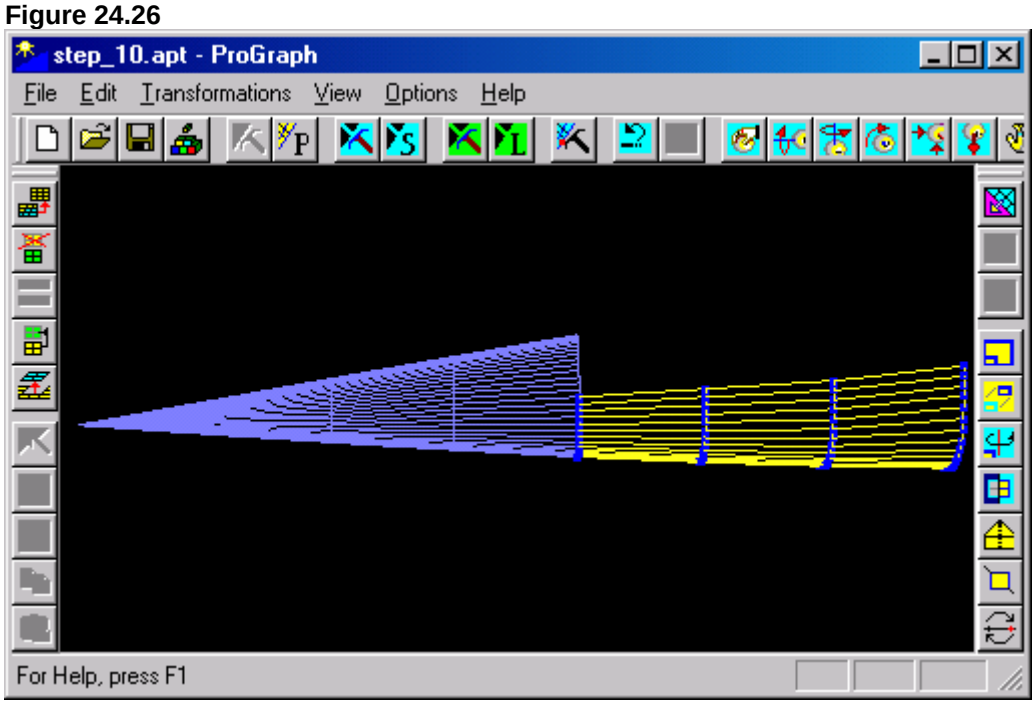
24. Choose all needed parameters in the ***Before or After Dialog Box*** as shown below.

Figure 24.25



25. Click the **OK** control button. Then a new Geometry will appear on your screen.

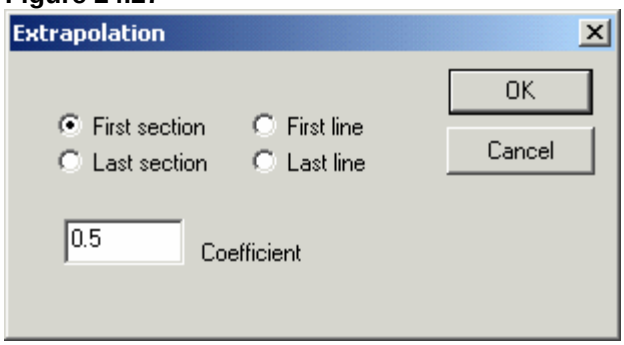
Figure 24.26



26. To enlarge the linear size of the block press right mouse button and choose the **Extrapolate...** command from the **Edit** menu. Then the ***Extrapolation Dialog Box*** will appear on your screen.

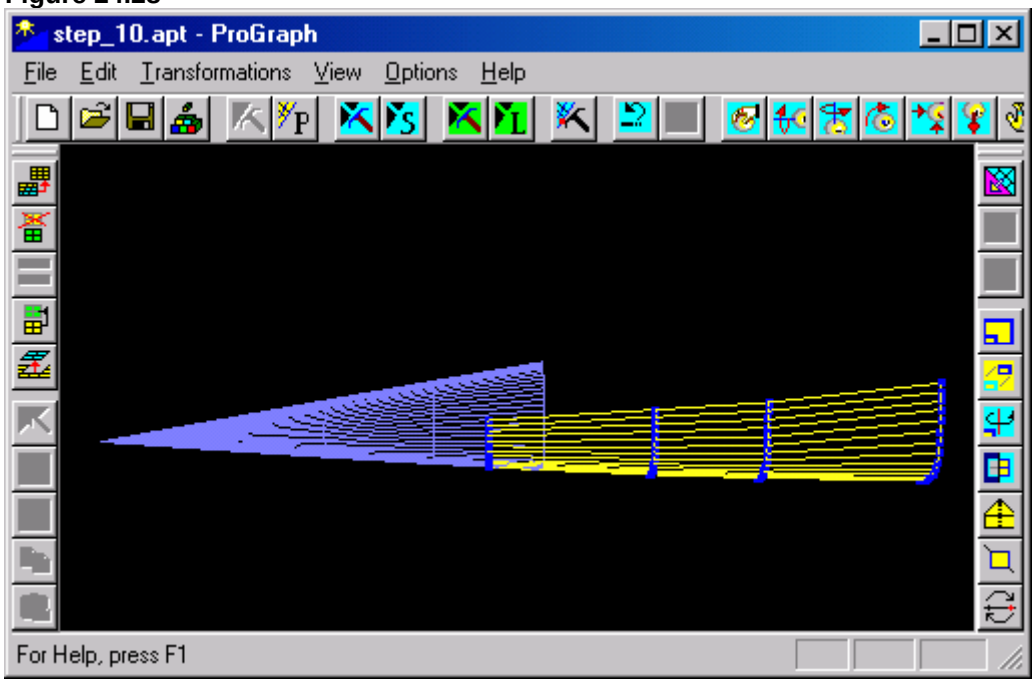
27. Choose all needed parameters in the ***Extrapolation Dialog Box*** as shown below.

Figure 24.27



28. Click the **OK** control button. Then a new Geometry will appear on your screen.

Figure 24.28

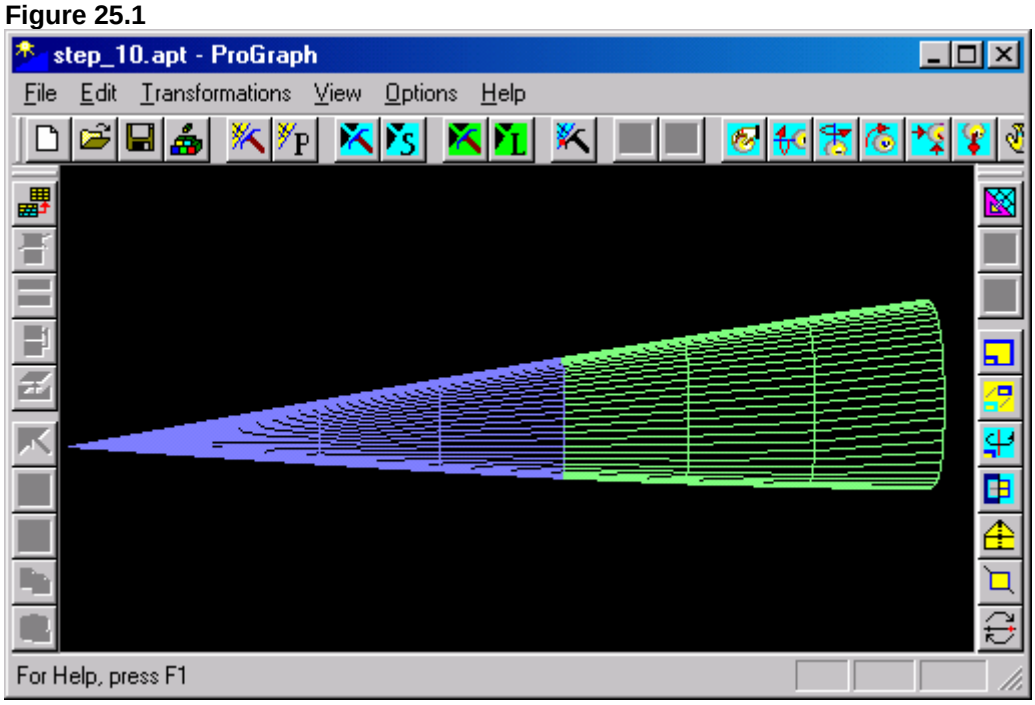


Chapter 4. Section transforming (using right mouse menu)

Step 25. A set of one-action transformations of section

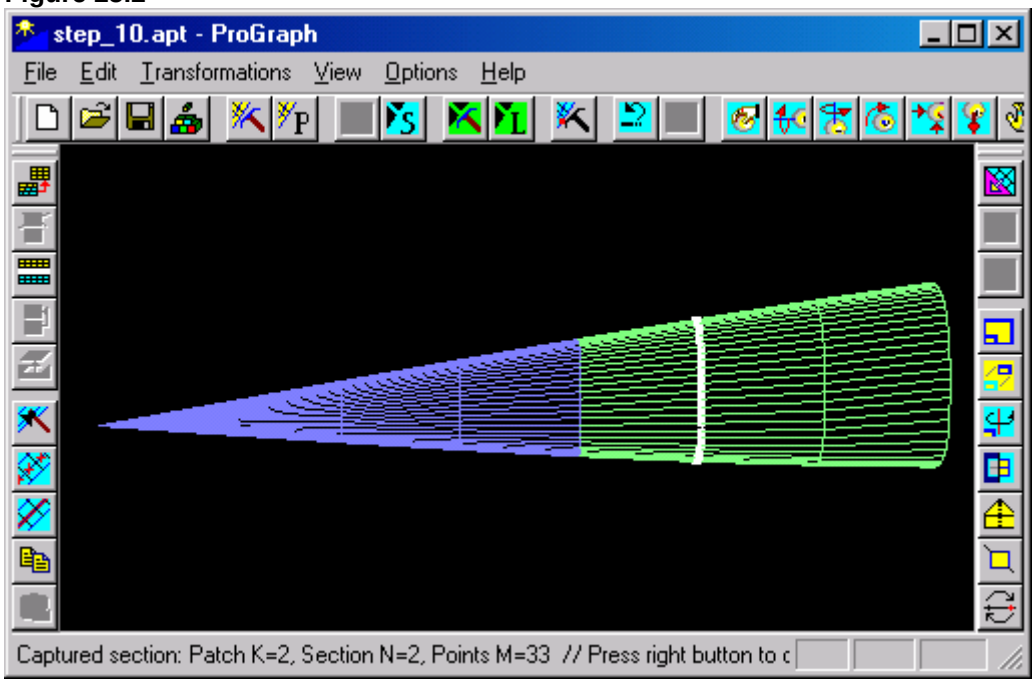
1. Open an existing file STEP_10.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

Figure 25.1



2. Capture a section. (For more information see steps 2-3 of **Step 11**.)

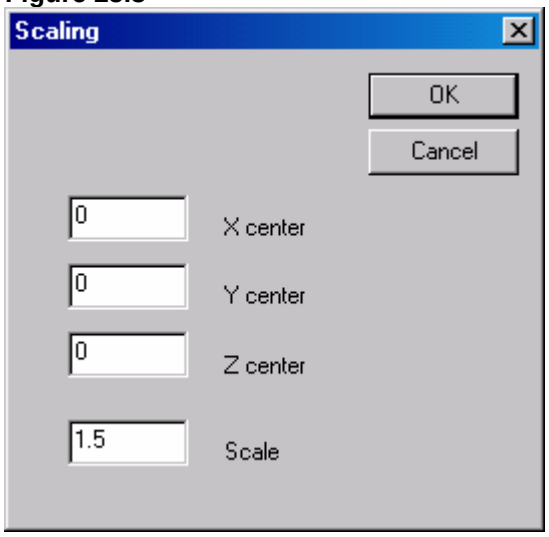
Figure 25.2



3. To scale the captured section press right mouse button and choose the **Scaling...** command from the context menu. Then the ***Scaling Dialog Box*** will appear on your screen.

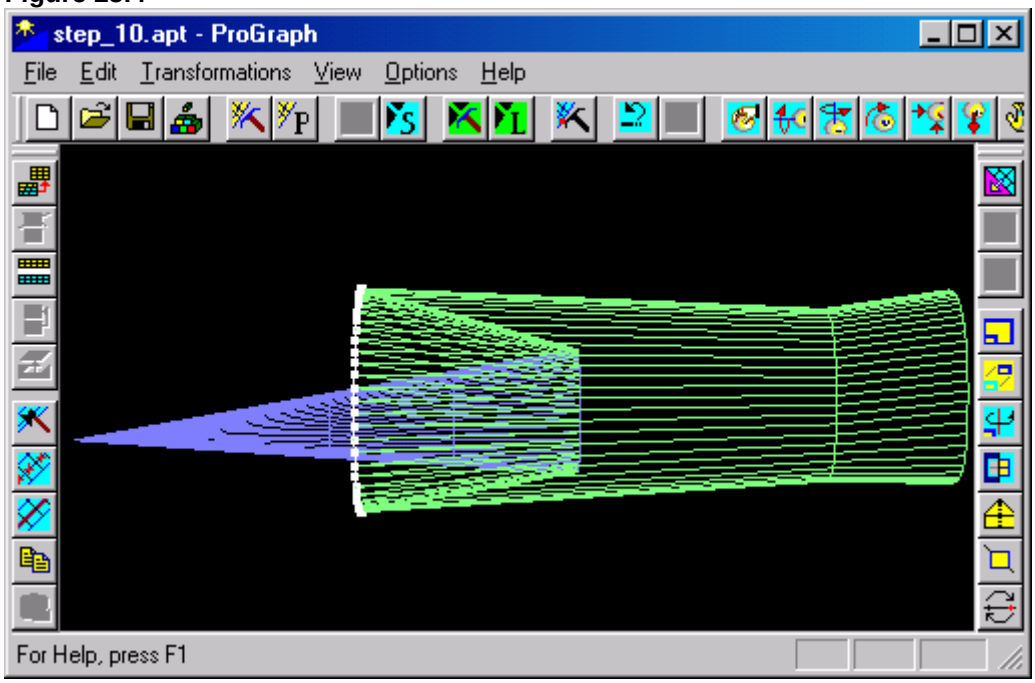
4. Choose all needed parameters in the ***Scaling Dialog Box*** as shown below.

Figure 25.3



5. Click the **OK** control button. Then the captured section will be scaled and a new Geometry will appear on your screen.

Figure 25.4



6. To undo all changes:

   - Choose the **Lines ~ Undo** command from the **Edit** menu.

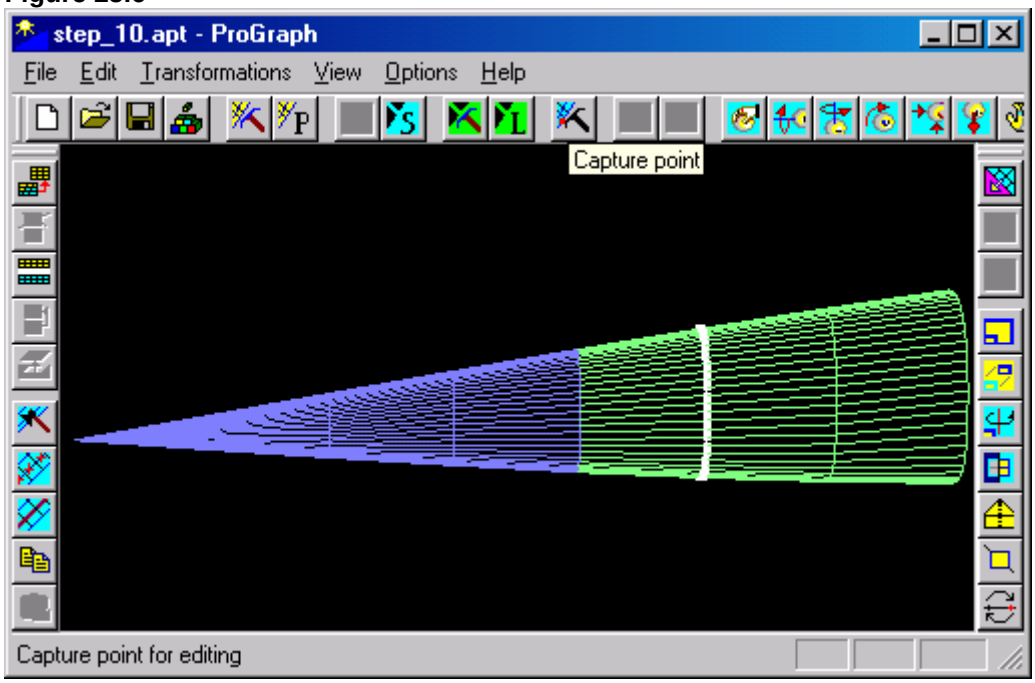
     or

   - Click the following icon from the upper toolbar:

Figure 25.5

Then old Geometry will appear on your screen again.

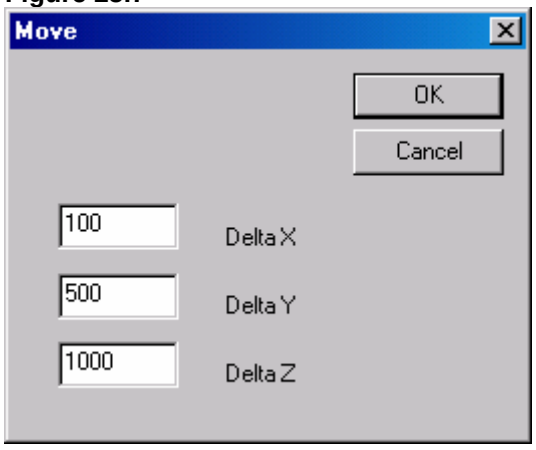
Figure 25.6



7. To move the captured section press right mouse button and choose the **Move...** command from the context menu. Then the ***Move Dialog Box*** will appear on your screen.

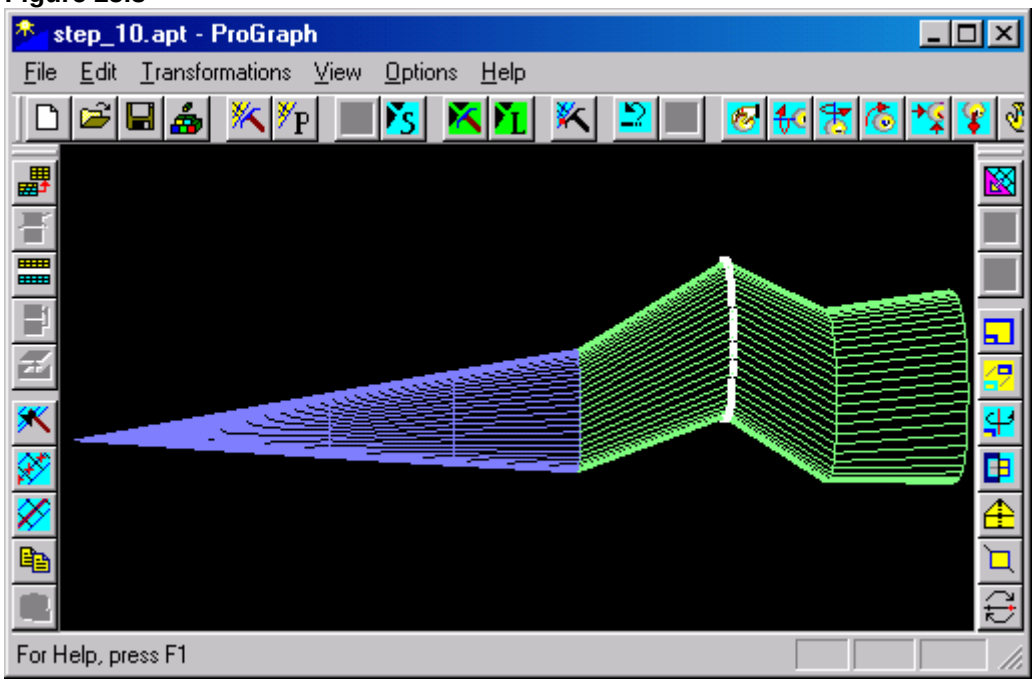
8. Choose all needed parameters in the ***Move Dialog Box*** as shown below.

Figure 25.7



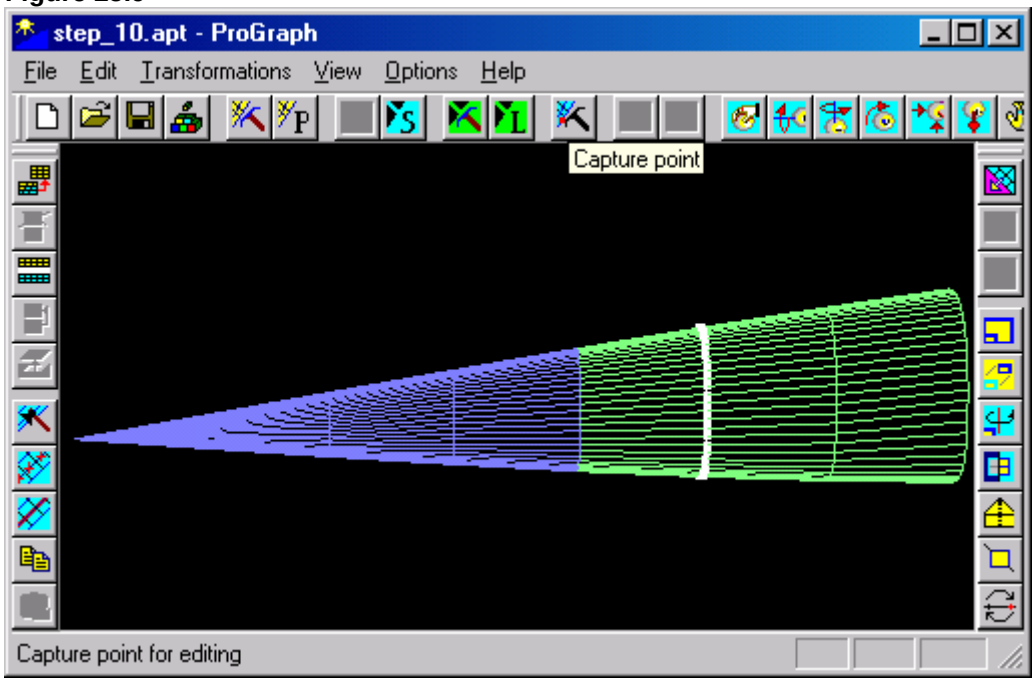
9. Click the **OK** control button. Then the captured section will be moved and a new Geometry will appear on your screen.

Figure 25.8



10. To undo all changes choose the **Lines ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

Figure 25.9

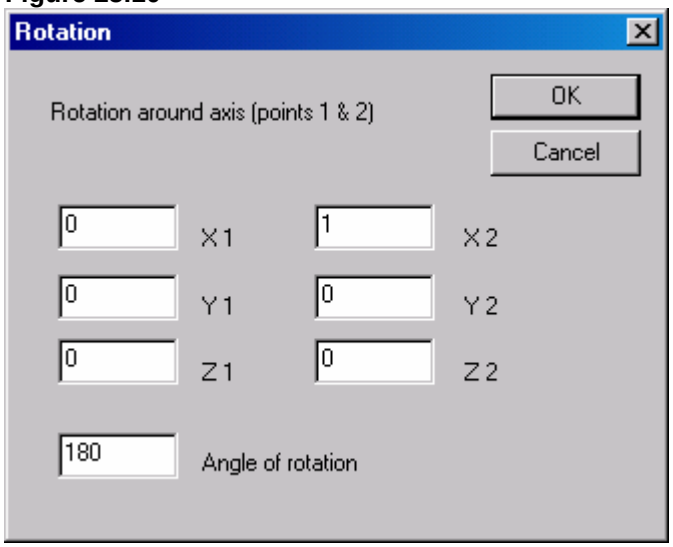


11. To rotate the captured section press right mouse button and choose the **Rotation...** command from the

context menu. Then the ***Rotation Dialog Box*** will appear on your screen.

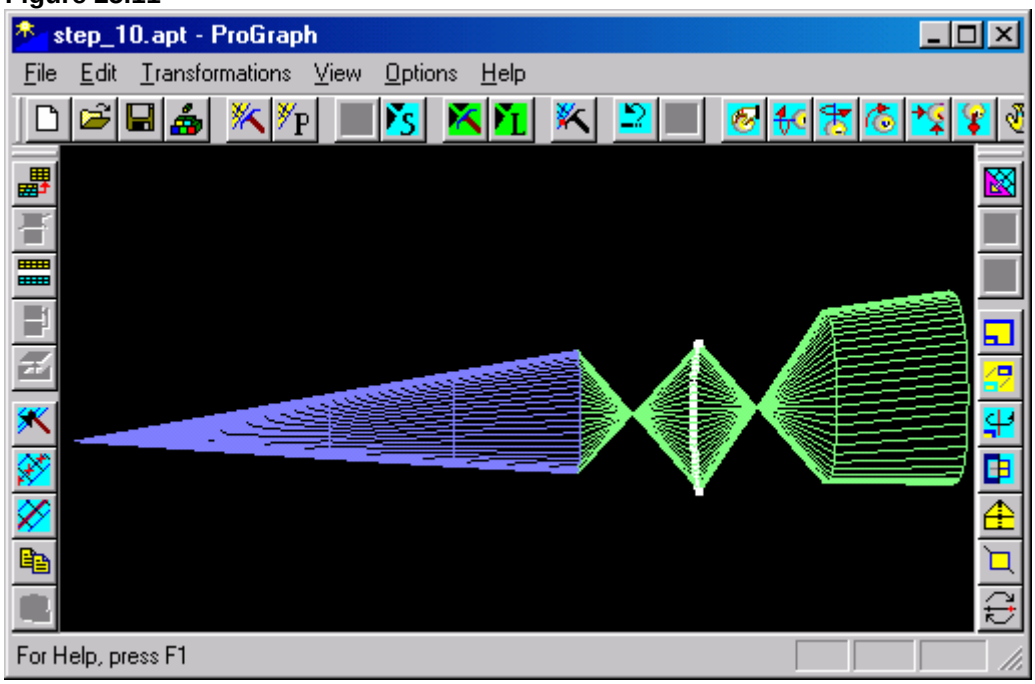
12. Choose all needed parameters in the ***Rotation Dialog Box*** as shown below.

Figure 25.10



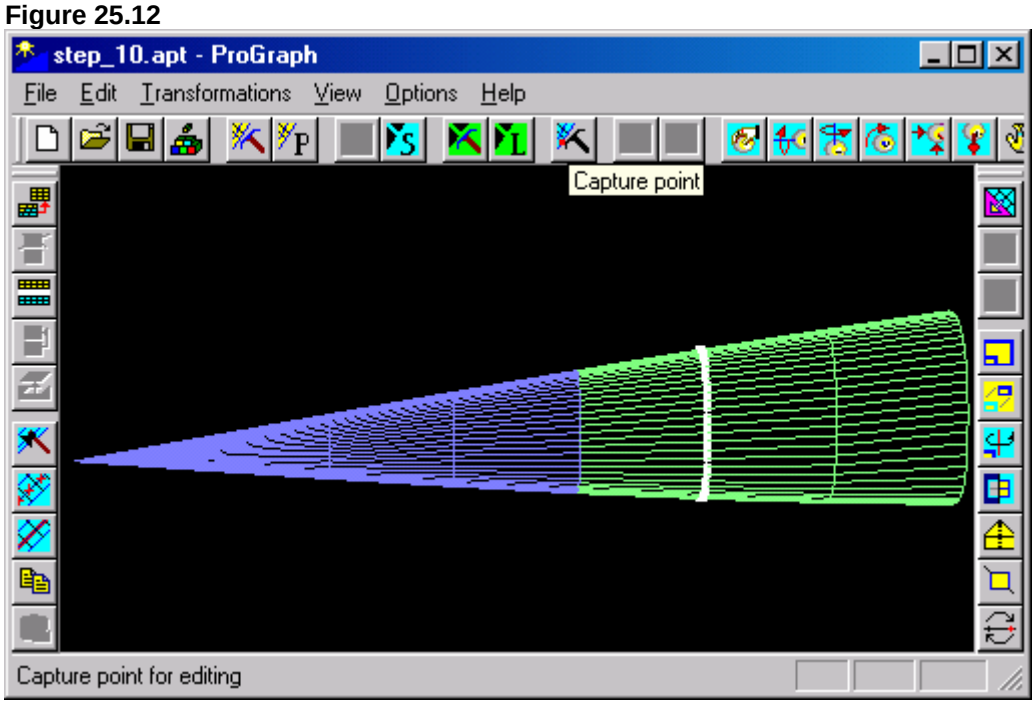
13. Click the **OK** control button. Then the captured section will be rotated and a new Geometry will appear on your screen.

Figure 25.11



14. To undo all changes choose the **Lines ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

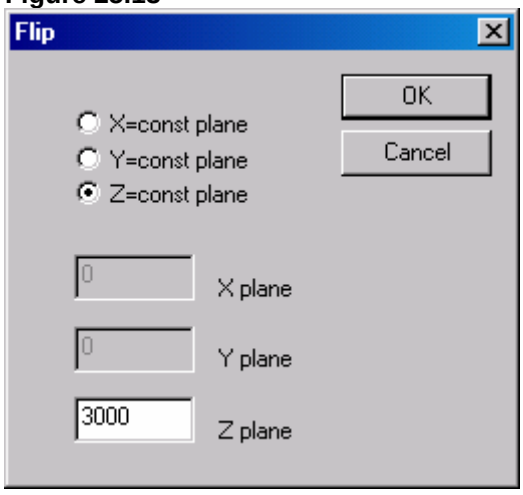
Figure 25.12



15. To mirror the captured section press right mouse button and choose the **Flip...** command from the context menu. Then the ***Flip Dialog Box*** will appear on your screen.

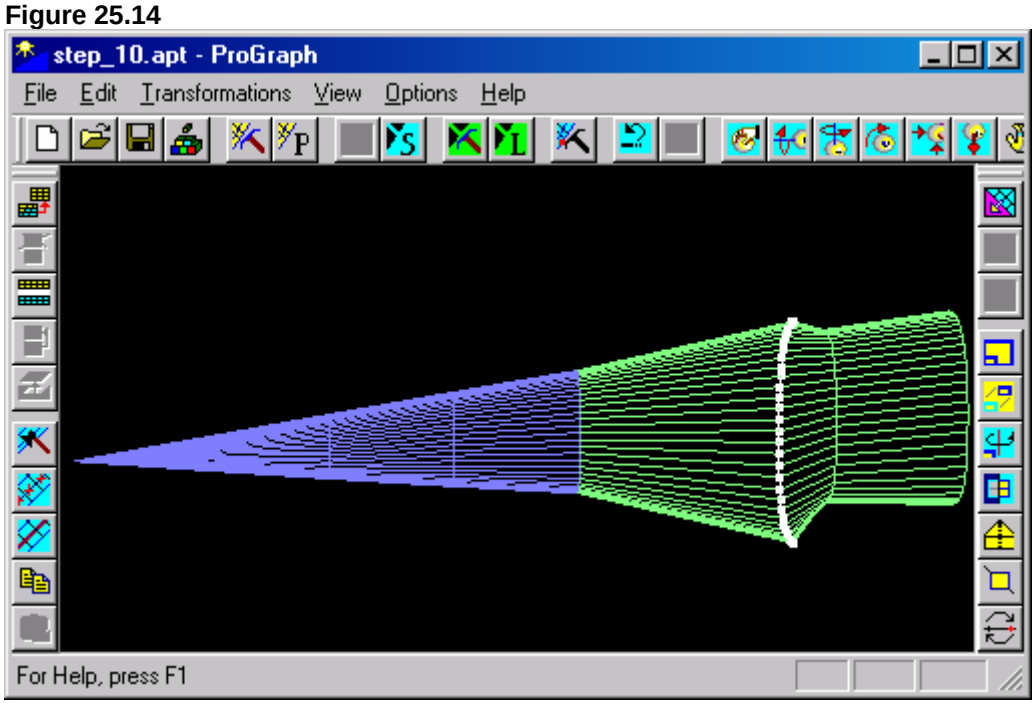
16. Choose all needed parameters in the ***Flip Dialog Box*** as shown below.

Figure 25.13



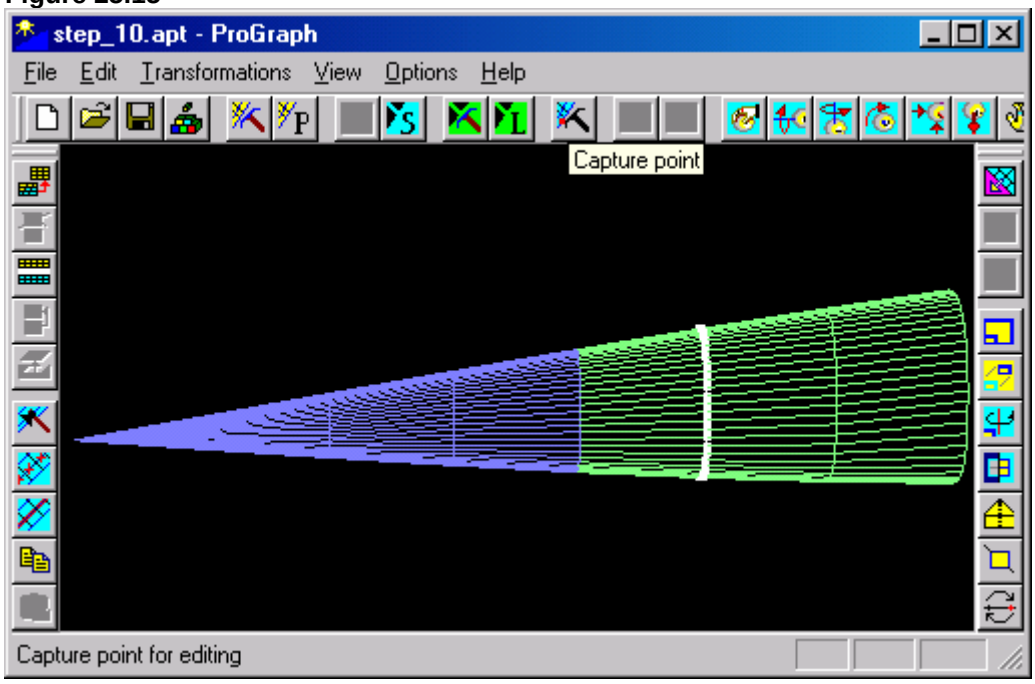
17. Click the **OK** control button. Then the captured section will be mirrored and a new Geometry will appear on your screen.

Figure 25.14



18. To undo all changes choose the **Lines ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

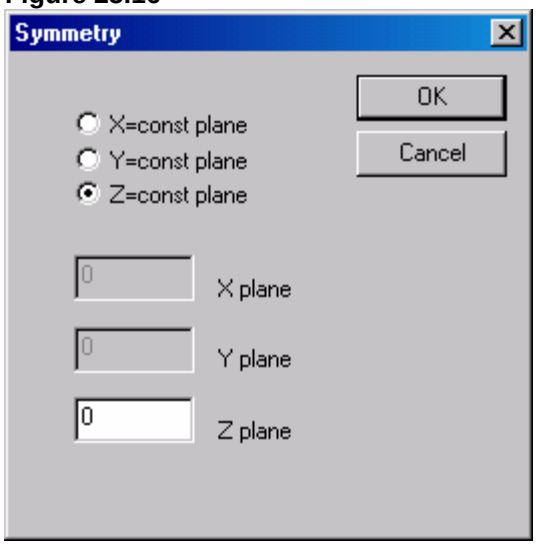
Figure 25.15



19. To add symmetrical section to the captured one press right mouse button and choose the **Symmetric...** command from the context menu. Then the ***Symmetry Dialog Box*** will appear on your screen.

20. Choose all needed parameters in the ***Symmetry Dialog Box*** as shown below.

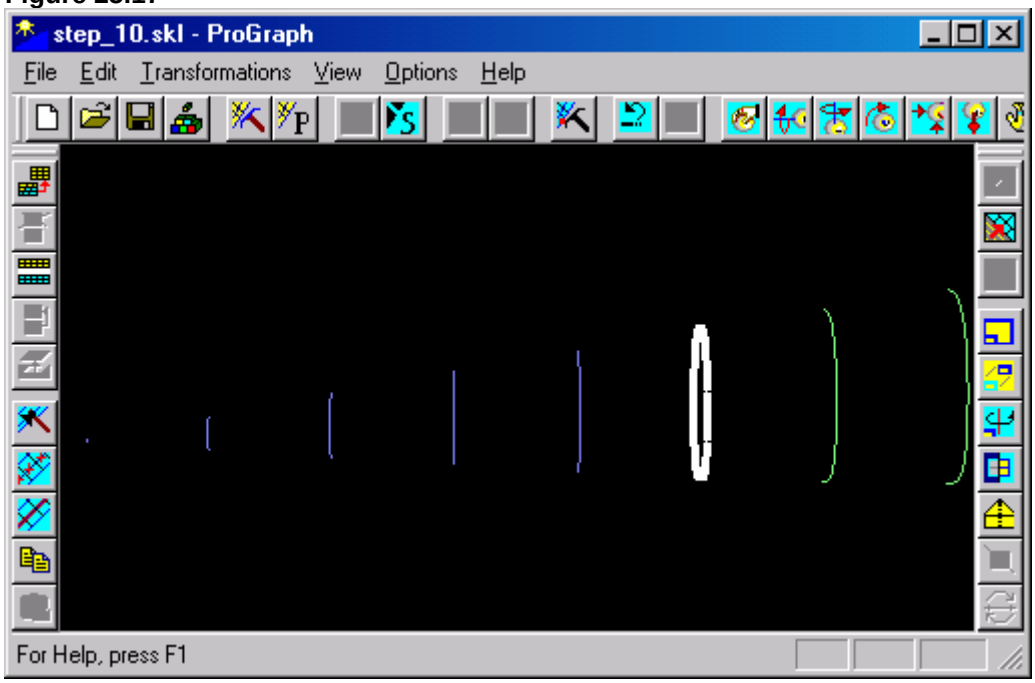
Figure 25.16



21. Click the **OK** control button. Then a new Geometry will appear on your screen.

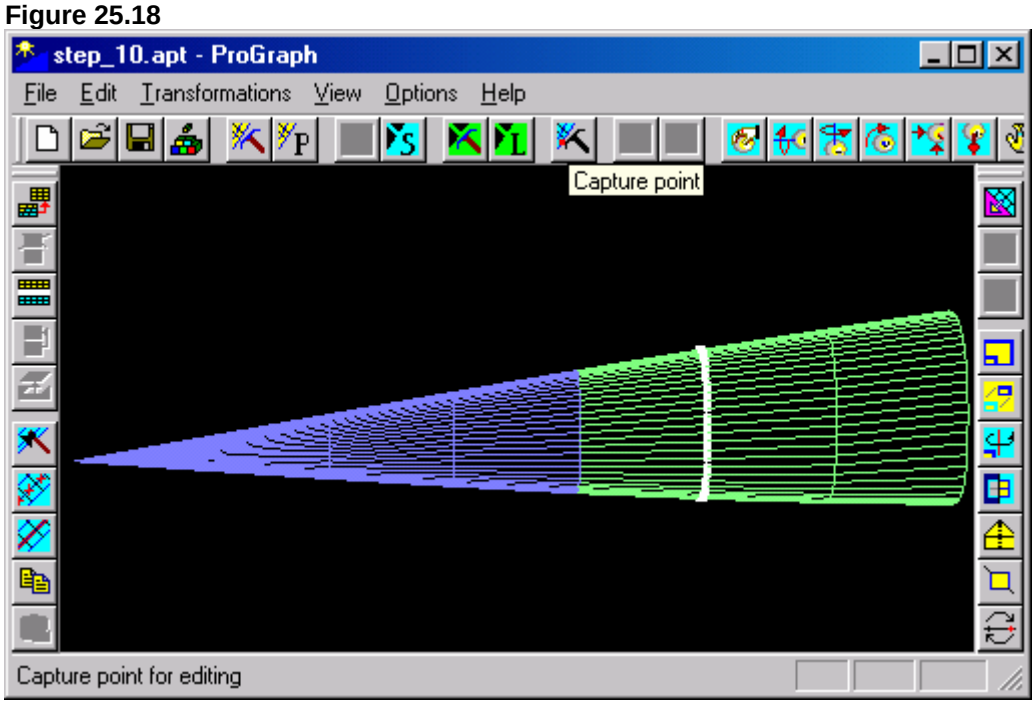
Note. APT format of opened file is violated.

Figure 25.17



22. To undo all changes choose the **Lines ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

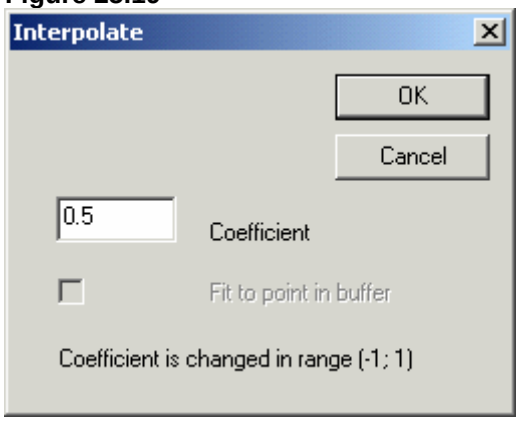
Figure 25.18



23. To move the captured section with the use of linear interpolation press right mouse button and choose the **Interpolate...** command from the context menu. Then the ***Interpolate Dialog Box*** will appear on your screen.

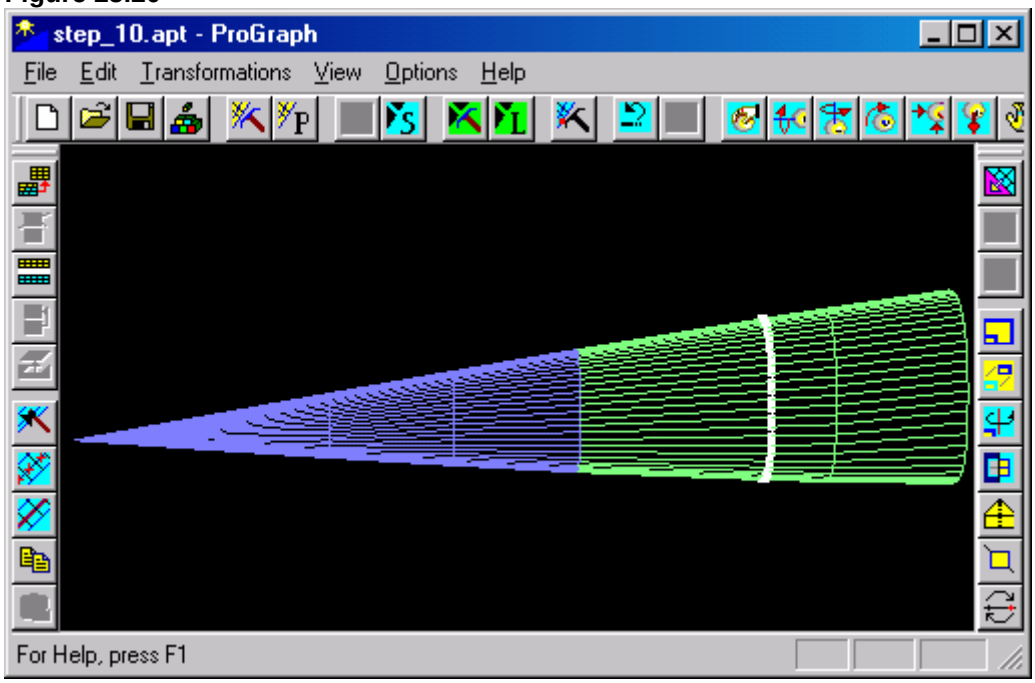
24. Choose all needed parameters in the ***Interpolate Dialog Box*** as shown below.

Figure 25.19



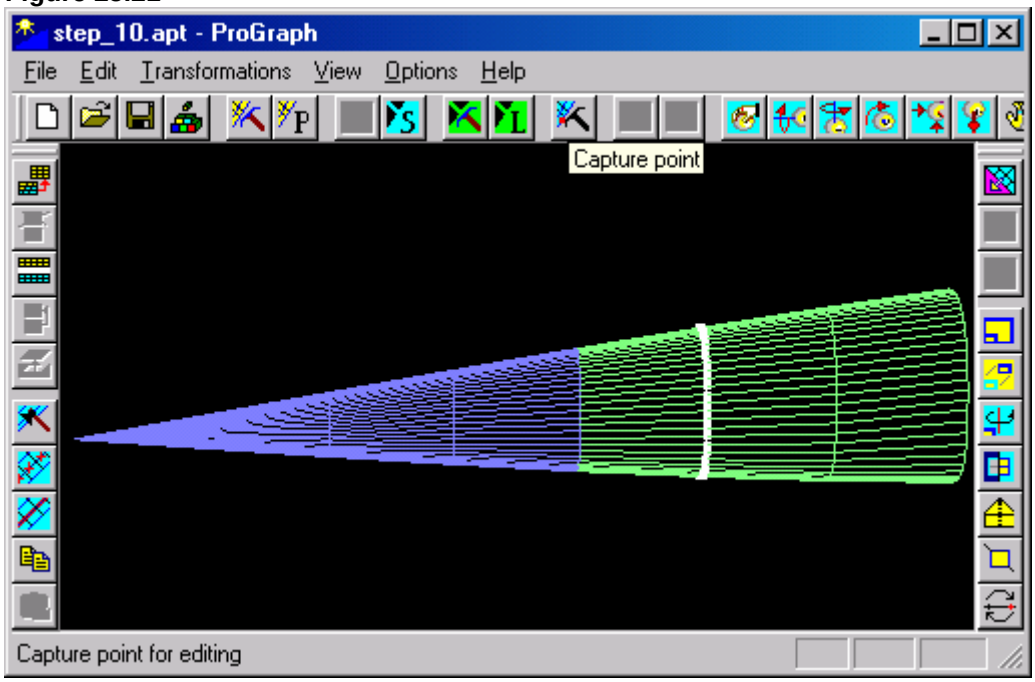
25. Click the **OK** control button. Then the captured section will be moved to the next one and a new Geometry will appear on your screen.

Figure 25.20



26. To undo all changes choose the **Lines ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

Figure 25.21

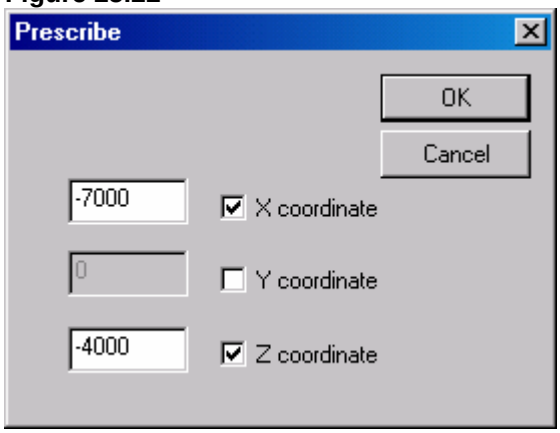


27. To prescribe a definite value for coordinate (X, Y or Z) of all the points included in the captured section press right mouse button and choose the

Prescribe... command from the context menu. Then the ***Prescribe Dialog Box*** will appear on your screen.

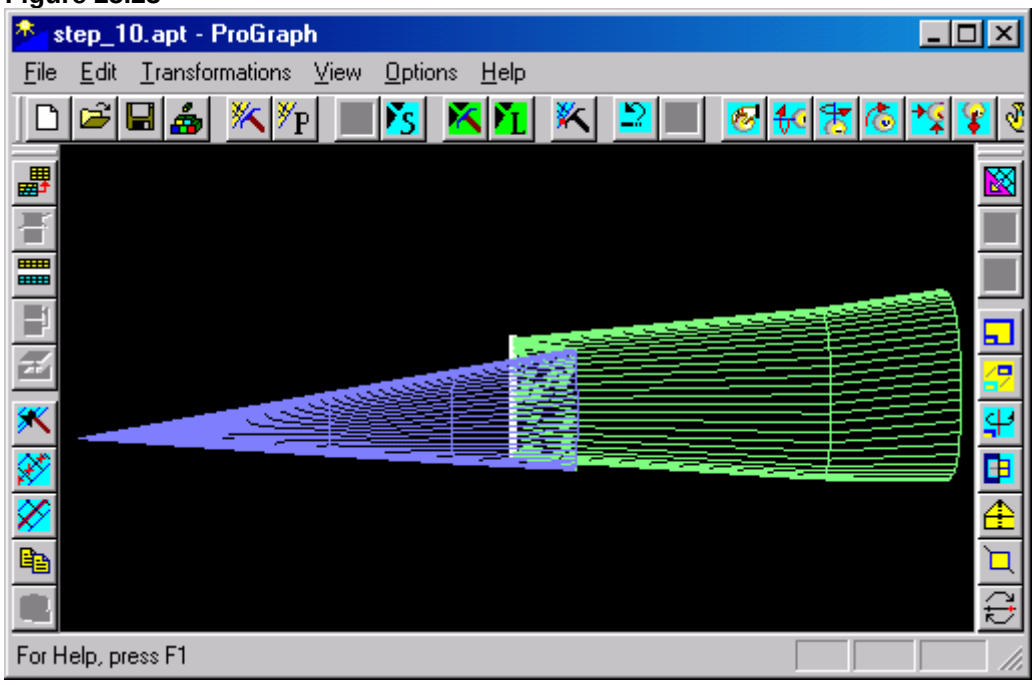
28. Choose all needed parameters in the ***Prescribe Dialog Box*** as shown below.

Figure 25.22



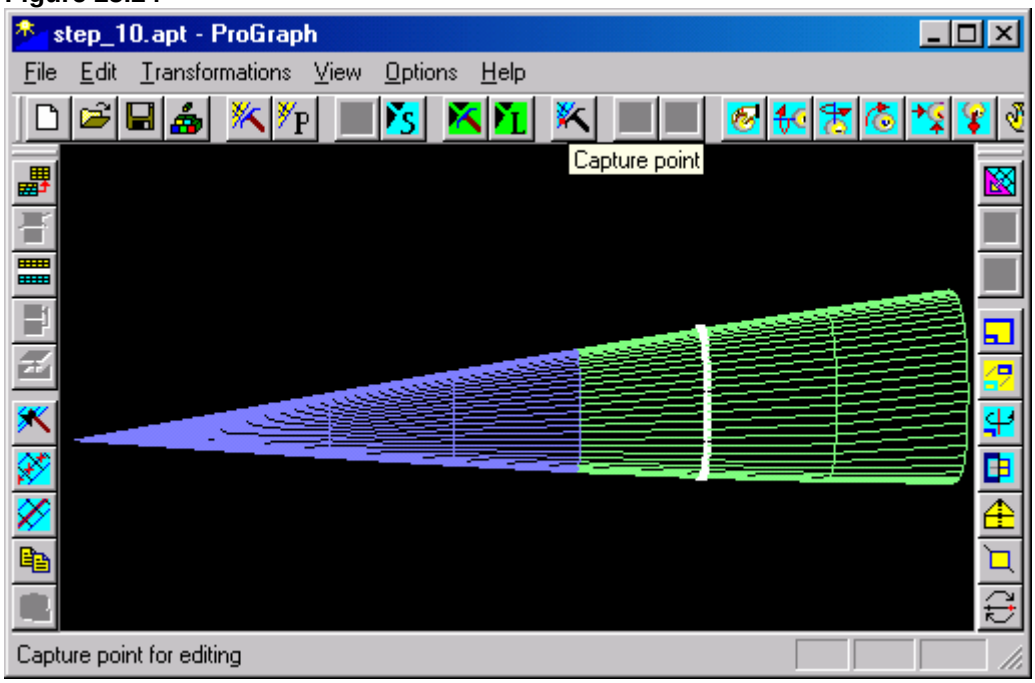
29. Click the **OK** control button. Then the captured section will be moved to the next one and a new Geometry will appear on your screen.

Figure 25.23



30. To undo all changes choose the **Lines ~ Undo** command from the **Edit** menu. Then old Geometry will appear on your screen again.

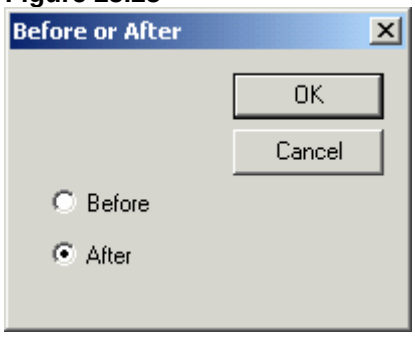
Figure 25.24



31. To halve the number of points in the captured section press right mouse button and choose the **Knife...** command from the context menu. Then the ***Before or After Dialog Box*** will appear on your screen.

32. Choose all needed parameters in the ***Before or After Dialog Box*** as shown below.

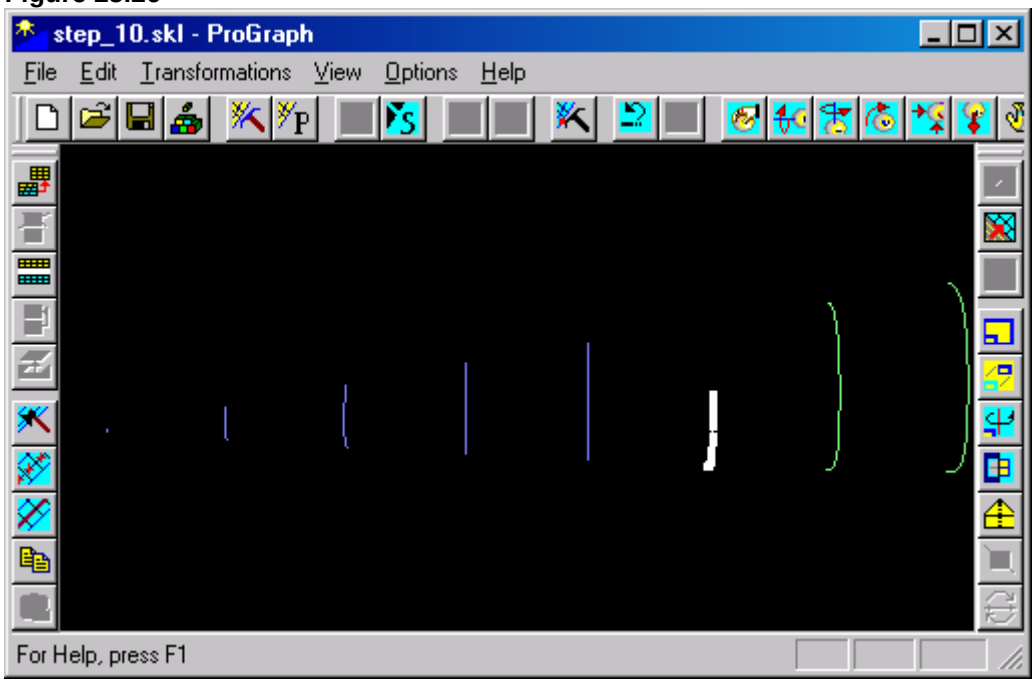
Figure 25.25



33. Click the **OK** control button. Then a new Geometry will appear on your screen.

Note. APT format of opened file is violated.

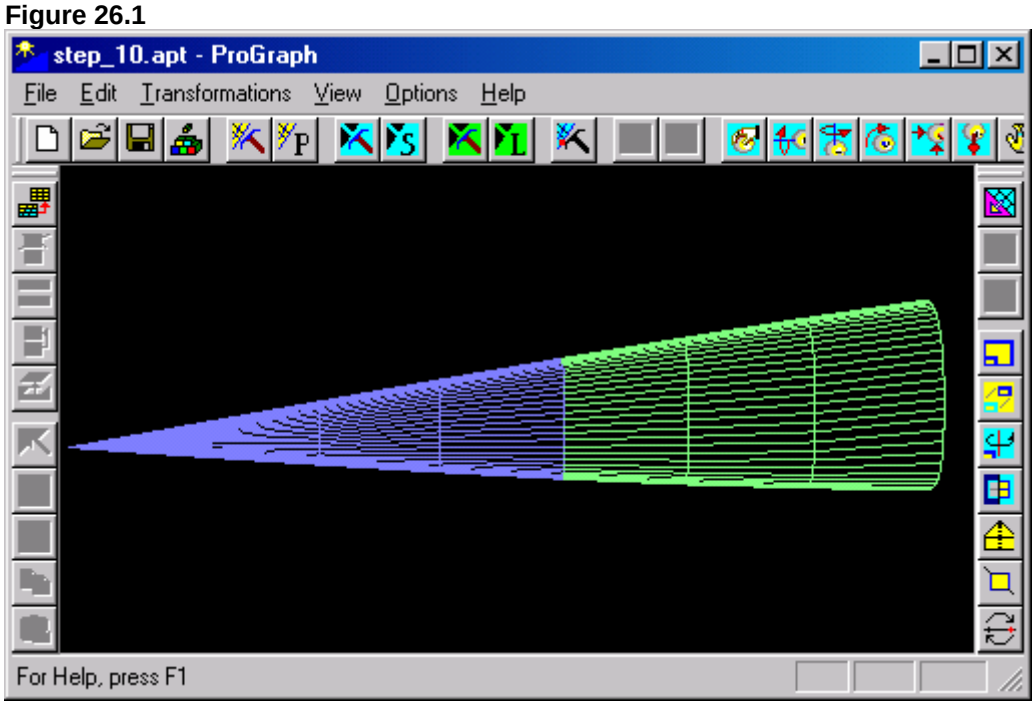
Figure 25.26


step_10.skl - ProGraph
File Edit Transformations View Options Help
For Help, press F1

Step 26. A set of one-action transformations of section part

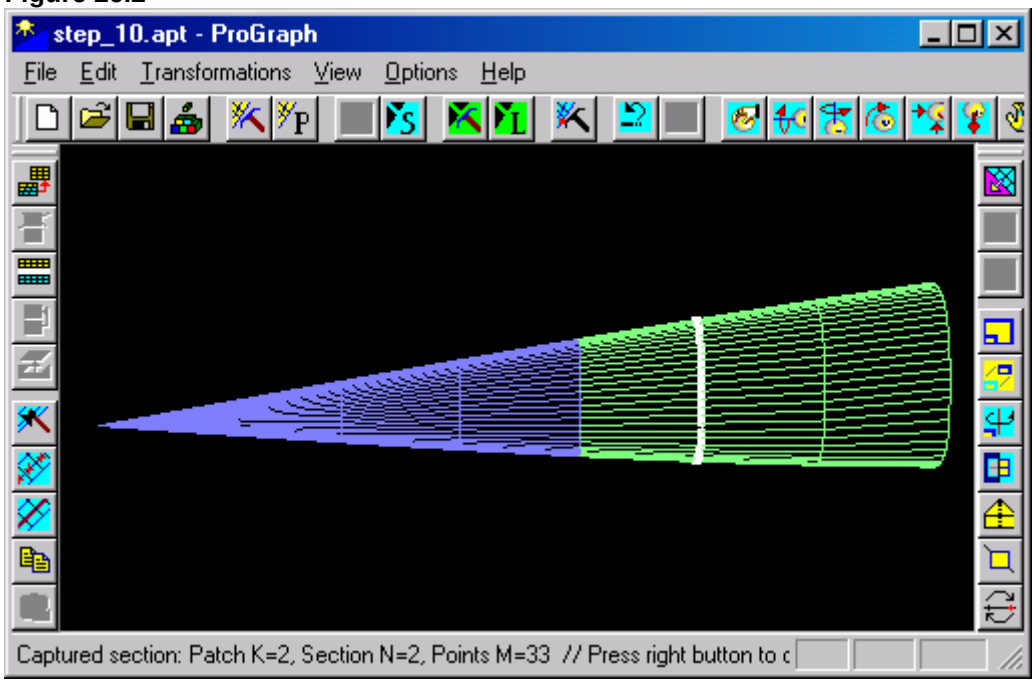
1. Open an existing file STEP_10.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

Figure 26.1



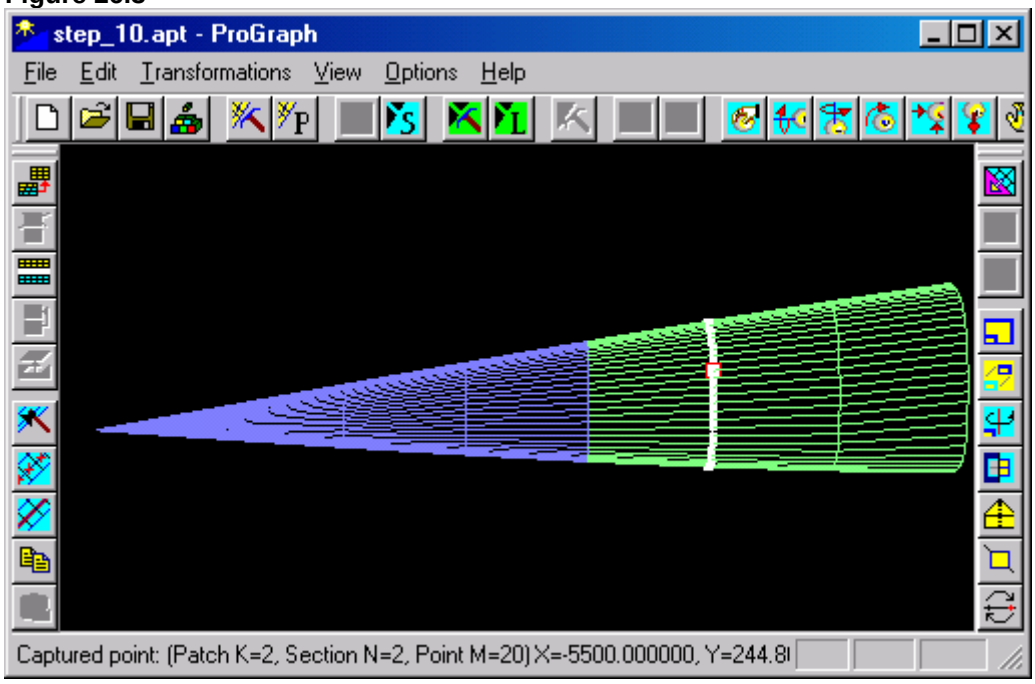
2. Capture a section. (For more information see steps 2-3 of **Step 11**.)

Figure 26.2



3. Capture a point of captured patch. (For more information see steps 2-3 of **Step 18.**)

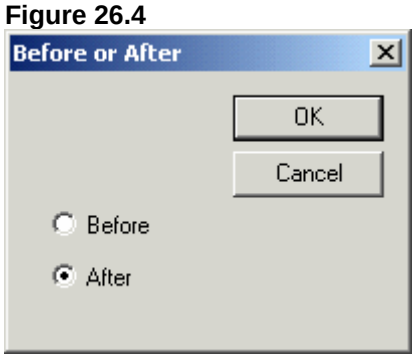
Figure 26.3



4. To diminish the number of points in the captured section press right mouse button and choose the **Knife part...** command from the context menu. Then the ***Before or After Dialog Box*** will appear on your screen.

5. Choose all needed parameters in the ***Before or After Dialog Box*** as shown below.

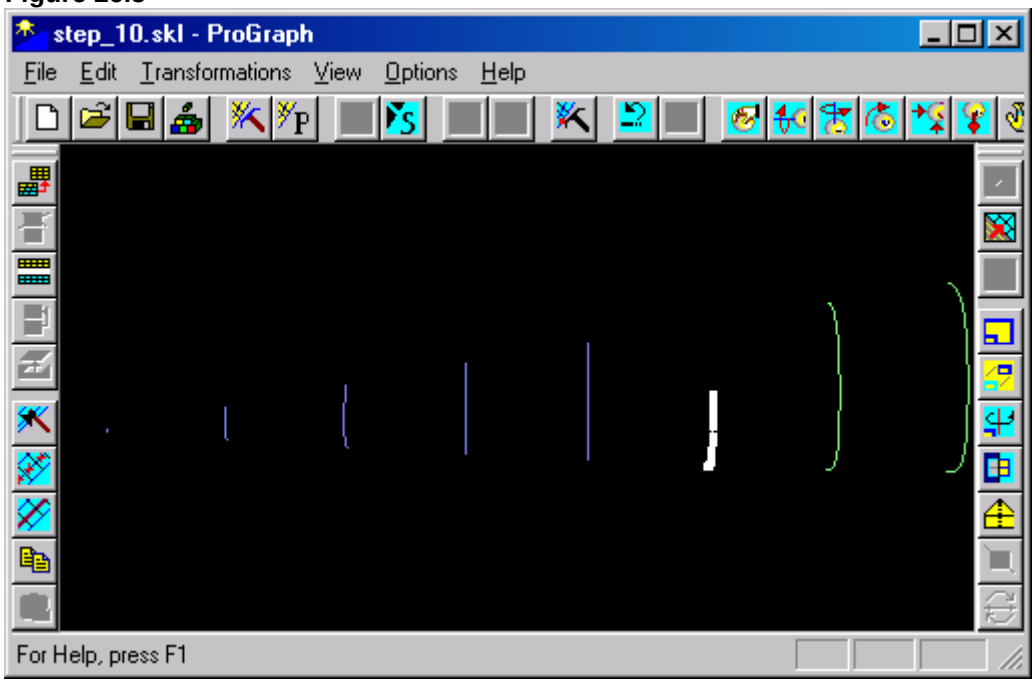
Figure 26.4



6. Click the **OK** control button. Then a new Geometry will appear on your screen.

Note. APT format of opened file is violated.

Figure 26.5



7. To undo all changes:

- Choose the **Patches ~ Undo** command from the **Edit** menu.

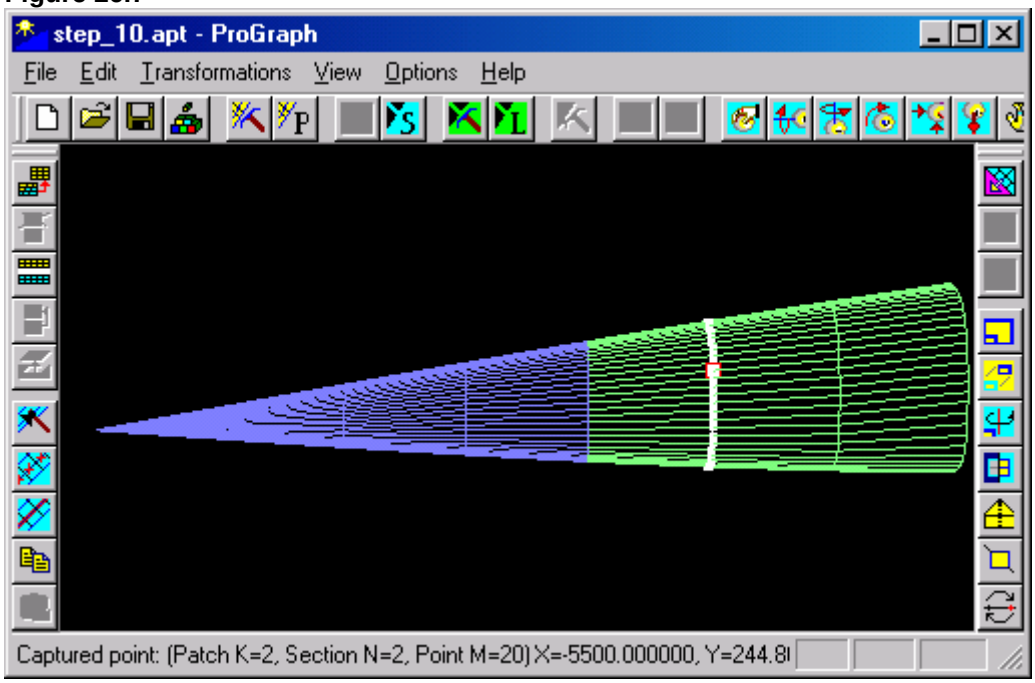
or

- Click the following icon from the upper toolbar:

Figure 26.6

Then old Geometry will appear on your screen again.

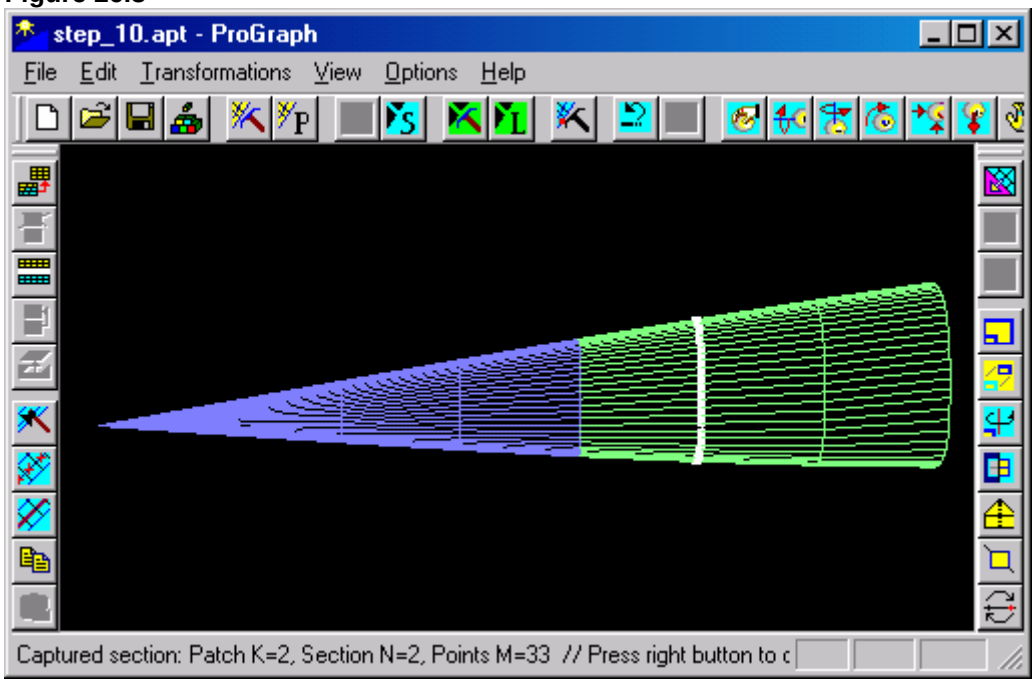
Figure 26.7



8. To copy a part of captured section to Clipboard press right mouse button and choose the **Copy part** command from the context menu. Then the section part from the first point up to the captured point will be copied to Clipboard. It may be placed at any position.

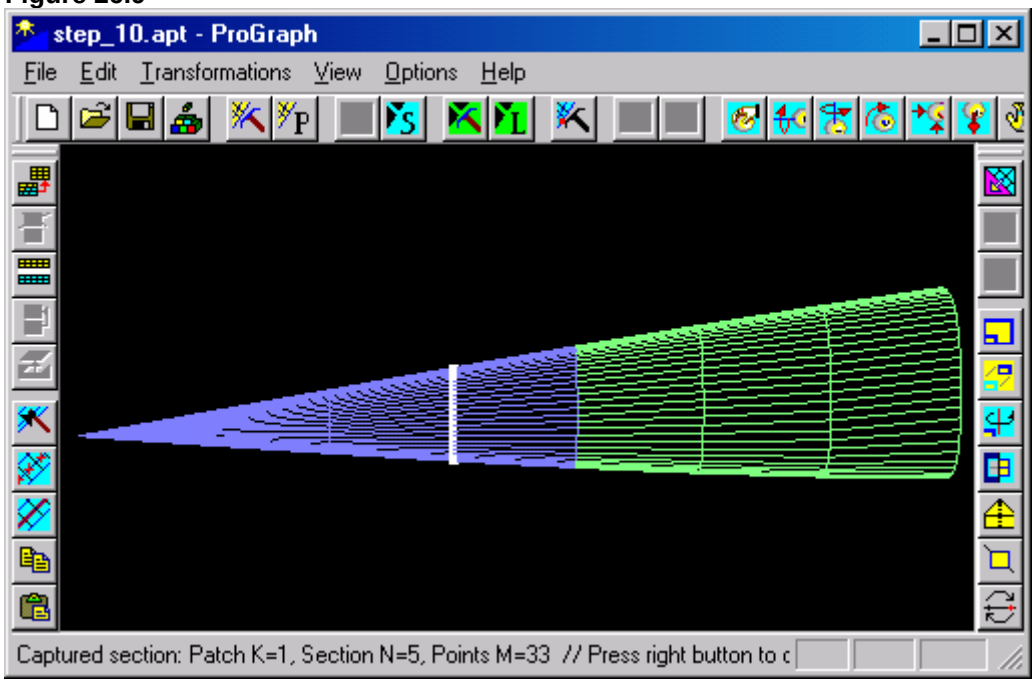
9. To return to regime of section editing press right mouse button and choose the **Exit** command from context menu.

Figure 26.8



10. To capture another section press right mouse button, choose the **Next Section (Line)** command from the context menu and capture necessary section. (For more information see steps 2-3 of **Step 11.**)

Figure 26.9

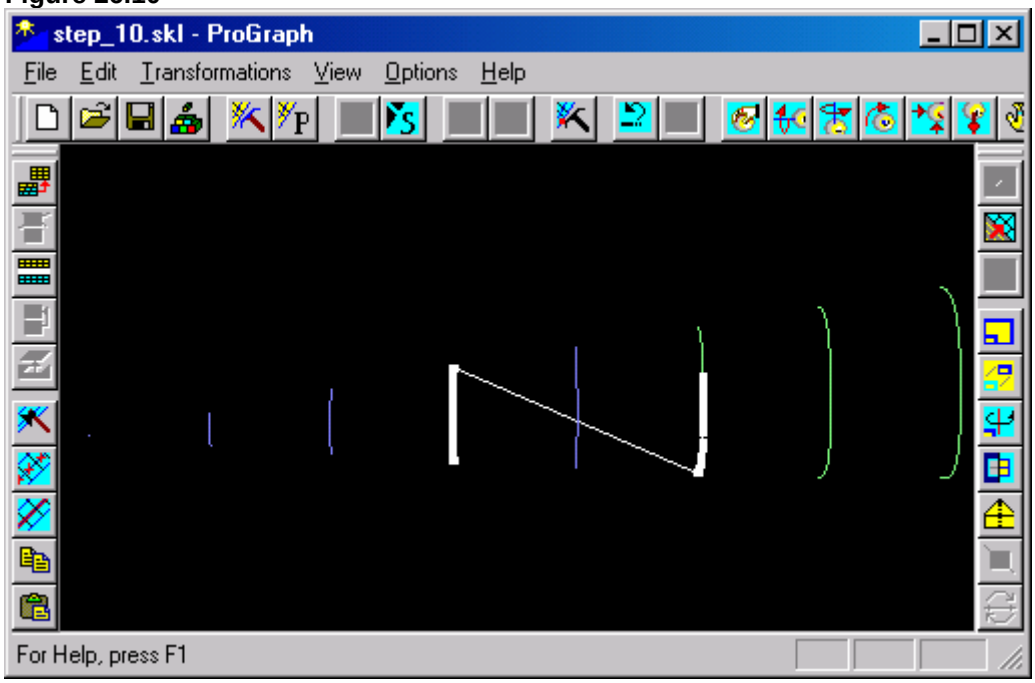


11. To place a copy of the Clipboard contents to the end of the captured section press right mouse button and

choose the **Merge** command from the context menu. Then a new Geometry will appear on your screen.

Note. APT format of opened file is violated.

Figure 26.10



Chapter 5. Special steps intended for experiment processing

Step 27. How to convert WRL (STL) files into APT format

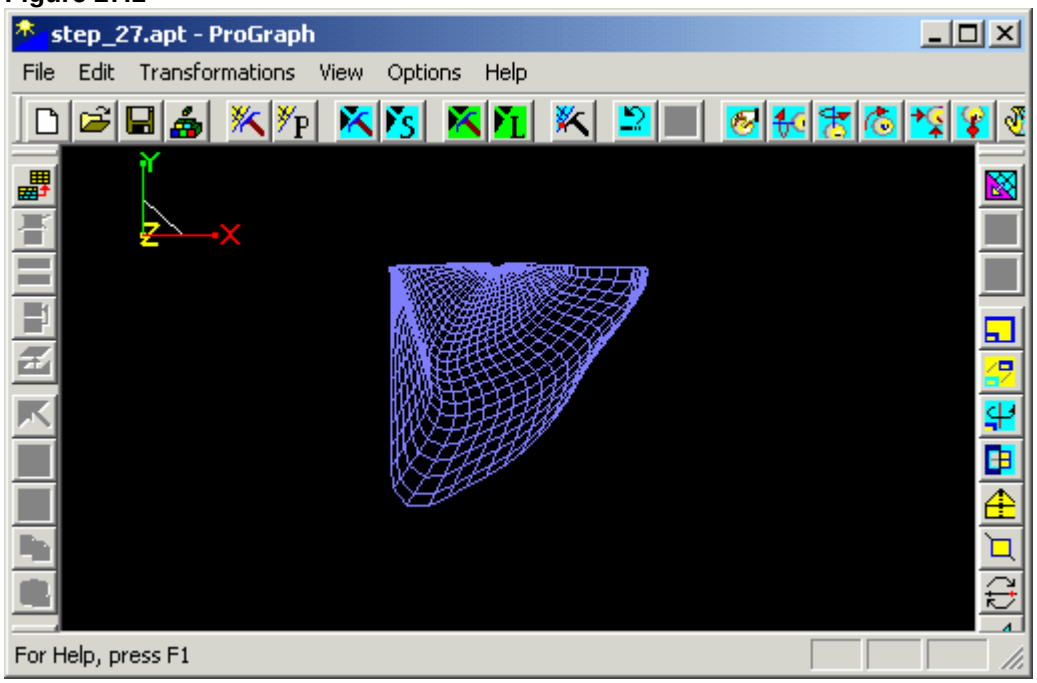
Introduction. In many cases, it is convenient to work with files that contain structured grids. Nevertheless, the main constructor systems (for example, UniGraphics) create these files in non-structured format. For more suitable work in these cases, a simple procedure that permits to obtain a structured grid on the model surface has been developed.

ProGraph permits to convert non-structured grid into structured one. It may be performed with the use of the **Convert to ~ APT...** and the **Convert to ~ SKL...** commands from the **Transformations** menu. (For more information see **Step 10**.) These commands works safely for simple geometries but they lead to ambiguous results in complex cases. It is connected with complication of analysis in the cases of self-crossing the surfaces.

In this **Step** an additional possibility is described. To its realization an algorithm of one-to-another grid reflection has been used. A normal vector is calculated at each node of the grid. Coordinates of point, where normal line (line directed to normal vector) intersects the non-structured grid surface, are determined. Point of intersection is named as New Target Point (NTP). As a result, we can receive the surface grid that consists of NTP. This surface grid is similar to template but contains all the nodes placed on the target surface (they are NTP). In fact, if template is a structured grid, then the result of projection is a structured grid too. The template may be created by any methods, but it is desirable to create it as close to target surface as possible.

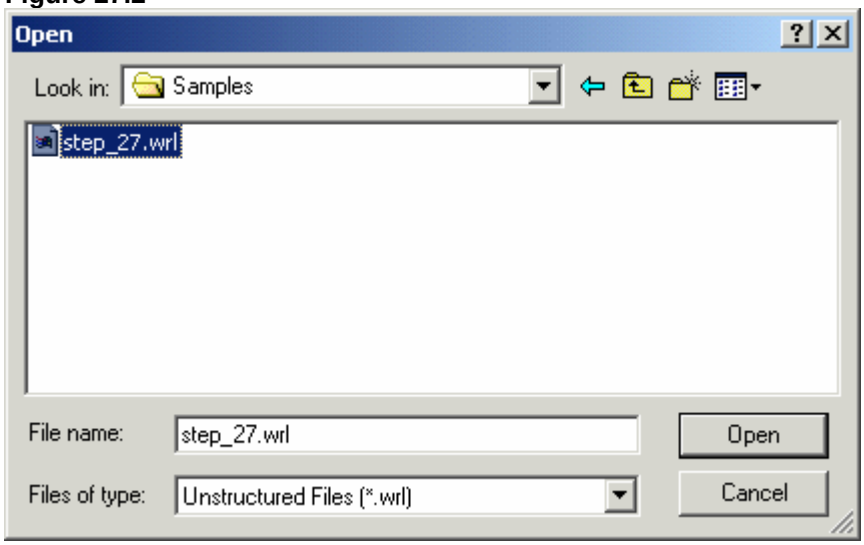
1. Open an existing file STEP_27.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

Figure 27.1



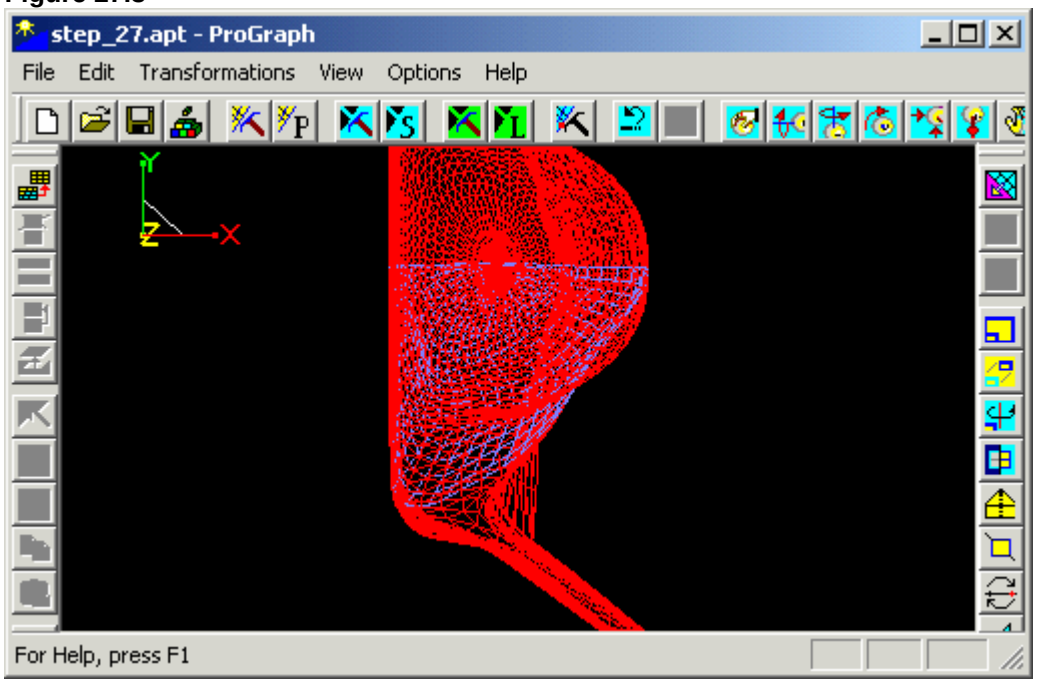
2. Append an existing file STEP_27.WRL that is presented in subfolder SAMPLES of the current folder. Choose the **Append wrl...** command from the **File** menu. Then the standard ***Open Dialog Box*** will appear on your screen.

Figure 27.2



3. Choose an existing file STEP_27.WRL. Then the Geometry will appear on your screen.

Figure 27.3



3. Rotate the Geometry on the screen to set convenient viewpoint.

   - Choose the **Rotate...** command from the **View** menu.

     or

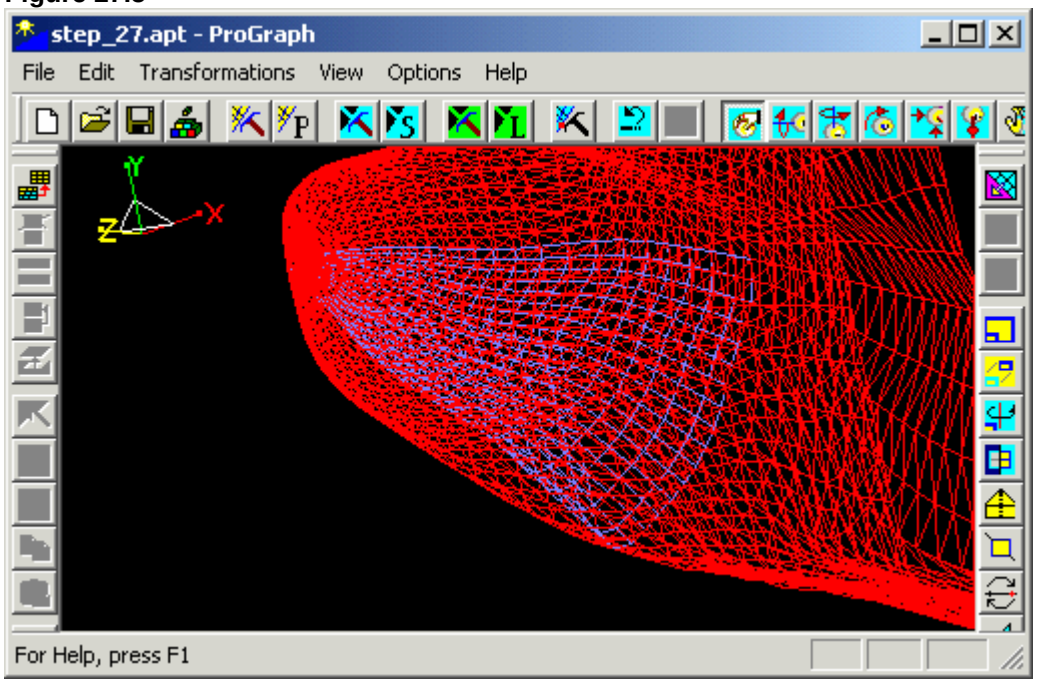
   - Click the following icon from the upper toolbar:

   Figure 27.4

   Then the cursor shape is changed to .

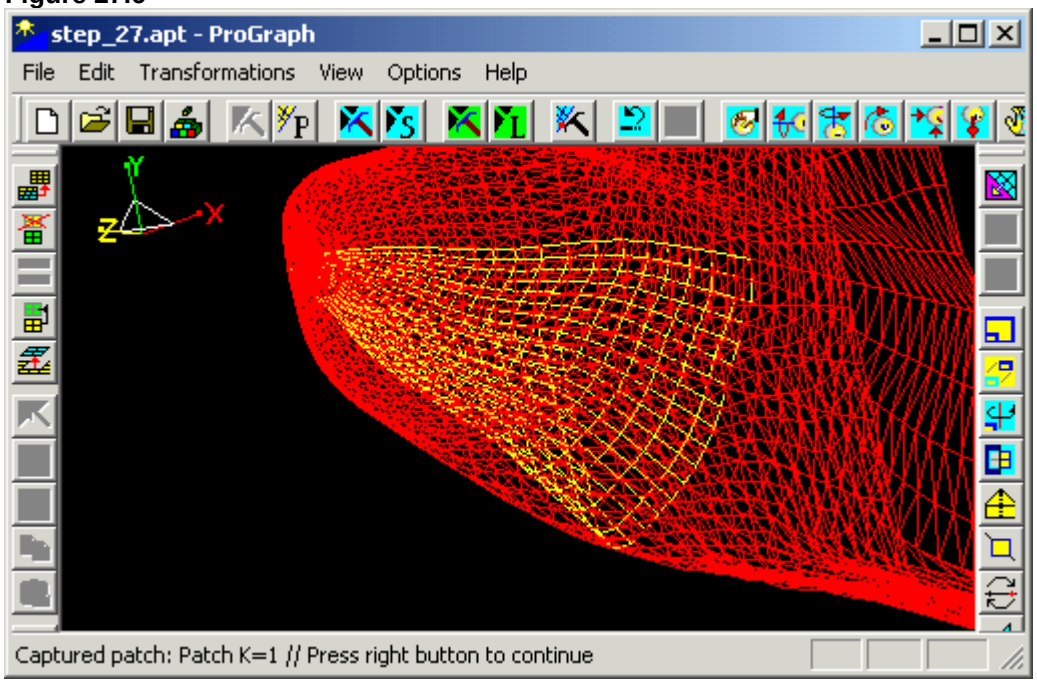
4. Move the mouse and see how the Geometry is rotated.

Figure 27.5



5. Capture the blue patch to the block. (For more information see steps 2-3 of **Step 5**.)

Figure 27.6



6. To create a new structured grid using non-structured surface grid (initial information):

   - Choose the **Projection to wrl** command from the **Transformations** menu.

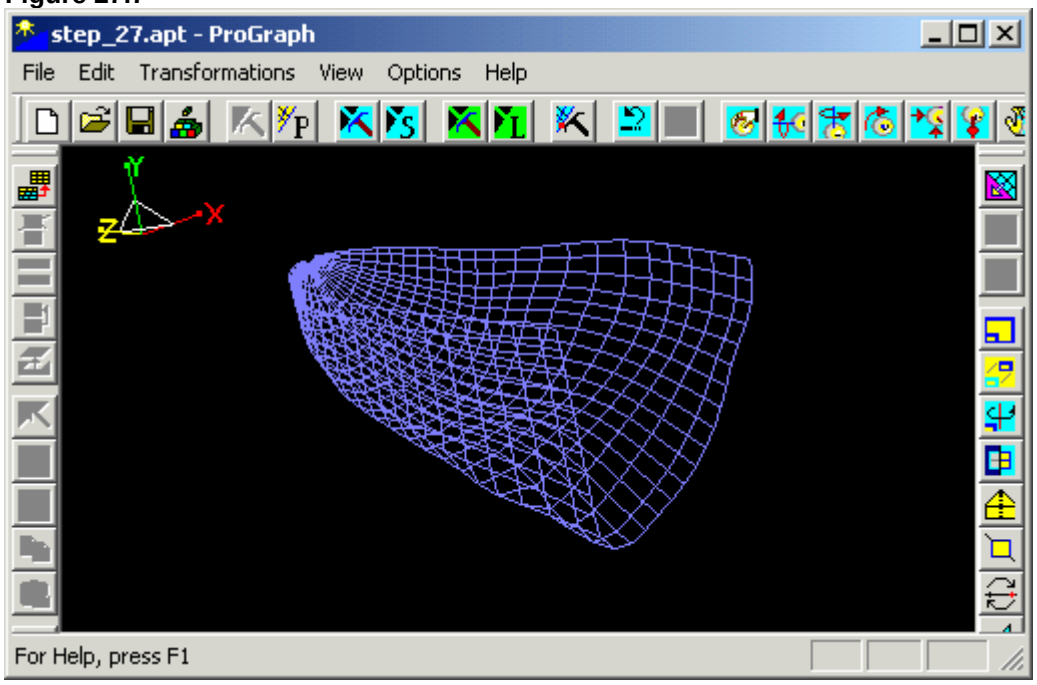
or

- Click the following icon from the right toolbar:

Figure 27.7

Then a new structured grid will remain on your screen. All the nodes of this grid belong to initial surface (defined by non-structured grid).

Figure 27.7



Step 28. How to correct the Geometry grid using displacement of markers

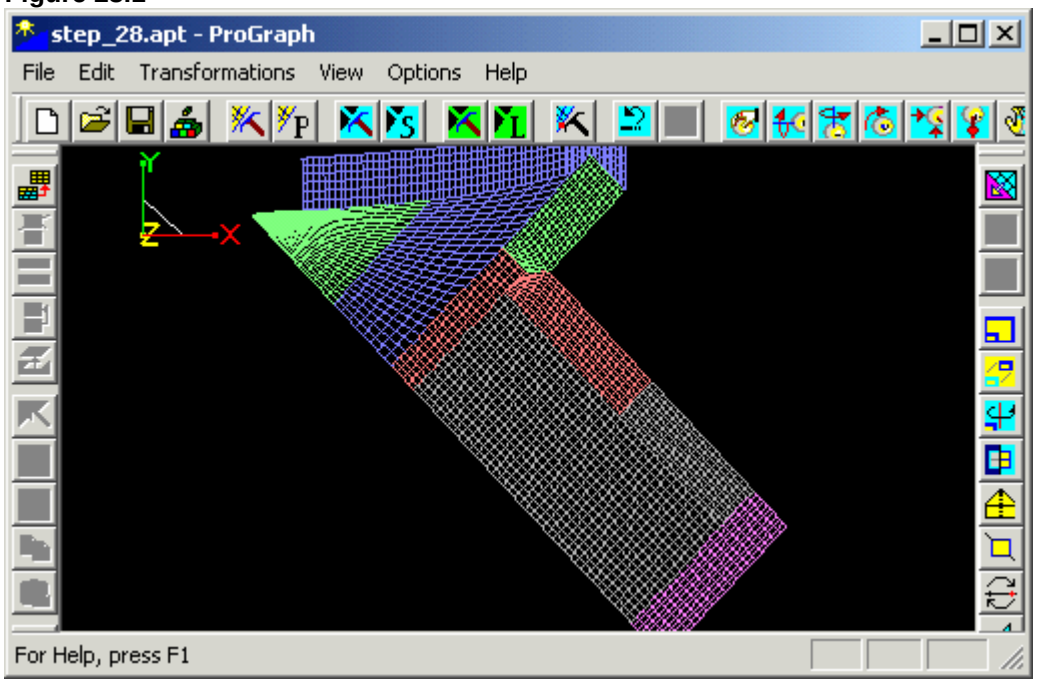
Introduction. During preparation of the experiment, the model surface is covered by markers. During the experiment the model is deformed. It results in shifting these markers. The same shifting takes place when the model surface is covered by a polymer to measure skin friction. Because of polymer liquidity, markers move. It permits to define local stresses and forces on the model.

This **Step** explains how to deform the mathematical surface of model with taking into account measured shifting the markers. File SFT contains the coordinates of all the markers both before the experiment and during it (deformed model). It is assumed that initial positions of markers coincide with model surface given as grid file of APT or WRL formats (another formats of *ProGraph* are available).

In general case, the procedure is following. The initial geometry and the file with markers are read. Then some geometry parts that are to be deformed are included into block. After the procedure, the geometry is deformed for the best correspondence with position of markers obtained during the experiment. For deformation, Micro-alignment algorithm is used. This algorithm has positive experience of implementation and it is described in OMS 3.1 Documentation. It is based on the least-squares method that is used locally. It permits to take into account local peculiarities of deformation.

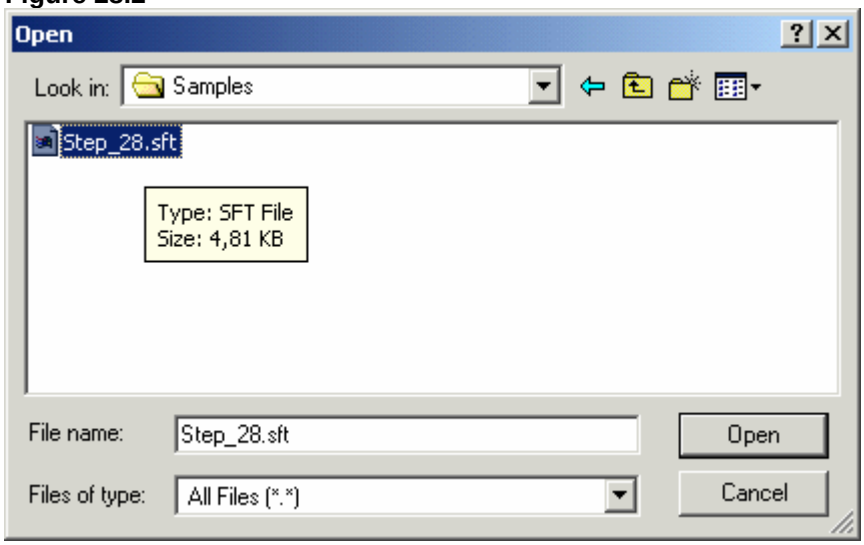
1. Open an existing file STEP_28.APT that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

Figure 28.1



2. Append an existing file STEP_28.SFT that is presented in subfolder SAMPLES of the current folder. Choose the **Append sft...** command from the **File** menu. Then the standard ***Open Dialog Box*** will appear on your screen.

Figure 28.2

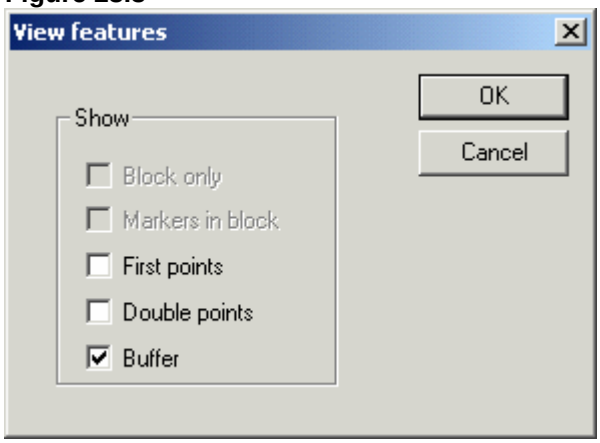


3. Choose an existing file STEP_28.SFT.

4. To view markers choose the **View features** command from the **Options** menu. Then the ***View features Dialog Box*** will appear on your screen.

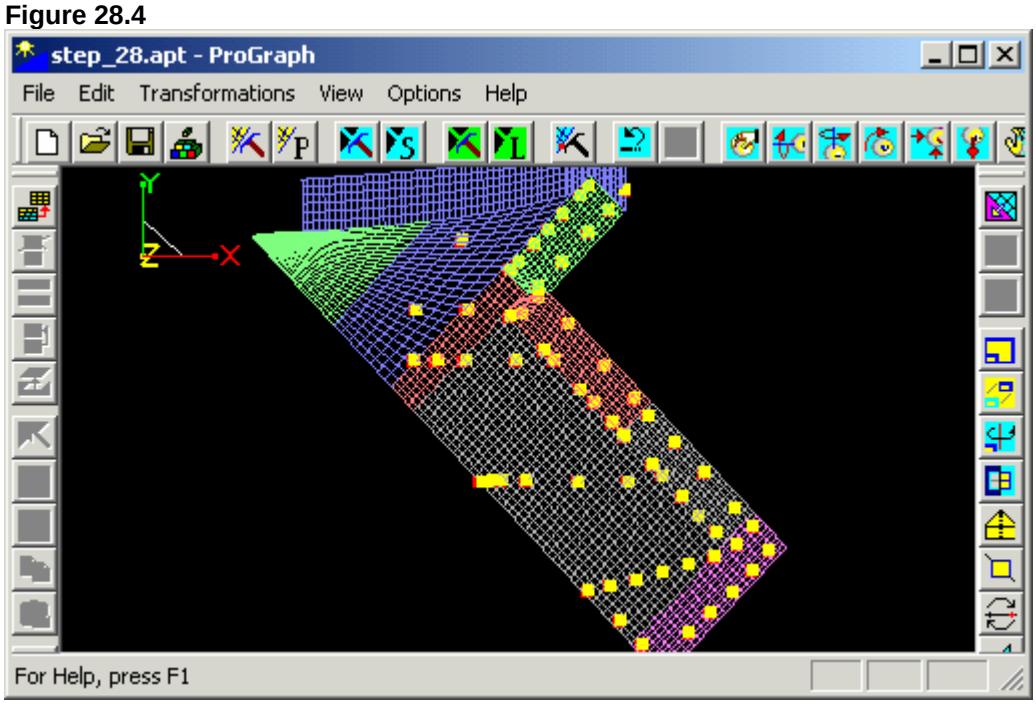
5. Choose all needed parameters in the ***View features Dialog Box*** as shown below.

Figure 28.3



6. Click the **OK** control button. Then pairs of markers will be shown on your screen. All the laboratory markers (X0, Y0, Z0) are painted with a yellow color and all the experimental markers (X0+dX, Y0+dY, Z0+dZ) are painted with a red color.

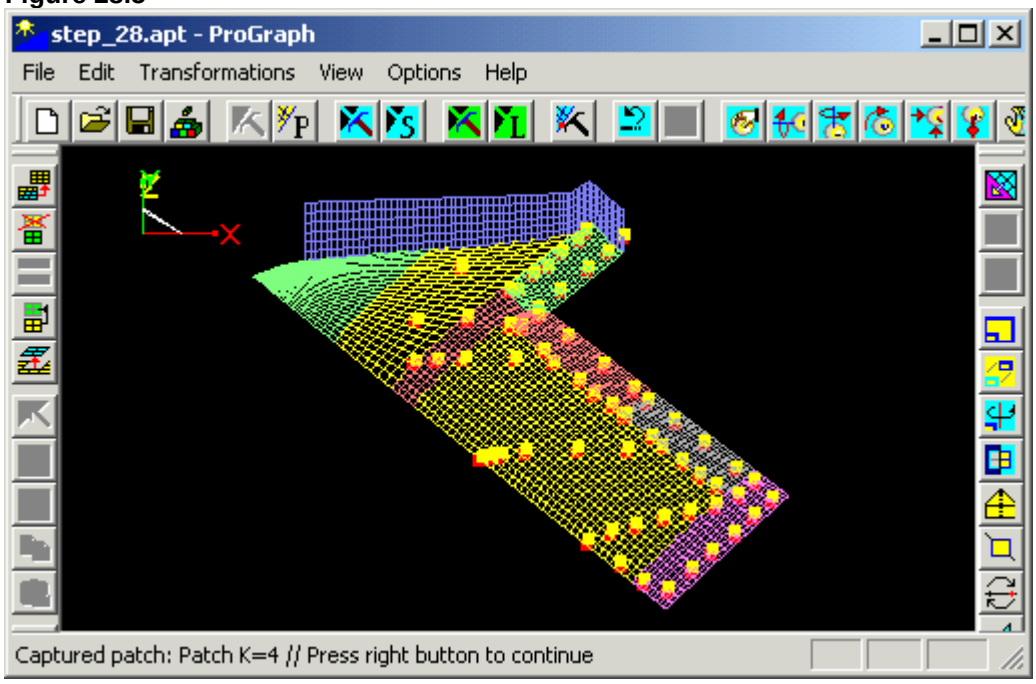
Figure 28.4



7. Rotate the Geometry on the screen to set convenient viewpoint. (For more information see steps 3-4 of **Step 27.**)

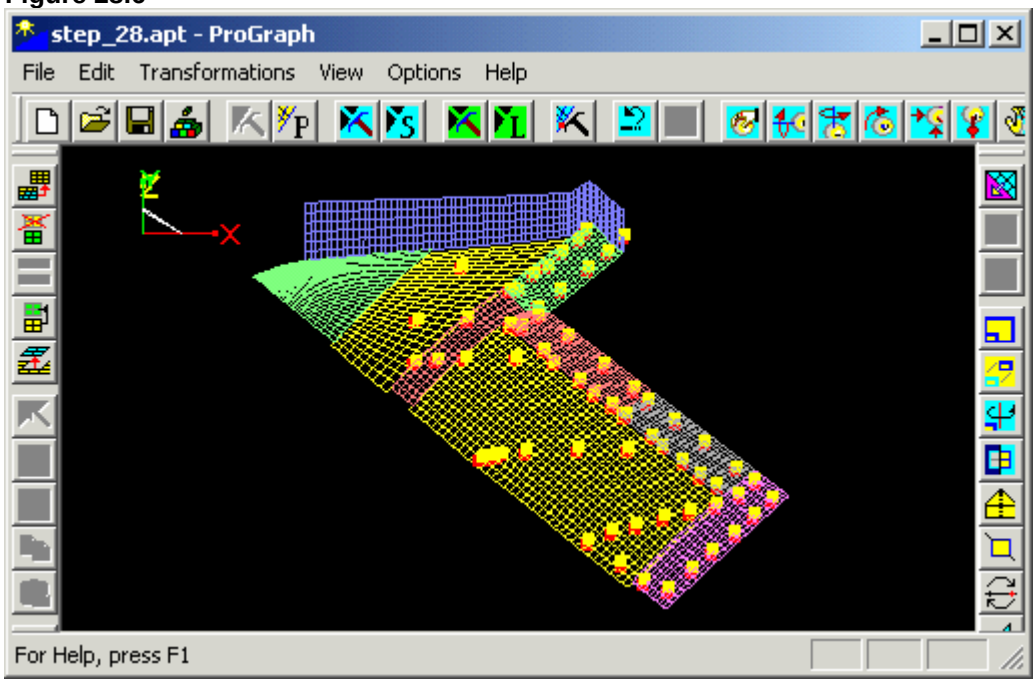
8. Capture the blue and grey patches into the block, for example. (For more information see steps 2-3 of **Step 5**.)

Figure 28.5



9. To transform grid and fit it to markers' displacement choose the **Projection to sft** command from the **Transformations** menu. Then the result of transformation will appear on your screen.

Figure 28.6



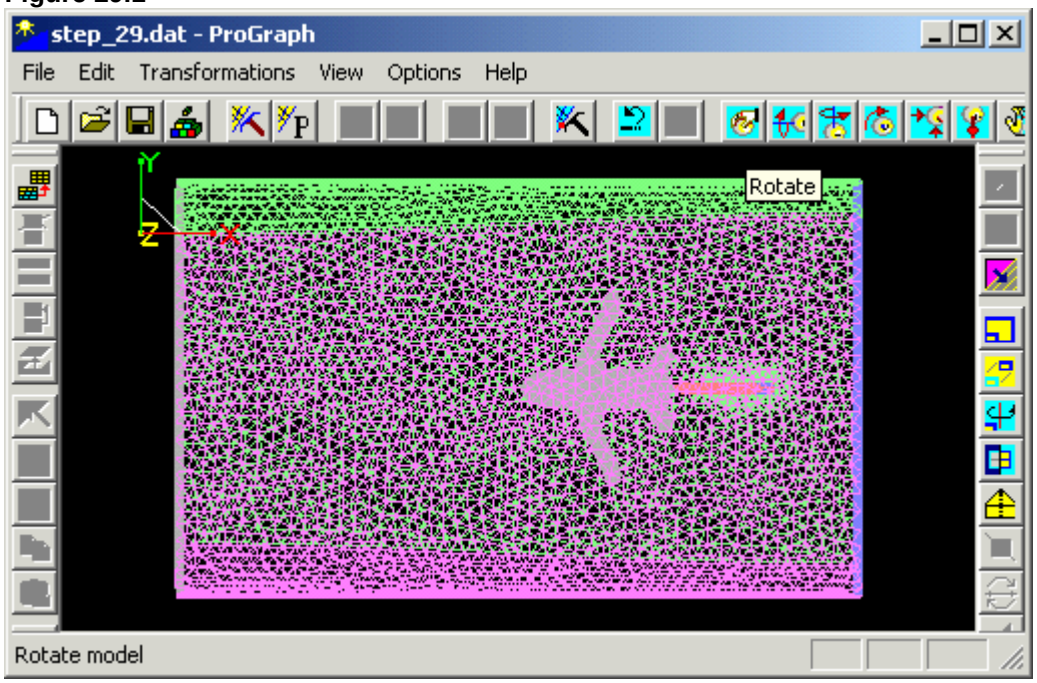
Step 29. How to open VAAC file

Introduction. One of the most important problems is to compare experimental and numerical data. As a rule, formats of grid files used in CFD differ from formats used in experiment processing. So, it is very important, in the framework of the same application package, to have the opportunity to open a grid intended for CFD calculations and to convert it into inner *ProGraph* format.

This **Step** helps you to work with a VAAC file that has GRD extension. This file contains a non-structured grid and it is described in documentation. To make the job convenient and pleasant for users there are two steps united together. Opened GRD file is investigated and sides that correspond to outer borders are selected. After it you can see 3D image of GRD file on your screen (the outer sides are represented only). As a rule, the experimental equipment (PST/TSP paint, pressure taps, etc) are placed at the solid surfaces of model and wind tunnel. For convenience of computation/experiment comparison, an additional command is created. To support this command an additional file with boundary conditions (of CBC/BC format) has to be read and analyzed. As result of this operation, you can see the image of VAAC file that is represented on your screen by solid surfaces only and only that outer borders of subregions, which correspond to solid surfaces, will remain on the base of this file analysis.

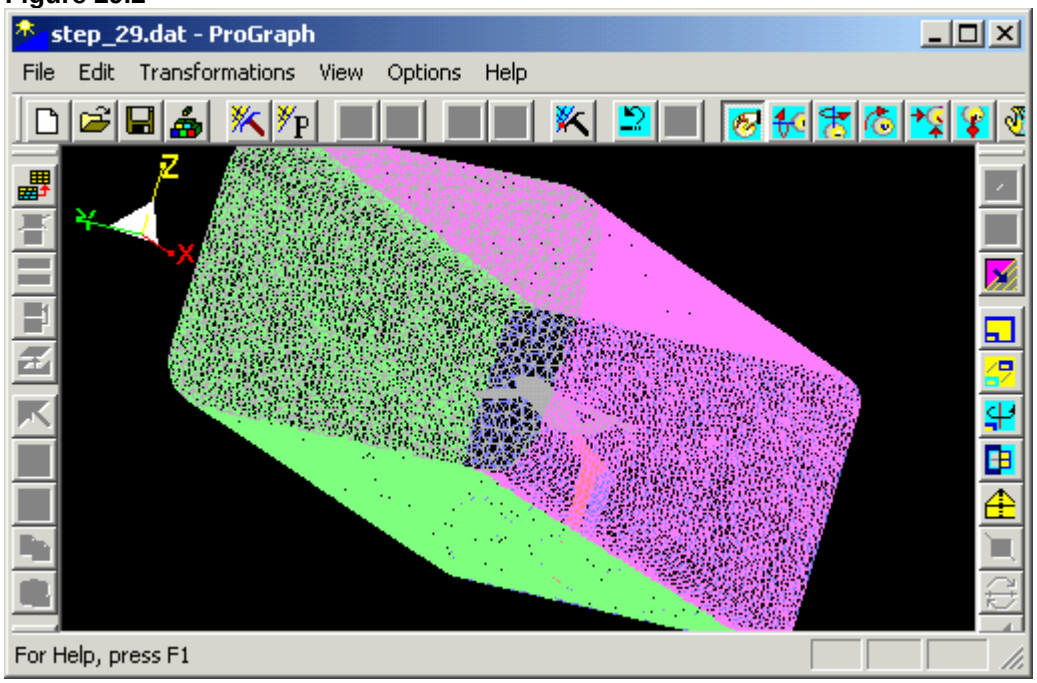
1. Open an existing file STEP_29.GRD that is presented in subfolder SAMPLES of the current folder. (For more information see steps 1-2 of **Step 2**.)

Figure 29.1



2. Rotate the Geometry on the screen to set convenient viewpoint. (For more information see steps 3-4 of **Step 27.**)

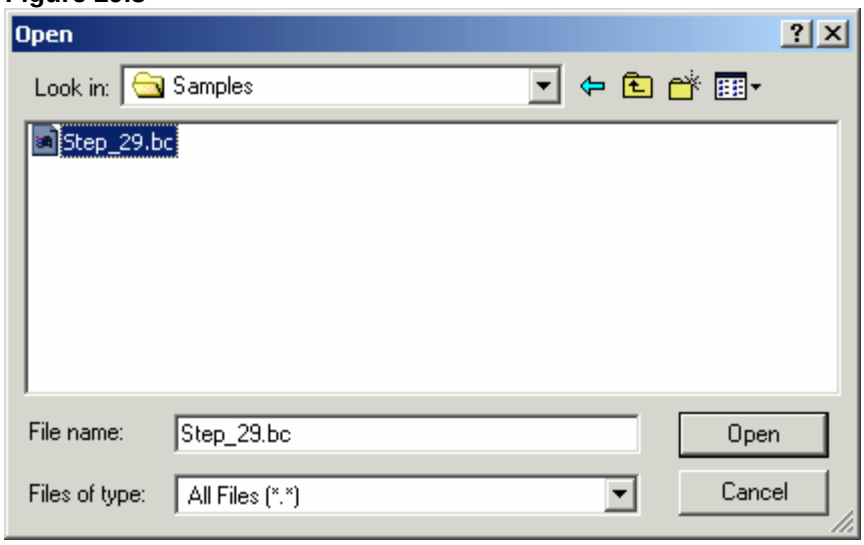
Figure 29.2



3. Append an existing file STEP_29.BC that is presented in subfolder SAMPLES of the current folder. Choose

the **Append CBC...** command from the **File** menu. Then the standard ***Open Dialog Box*** will appear on your screen.

Figure 29.3



4. Choose an existing file STEP_29.BC. Then the solid walls of surface grid will remain on your screen only.

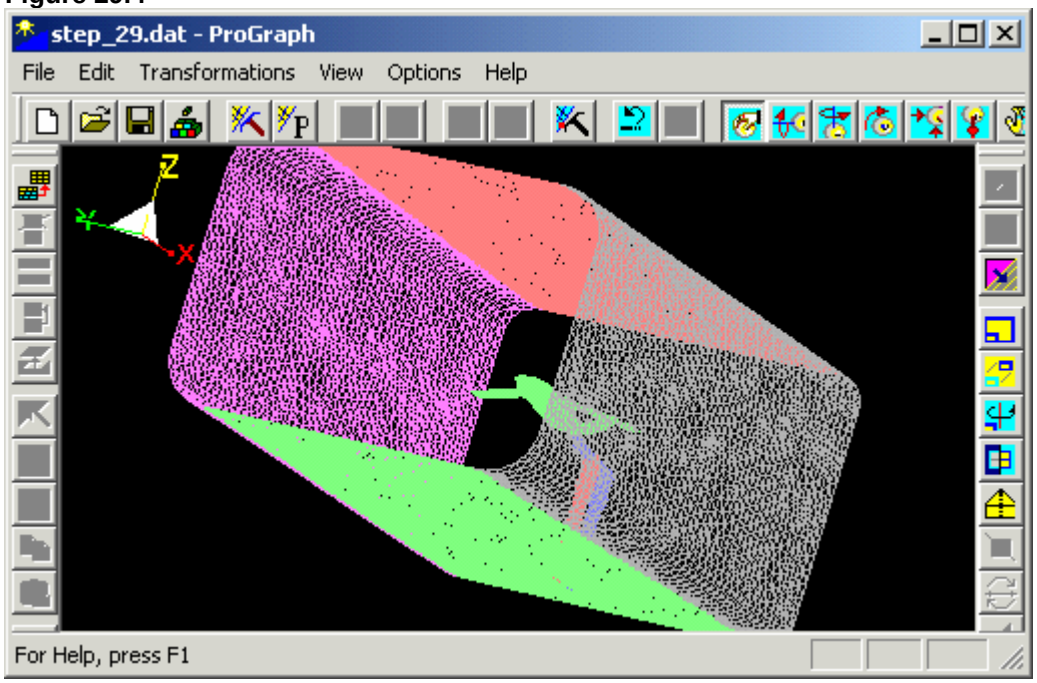



Figure 29.4