OptiNest II

General Shapes Optimized Nesting
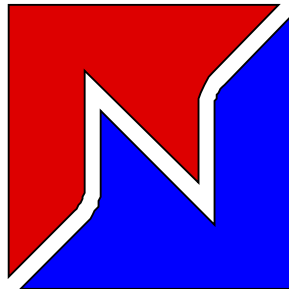
User Manual V 2.10

OptiNest LT / Std / Usi

OptiNest II

SUMMARY

OptiNest II

OptiNest™ *for Windows* is the sole property of BOOLE & PARTNERS.
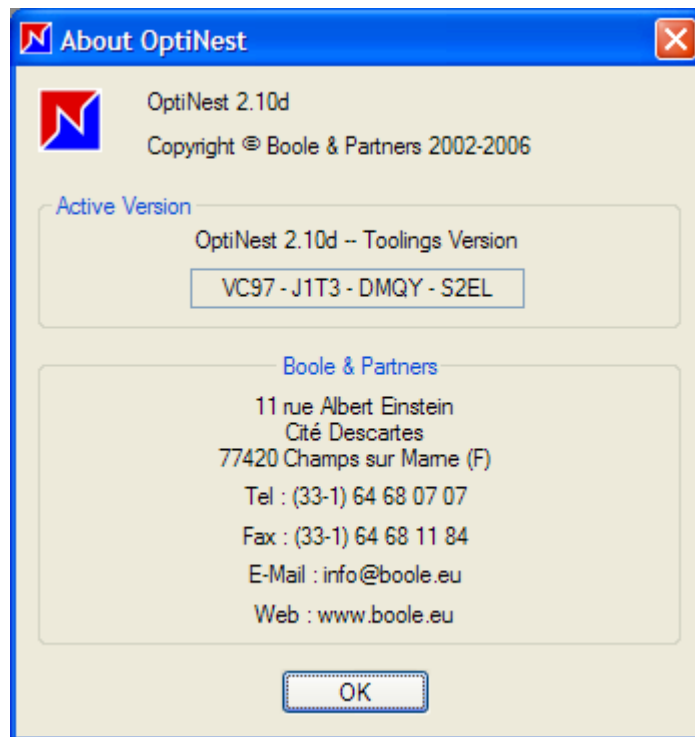
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For any information or request related to **OptiNest**, *please contact BOOLE & PARTNERS :*

> *Tel   : 33 (0)1 64 68 07 07.*
>
> *Fax   : 33 (0)1 64 68 11 84.*
>
> *Mail   :* *info@boole.eu*

I. INTRODUCTION

Preliminary

General shapes nesting problems generate a large number of combinations, and this number goes increasingly with the shapes variety and complexity. This is why, for duration reasons, it is not reasonably possible to examine individually each of these combinations.

Therefore a nesting software will not always be able to identify "the best solution", but the more time is allocated to calculus and combinations are selected with relevance, the better the final solution.

I. 1 PRESENTATION

OptiNest II is a nesting software designed and developed by **BOOLE & PARTNERS**, computer assisted optimization specialist since 1988, with the experience of several thousand software licences in use in over 30 countries.

OptiNest II is available in the three following versions :

  - **OptiNest II-LT** :   "Light" version, limited to polygonal shapes of no more
                             than 10 vertices *(left example)*.

  - **OptiNest II-Std** :   "Standard" version, compatible with all outlines described
                             by any polygon or DXF polyline *(right example)*.
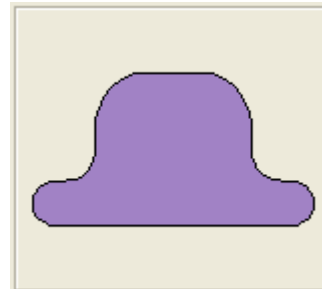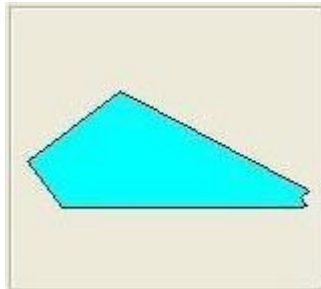
  - **OptiNest II-Usi** :   "Toolings" version, stores each shape holes and toolings,
                             and restores them in the nesting maps.
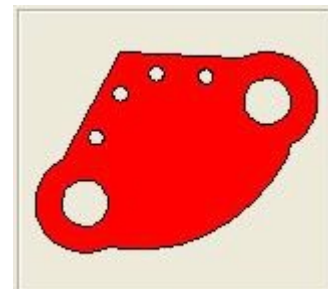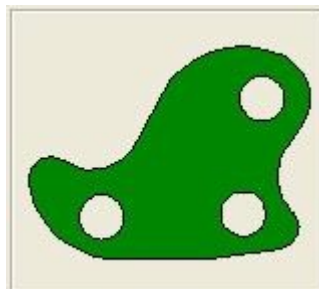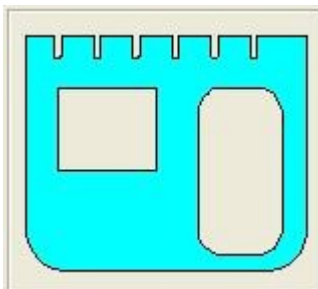
I. 2 INSTALLATION

**OptiNest II** may be installed on any PC operating under Windows 98, Windows 2000, or Windows XP Pro, with the "**InstallOptiNest.exe**" file available on the CD supplied, as well as on **www.boole.eu** .

Launching the "**InstallOptiNest.exe**" file displays the following window :

You just have to follow instructions, the installation procedure lasts only a few seconds.

Once **OptiNest** is installed, you will be able to start it from the shortcut created automatically on your desk. The following window will appear, and **OptiNest** will work in demonstration mode until you enter the Activation Code that we shall send you.
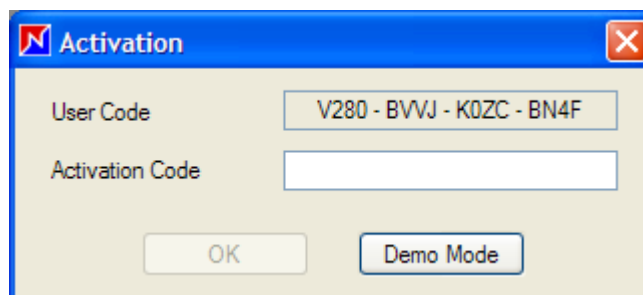
You will therefore have to send us your User Code, by either Fax or E-Mail :

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@ IMPORTANT :

You must **Uninstall OptiNest II** before any intervention on your system or hard disk.

In this case, you have to go through the "Start / Program" Menu of your computer, and launch the "Boole & Partners / OptiNest 2 / Uninstall OptiNest" Command.

ATTENTION : Do not forget to note the Uninstallation Code that will be displayed.

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I. 3 OPTINEST SCREEN

After drawing or importing the shapes to be nested, and defining their quantities and optimization parameters *(cf. following chapters)*, you just need to execute the Menu "**Optimization**" Command or to click on the "Square Root" icon in order to start calculus.

OptiNest II displays pieces positionings one by one, and its screen looks as follows:
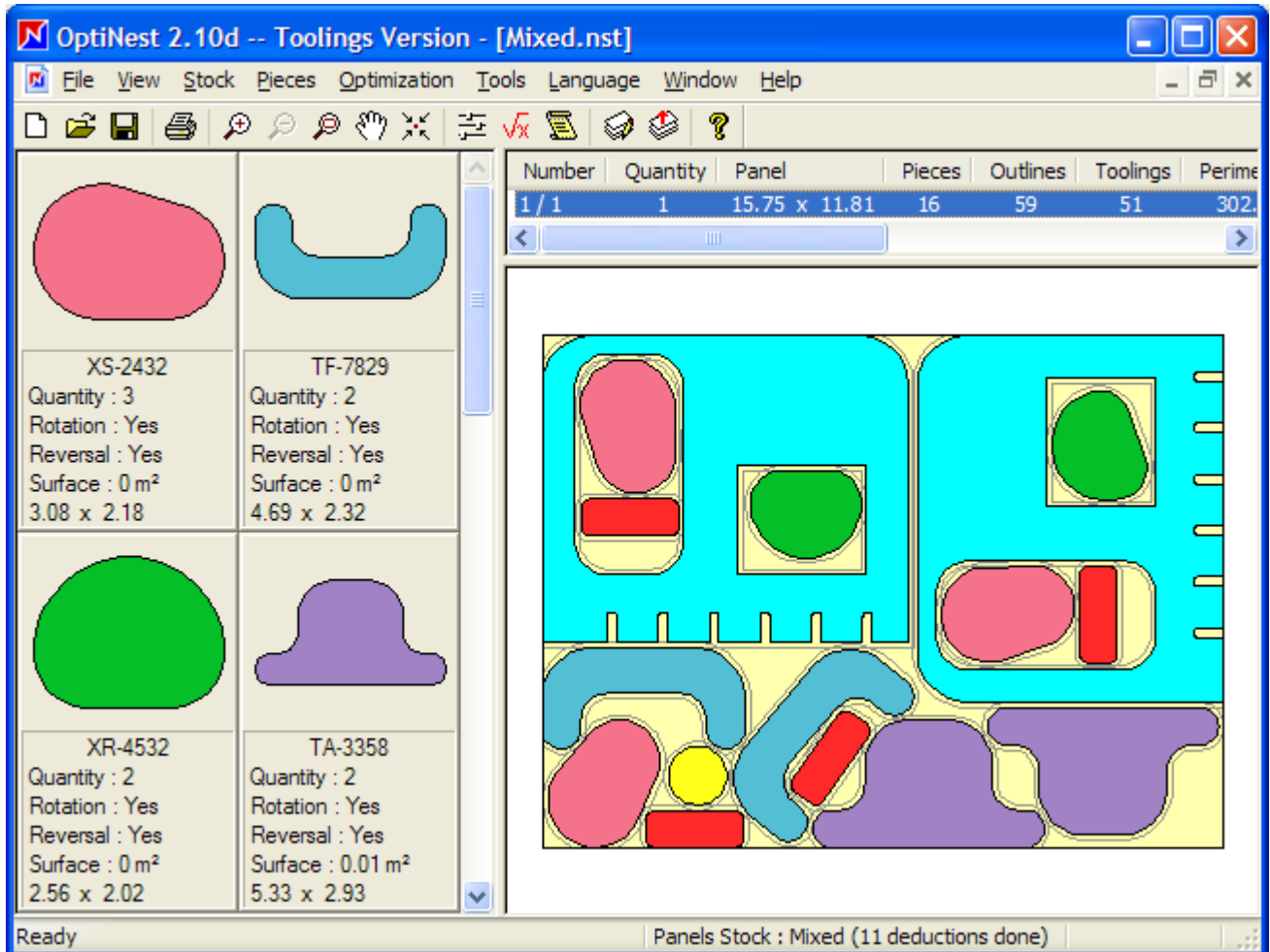

On the screen left side is the pieces graphic list, detailing each piece main characteristics :
Reference, quantity, rotation, reversal, surface, and Bounding Box dimensions H x L.

A "double click" on any piece of this list opens a window allowing to modify its characteristics, to display *(and delete)* its toolings, and to edit the corresponding polygon *(add / delete / modify vertices)*.

In the upper right frame is the nesting maps list, with the corresponding data.

A "double click" on any piece of a nesting map opens the opposite window :
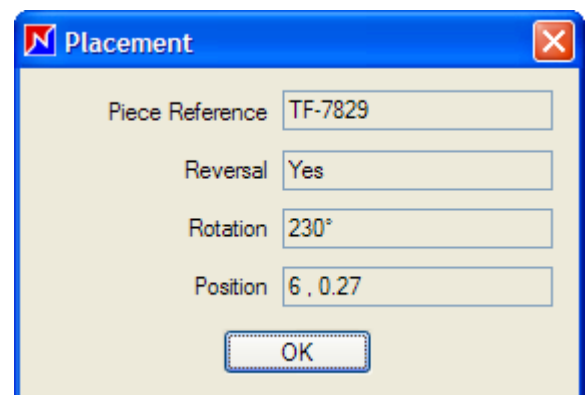
II. OPTIMIZATION PARAMETERS

OptiNest II optimization parameters have been grouped in three categories detailed in this chapter, and corresponding to the three indexes of the below window.

II. 1 CUTTING PARAMETERS

These parameters determine :

   - The panels stock in which pieces should be nested,

   - Whether all panels formats should be tested and compared
     (otherwise only the first available panel format will be used),

   - The cutting tool kerf *(minimum distance between pieces),*

   - The panels trim cut thickness around the panels.
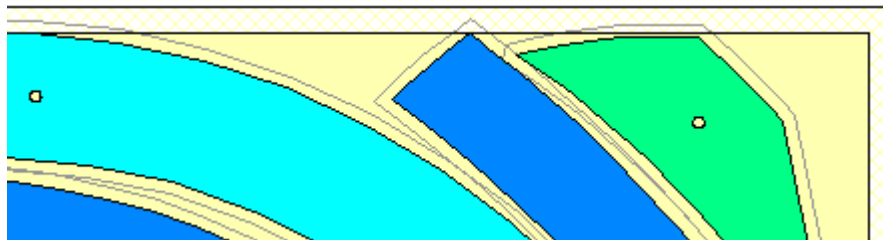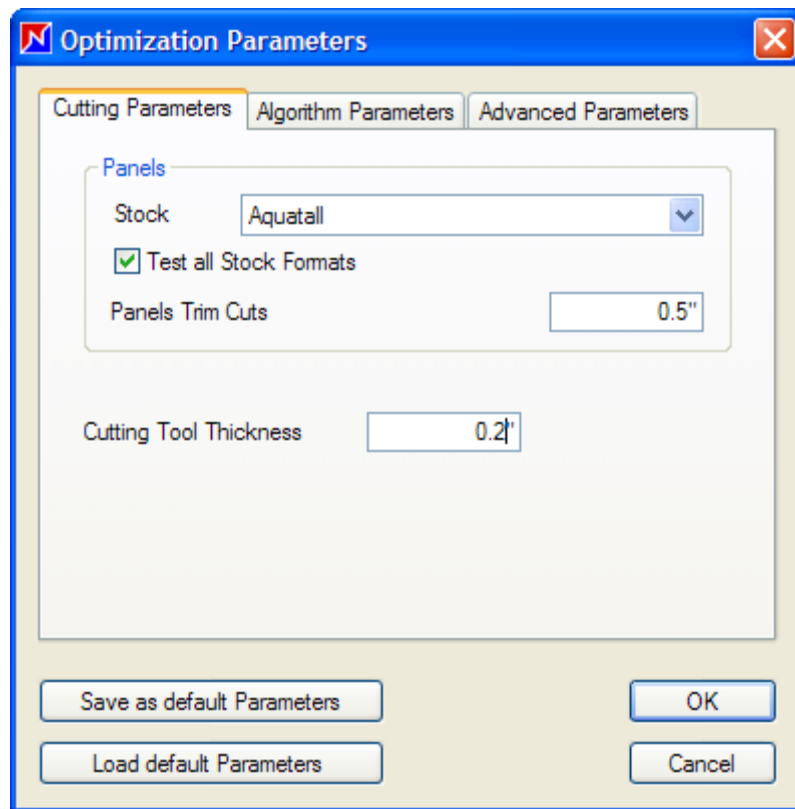
The above diagram illustrates both the panel trim cut thickness along its border, and the cutting tool thickness around nested pieces.

II. 2 ALGORITHM PARAMETERS

These parameters determine the levels and options of the calculus algorithm which will select the successive pieces positionings.

Each of these parameters is detailed and illustrated hereafter :
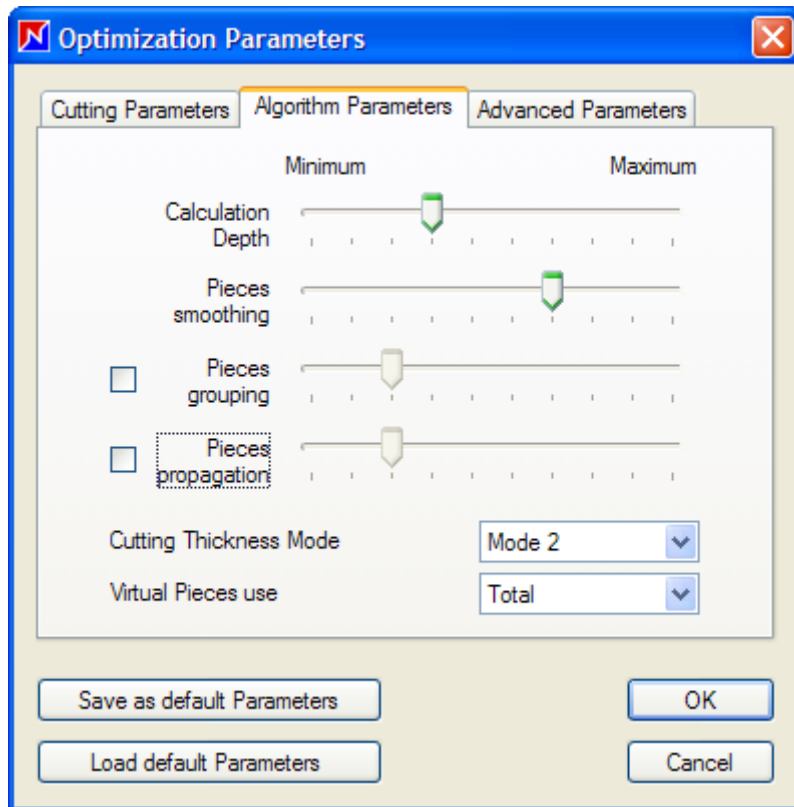
Calculation depth

This parameter defines the number of positions which will be tested and the anticipation level of the next pieces positionings before deciding for the current piece final position.
This parameter has a direct effect on the calculus duration.

The anticipation level is equal to 0 for positions 1 to 4 of the cursor, 1 for positions 5 and 6, 2 for positions 7 and 8, and 3 for positions 9 and 10.
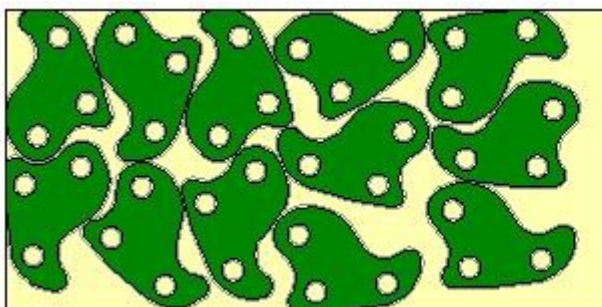
Position 1 of the cursor : **12** pieces   Position 4 of the cursor : **14** pieces
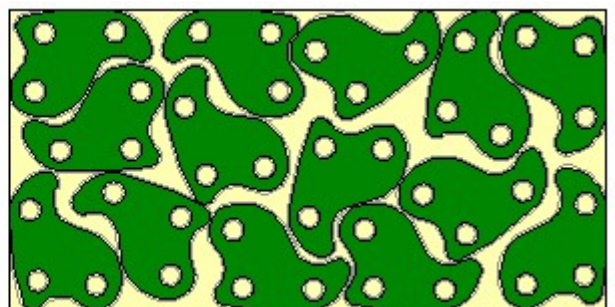
Pieces smoothing

In order to improve calculus efficiency, each piece is approximated by a polygon, and with an approximation level defined by the smoothing factor.
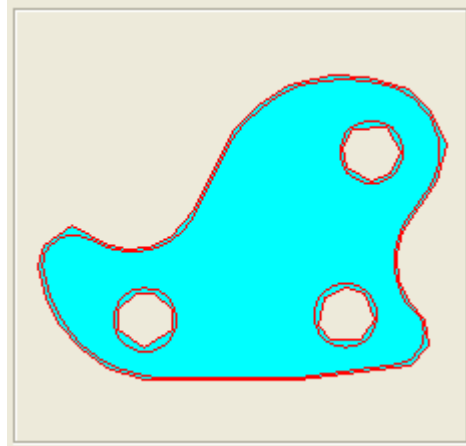
When the cursor is in position 10 *(maximum),* no smoothing is applied to the piece. In this case, polygons will be used just as they are, and polylines will be positioned with the initial description defined while they were imported.

Increasing the smoothing factor will lead to an increase of the polygons vertices numbers and the calculus duration, but will generally also lead to improved results, provided a sufficient calculation depth has been allocated.
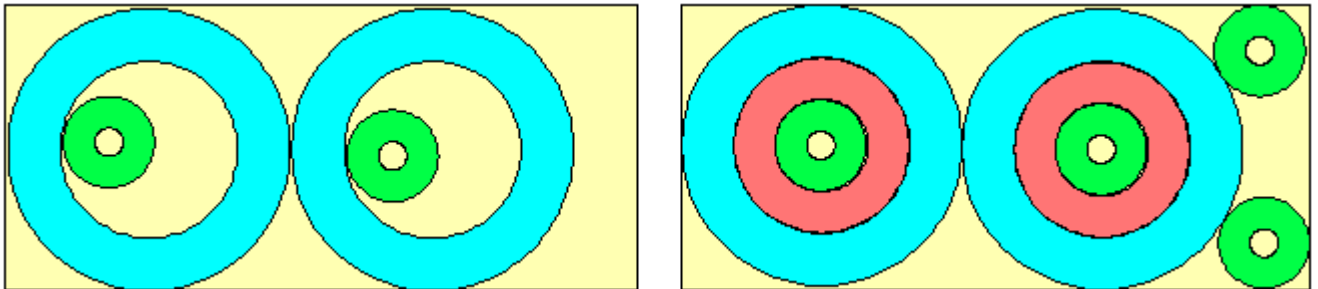
In the above example, nesting has first been calculated with the cursor in position 3 *(left diagram),* then in position 9 *(right diagram).*

In the left nesting map, the red discs did not fit inside the blue ones, and the last two green discs did not fit in the panel right side corners.

Arcs, circles, and polylines smoothing limit

Upon their creation or importation, these shapes are first converted to polygons on the basis of a reference coefficient, corresponding to a minimum number of vertices per full circle *(360 degrees),* and variable between 36 and 360.

These polygons represent circular shapes smoothing limits.

Pieces grouping

The pieces grouping parameter generates couples of pieces with complementary shapes, and uses the virtual grouped piece in calculus.

Groupings may be generated by using two pieces of either different or identical shapes.

The three following nestings, calculated with the same piece, illustrate this principle.
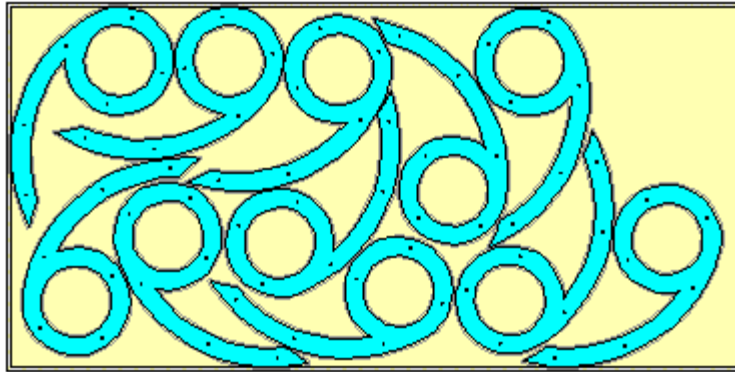
Quick nesting without grouping : 11 pieces
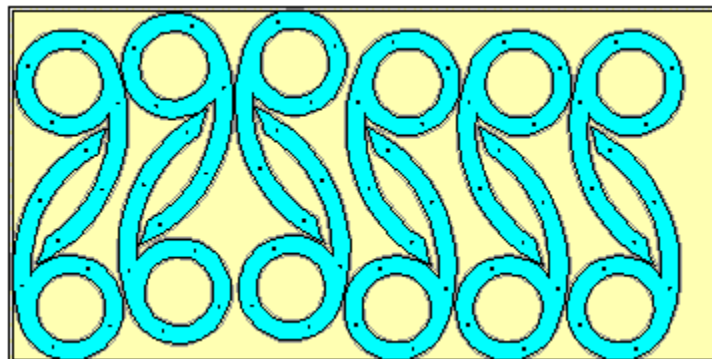
Quick nesting with grouping : 12 pieces

Grouping and smoothing : 13 pieces

In this last example, the smoothed piece has been grouped with a more compact shape than the previous one, enabling the positioning of one more piece.

Pieces Propagation

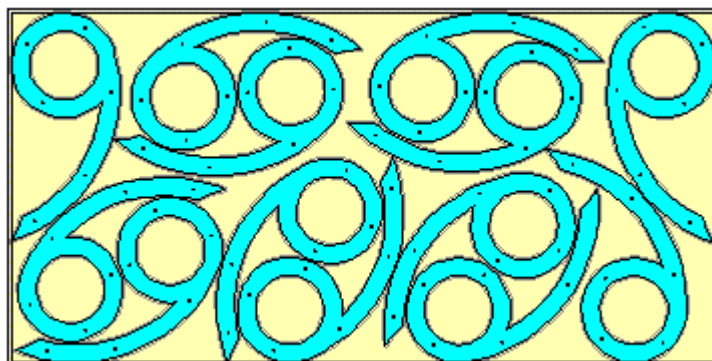**OptiNest** places pieces individually one after another, and determines each new positioning taking into account the panel residual shape after the previous positioning.

The pieces propagation parameter completes the above "one by one" general principle, and predetermines a single piece's best positions admitting it disposes of an infinite surface panel.

Theses positions will be evaluated by **OptiNest II**, and compared to alternative positions.

The two following maps have been nested with 50 blue pieces, and 65 green pieces. The propagation mode was first desactivated, then has been activated for the second nesting.
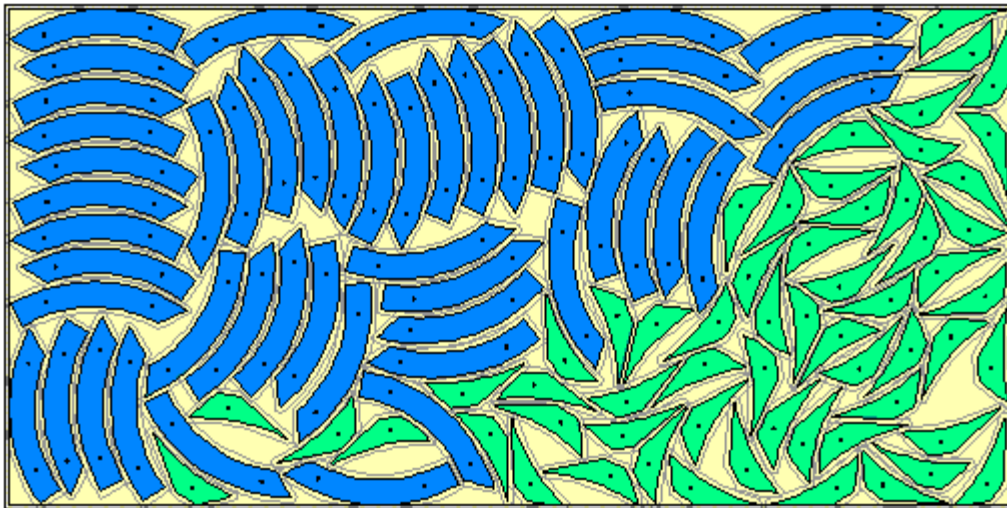
Propagation mode desactivated : 6 green pieces were not positioned
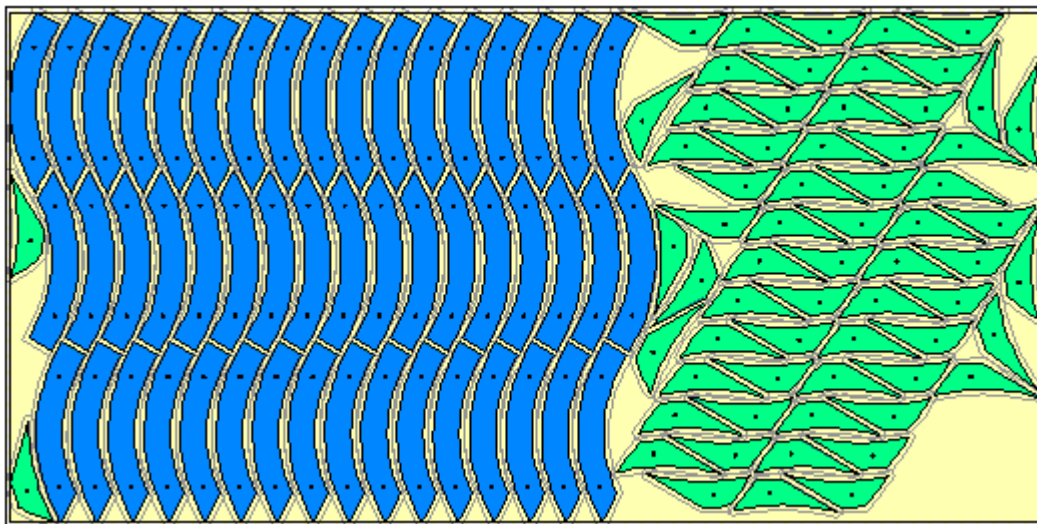
Propagation mode activated : All pieces were positioned

The propagation mode is applied to the smoothed shapes.

When the smoothing level is very high, the propagation identification of a complex shape may be given up if the calculus duration is estimated to be excessive.

## Cutting thickness mode

OptiNest II takes the cutting tool thickness into account using one of the two following calculation modes :
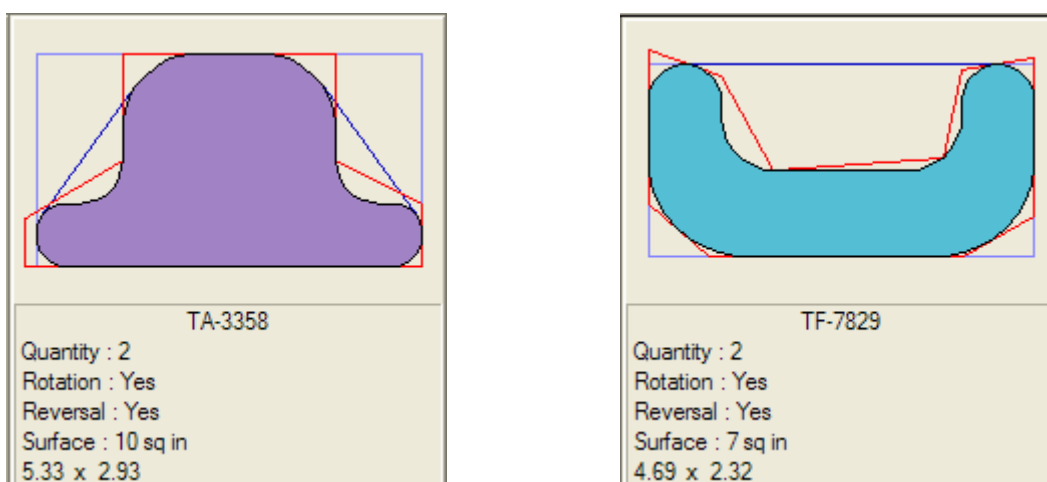
- **Mode 1** *(left side)* first enlarges virtually both pieces and panels by a half cutting thickness, then determines the positions of the virtual enlarged pieces assuming there are no additional cutting losses.

- **Mode 2** *(right side)* uses real dimensions, and places each piece in the residual panel after deducting the cutting losses due to the previous positioning.
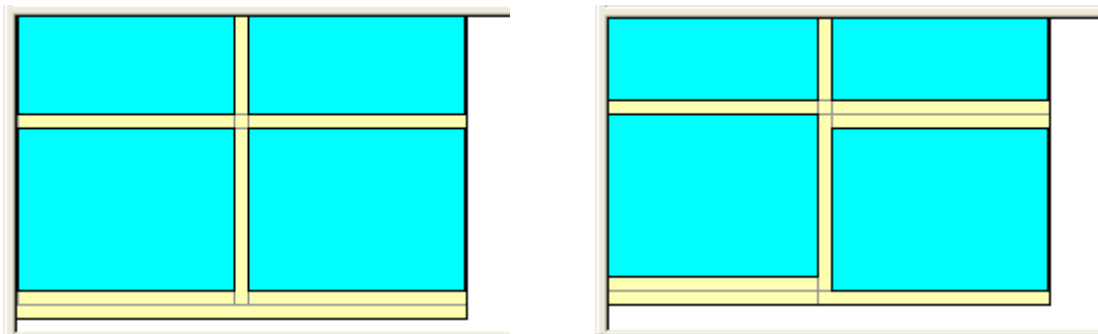
Mode 1 will generally favour simple shapes alignement, while Mode 2 would rather lead to lower off-cuts rates in the case of complex shapes.

Virtual pieces use

For each shape to be nested, **OptiNest II** generates three virtual pieces which contain the original one, and which will be used in order to facilitate the positioning search.

TA-3358
Quantity : 2
Rotation : Yes
Reversal : Yes
Surface : 10 sq in
5.33 x 2.93

TF-7829
Quantity : 2
Rotation : Yes
Reversal : Yes
Surface : 7 sq in
4.69 x 2.32

The three virtual pieces associated to a shape *(cf. above)* are the convex envelope, the bounding rectangle *(B_Box),* and a polygon resulting from a low level smoothing.

In "Partial use" mode, only the convex envelope will be considered.

II. 3 ADVANCED PARAMETERS

OptiNest II's standard algorithm is based on freely determined positions.

The following parameters introduce, within a same calculus level, nesting variations which favour positions located either within one of the eight panel regions *(4 sides and 4 corners),* or in the neighbourhuod of the previous positioning.
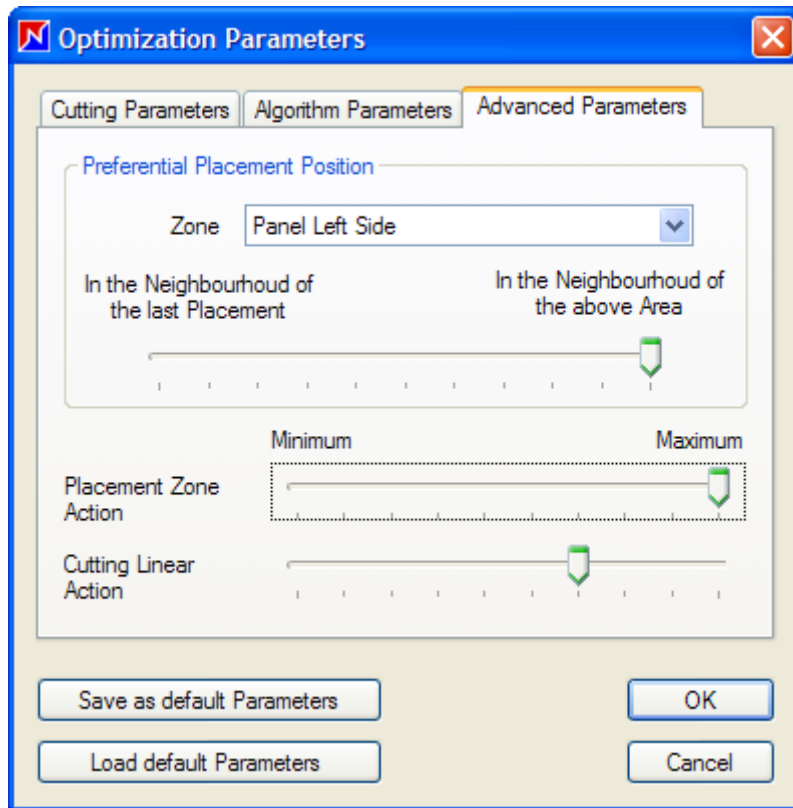
The two below maps have been nested first with the standard algorithm parameters, leading to freely determined positions *(left),* then by favouring positions in the neighbourhood of the panel top side *(right).*
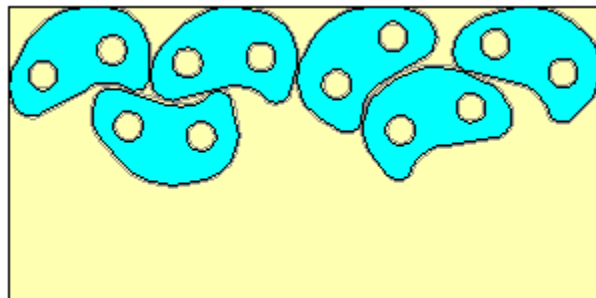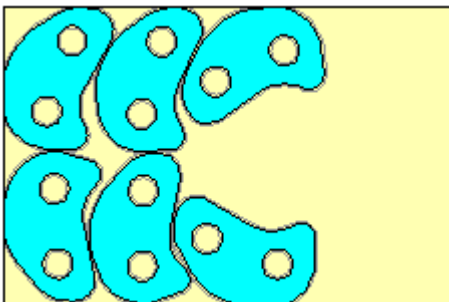
The "Cutting Linear Action" parameter will favour positions which minimize the total cutting linear required for the piece extraction.

Please note that advanced parameters effects have been limited to a certain extent.

# III. DXF IMPORTS AND EXPORTS

III. 1 PIECES DXF IMPORT

OptiNest II imports in DXF format pieces which outlines are described :

- Either by a closed polyline,

- Or by a group of quasi joined *(threshold)* open polylines, lines, and arcs, which will generate a closed poyline upon its importation.

In the nesting maps, these pieces will be exported up to the user, either as closed polylines, or with their original DXF description.

Pieces toolings will be described by lines, arcs, open and closed poylines. These DXF descriptions will be stored in **OptiNest II**, then restored unchanged.

The "Pieces DXF import" Menu Command opens the following window, enabling either an automatic or a manual selection :
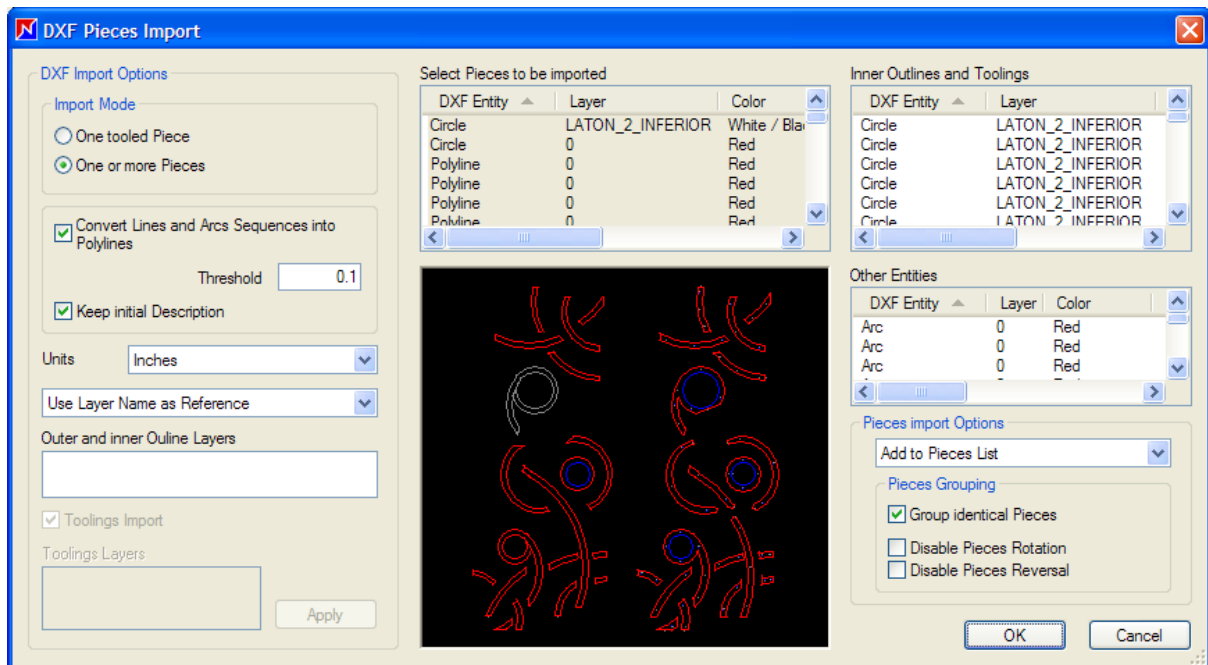
This window includes the three following DXF entities lists :

- The list of pieces corresponding to all selection criteria and which may be imported. Preselected pieces are displayed in red, and pieces which do not comply with the selection criteria appear in grey.

  A simple click in this list switches selection to manual mode.

- The list of toolings and inner outlines *(holes)* which will be imported in relation to the pieces they belong to.

- The list of DXF entities which will not be imported *(Other entities)*.

Pieces DXF import options
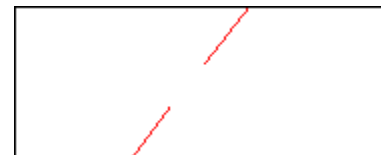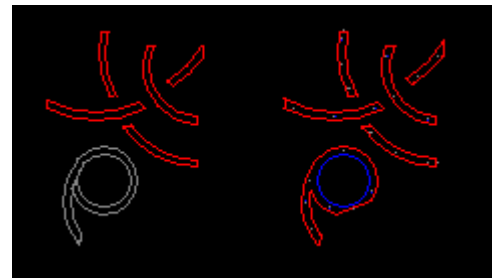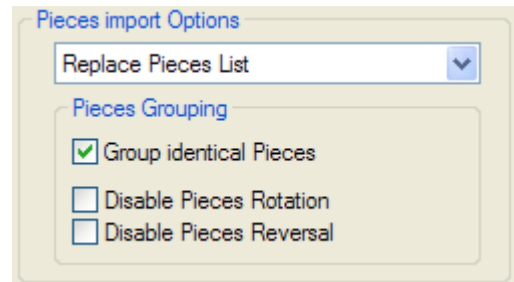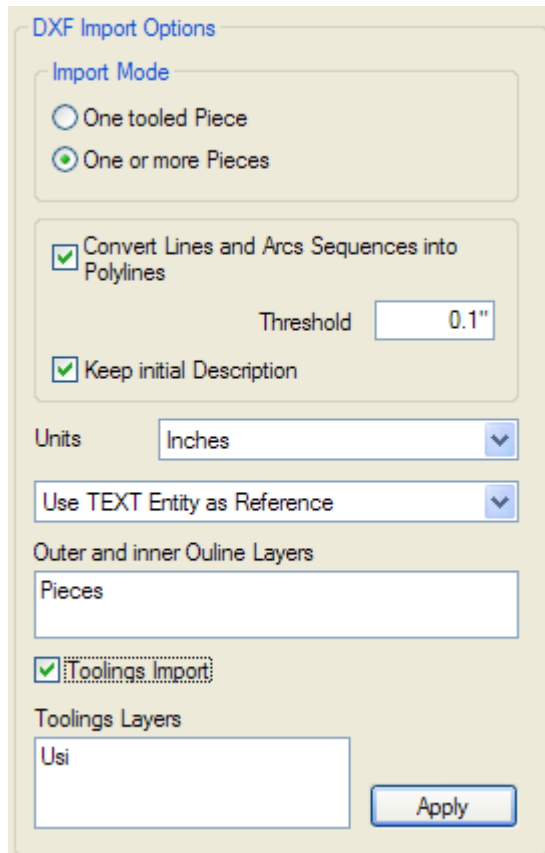
Non joined arcs

The "Import Mode" option allows to import :

- Either a single piece and all included toolings, regardless of layer names : If the file contains several pieces, only one piece will be imported.

- Or several pieces simultaneously : In this case, pieces and toolings will be filtered by the selected layer names *(cf. § "DXF layers selection")*.

The conversion option permet converts quasi-joined shapes into closed polylines, provided that all defaults dimensions are smaller than the the threshold value.

*In the above diagram, the grey piece will not be imported, because it includes two non joined successive arcs, distant from more than **0.1"**.*

The associated "Keep initial Description" option restores pieces with their initial DXF description in the exported nesting maps.

The "Reference" option associates to each imported piece a reference corresponding either to its DXF layer name, or to the first "Text" DXF entity it includes.

The other options are not related to the DXF format. They allow either to add imported pieces to existing ones, or to replace the latter, and to define automatically pieces grouping, rotation, and reversal characteristics upon importation *(cf. § "Pieces individual parameters")*.

III. 2 PANELS DXF IMPORT

The "Edit Stock" window "**Import**" button *(cf. § "Stocks follow up")* opens the following window, enabling the import of one or more panels in this stock, with rules similar to the DXF pieces import.
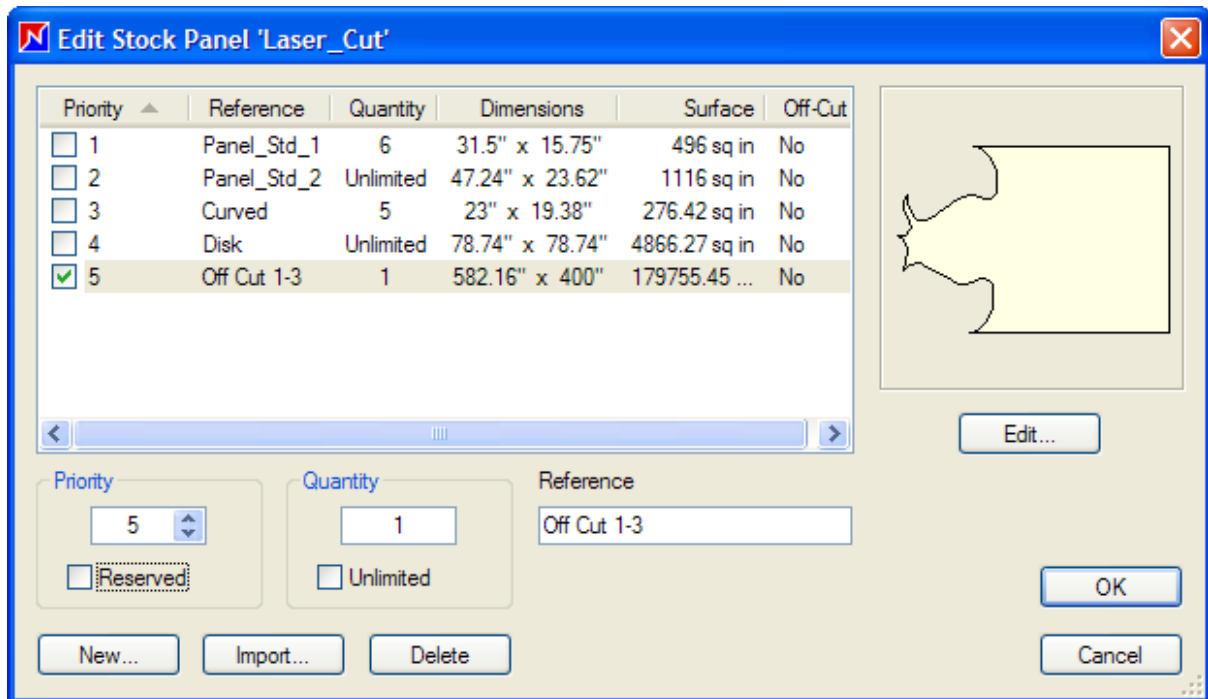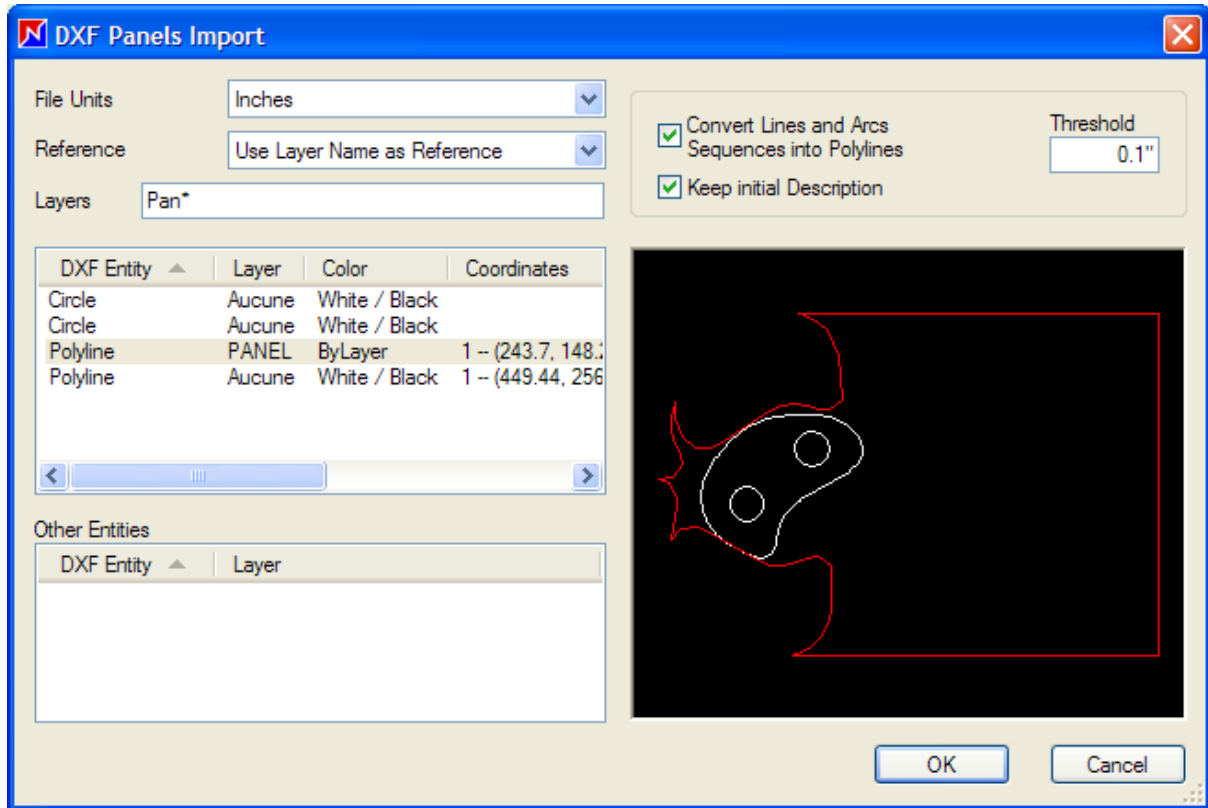
Once the panel is imported, it is displayed in the stock graphic panels list
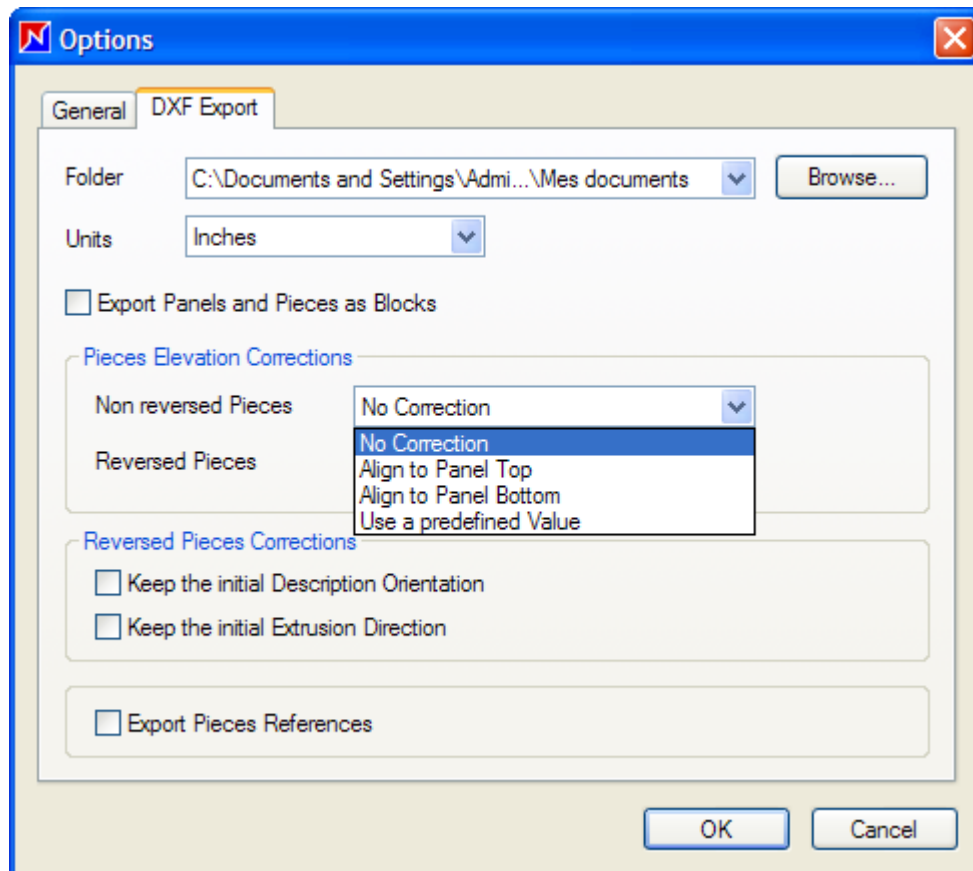
III. 3 NESTING MAPS DXF EXPORT

Nesting maps generated by **OptiNest II** may be exported in DXF format, in order to be transferred either to a CAD software, or to a CNC cutting machine.

OptiNest II exports either all nesting maps simultaneously with the "DXF Export" File Menu Command, or a a single nesting map with <u>a mouse right click</u> on the corresponding line, then by confirming *(any button click)*.

Number	Quantity	Panel	Pieces	Outlines	Toolings	Perimeter	Off-Cuts Rate
1 / 4	2	500.0 x 300.0	60	60	328	11402.6 mm	25.06 %
2 / 4	1	500.0 x 300.0	77	77	88	11931.3 mm	30.66 %
3 / 4	1	400.0 x 250.0	55	55	64	8408.	
4 / 4	1	400.0 x 250.0	48	48	192	8007.	DXF Export...

The "DXF Export" index of the "Tools / Options" Menu opens the following window :

N Options

General | **DXF Export**

Folder   C:\Documents and Settings\Admi...\Mes documents   Browse...

Units   Inches

☐ Export Panels and Pieces as Blocks

Pieces Elevation Corrections

Non reversed Pieces   No Correction

Reversed Pieces

    No Correction
    Align to Panel Top
    Align to Panel Bottom
    Use a predefined Value

Reversed Pieces Corrections

☐ Keep the initial Description Orientation
☐ Keep the initial Extrusion Direction

☐ Export Pieces References

OK   Cancel

The "Export as Blocks" option exports each piece description one single time, then desccribes each nested piece by a transformation *(translation and rotation)*.

This option is particularly interesting in the case of large quantities, as it reduces extensively the exported nesting file size.

The "Pieces Elevation Corrections" option aligns pieces and their toolings to a given vertical level, and distinguishes reversed pieces *(face change)* from non reversed pieces.

The "Reversed Pieces" option either inverts or keeps the initial course and extrusion directions.
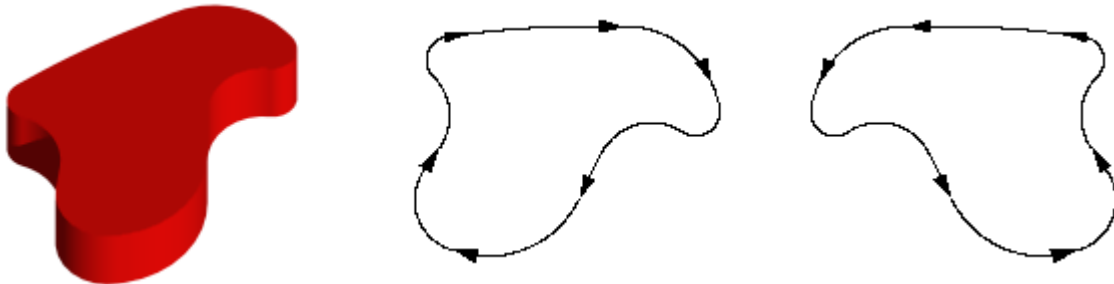

This option allows the **OptiNest II** nesting maps transfer to software and CNCs which are not compatible with a three dimensions coordinates system.

Pieces toolings export

The **OptiNest II-Usi** version also exports pieces toolings, positionned in the nesting map according to their initial positions.

Pieces toolings are stored with their DXF original layer names, then restored just as they are in the nesting map, in DXF layers named identically, and in the same relative positions to the pieces they belong to.
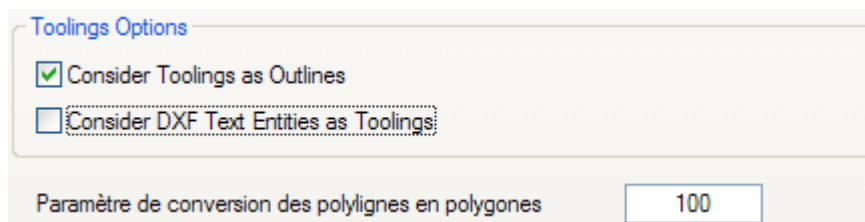
The "Consider Toolings as Outlines" option :

    - Adds closed toolings to the total outlines number,

    - Adds their perimeters to the total nesting map.

Number	Quantity	Panel	Pieces	Outlines	Toolings	Perimeter	Off-Cuts Rate	Net Off-Cuts Rate
1 / 2	5	15.75 x 11.81	17	119	102	343.49"	39.74 %	39.74 %
2 / 2	1	15.75 x 11.81	15	105	90	303.08"	46.83 %	46.83 %

   The above nesting map N° 1 contains 17 pieces, each piece including 6 drillings

Open toolings (lines and arcs) are counted in the total toolings number, but they are ignored in the outlines and perimeter totals.

III. 4 DXF LAYERS SELECTION

In order to ease DXF layers selection upon pieces and panel import, **OptiNest II** handles the following generic characters :

- **Semicolon** (";") allows a multiple layer name selection, and is used as separator between two successive layer names.

- **Asterisk** ("*") replaces any number of characters, and might be used in any position of the layer name *(beginning / middle / end)*.

- **Question Mark** ("?") replaces one unique character, but might be used in any position of the layer name *(beginning / middle / end)*.

- **Slash** ("/"), when it is placed in the beginning of a layer name, excludes this layer name from the selection.

The following example illustrates the use of the above chararcters by simulating the DXF import of the below six pieces, which could all be selected with an empty *(or "*")* entry :
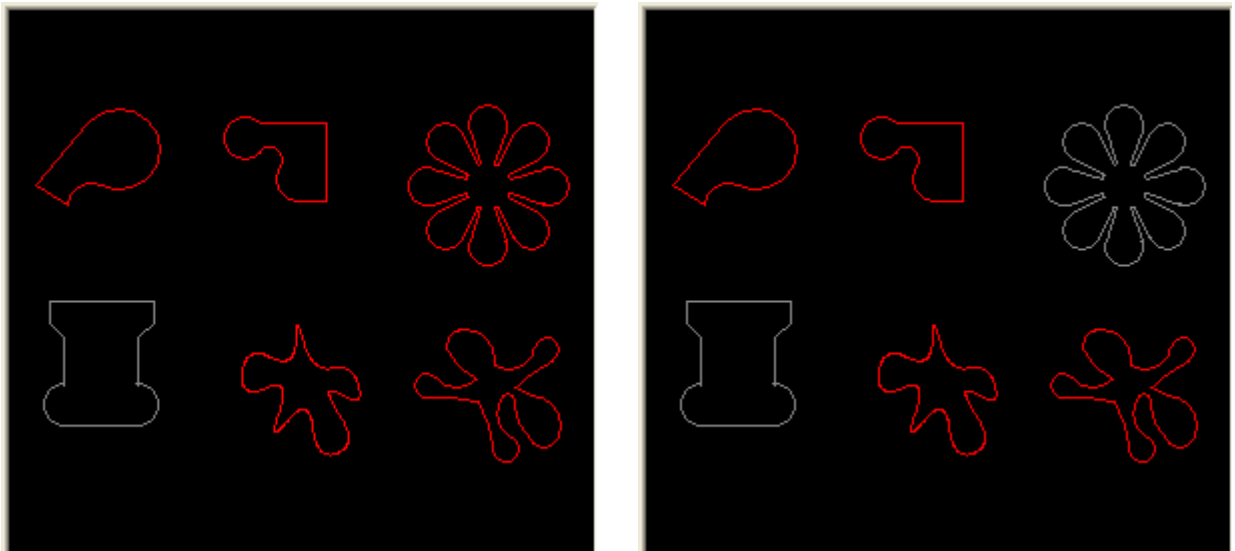
The left diagram corresponds to the "PI*" entry, which selected the five pieces in layers "PI_1", "PI_2",and "PI_3", excluding the single piece in layer "NP".

The right diagram corresponds to the "PI_1; PI_2" entry, which selected the four pieces included in theses two layers, and excluding the two pieces in layers "PI_3" and "NP".

IV. PIECES AND PANELS DIRECT ENTRY

OptiNest II allows a direct entry of pieces outlines having either a rectangular, a circular, or a polygonal shape.

*In its current version, **OptiNest II** does not allow the direct entry of polyline arcs and pieces toolings.*

In order to enter a new piece, you just need to open the below "Pieces List" window *(left)* from the "Pieces \ Edit Pieces" Menu Command, then click on the "Add" button.

This button opens the right window, where you may define the piece type you wish to enter.
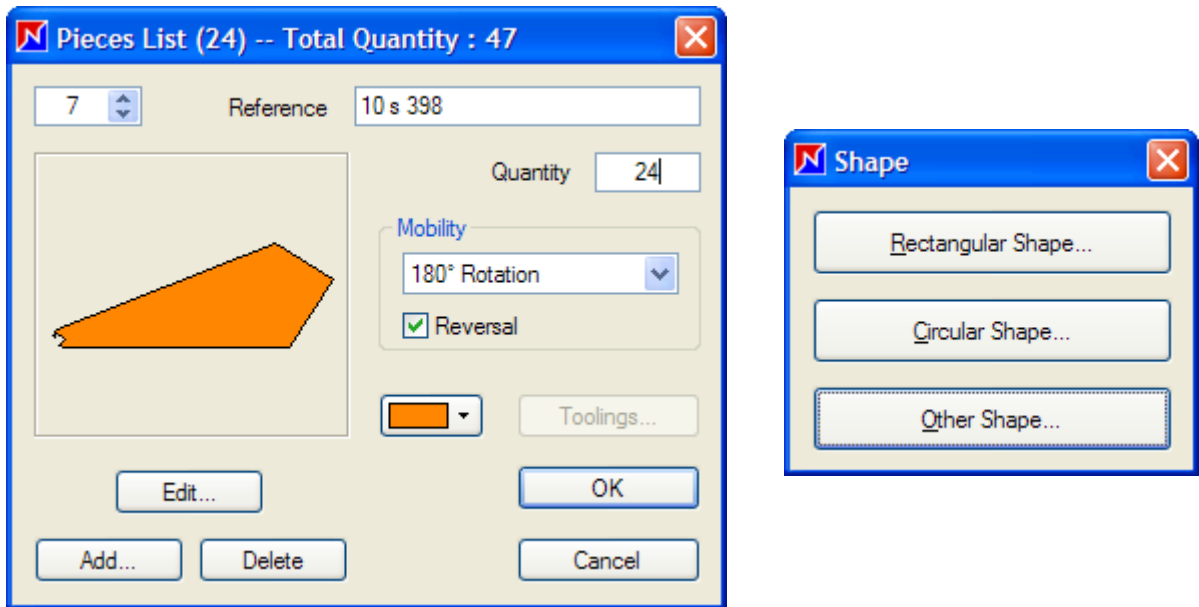
IV. 1 RECTANGULAR AND CIRCULAR SHAPES ENTRY

The "Rectangular Shape" option opens the below left window, where you may enter the piece two dimensions *(height and width)*.

The "Circular Shape" option opens the below right window, where you may enter the radius of the circle which will be created.
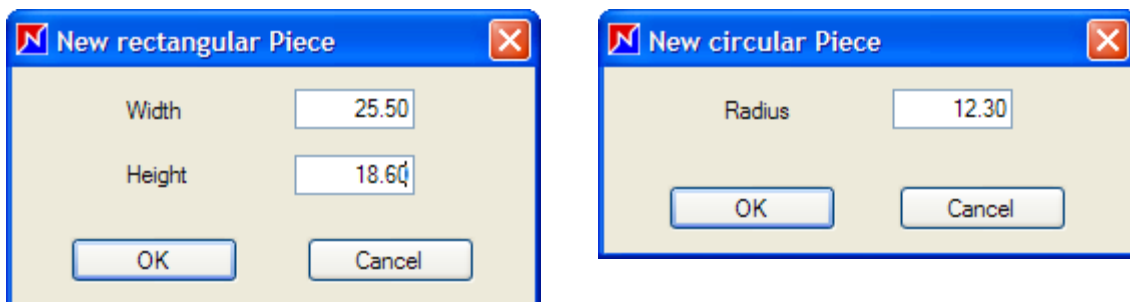

Upon entry, circles will be defined with the polylines to polygons conversion parameter of the "Tools \ Options \ General" Menu.

IV. 2 POLYGONAL SHAPES ENTRY

The "Other Shape" option opens the "Polygon Edit" window, common to both new polygonal shapes entry, and existing polygonal shapes modification.

This window will allow you to define a polygon vertex by vertex, either by its coordinates or by its relative position to the previous vertex, and to insert, delete, or move any vertex.
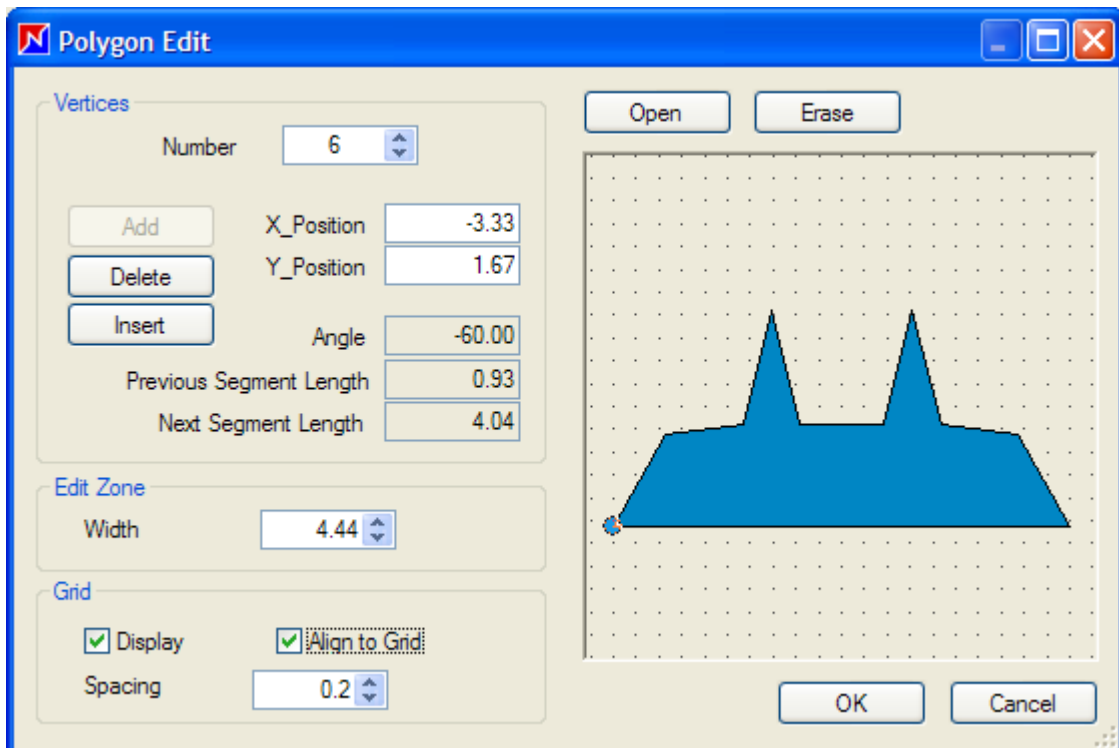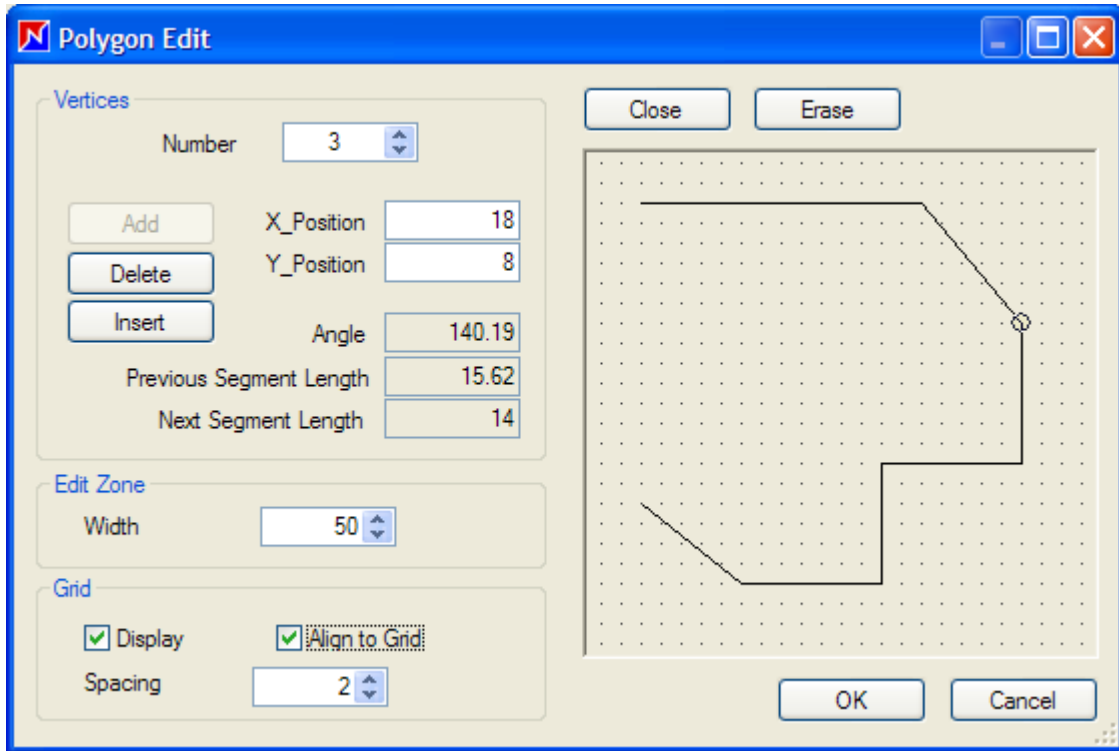
V. PIECES INDIVIDUAL PARAMETERS

To each **OptiNest II** piece are attached the following individual characteristics :

- **Reference** allows the piece follow up along the production process.

- **Quantity** defines the total number or identical pieces to be nested.

- **Rotation parameter** defines rotation rights among 4 possibilities.

- **Reversal parameter** specifies whether the piece can change face
  (Reversal is done around a vertical axis).

- **Color** facilitates pieces visual classification by category.

Default parameters defined upon DXF import may be changed.
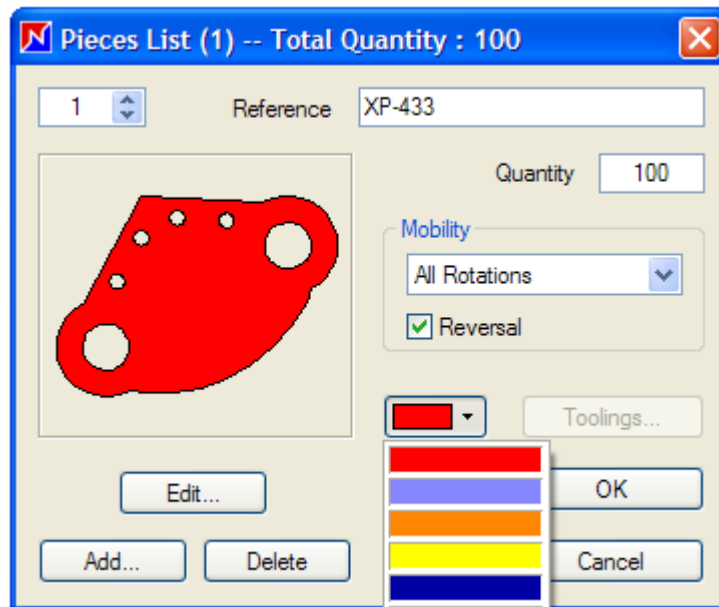
Piece color selection
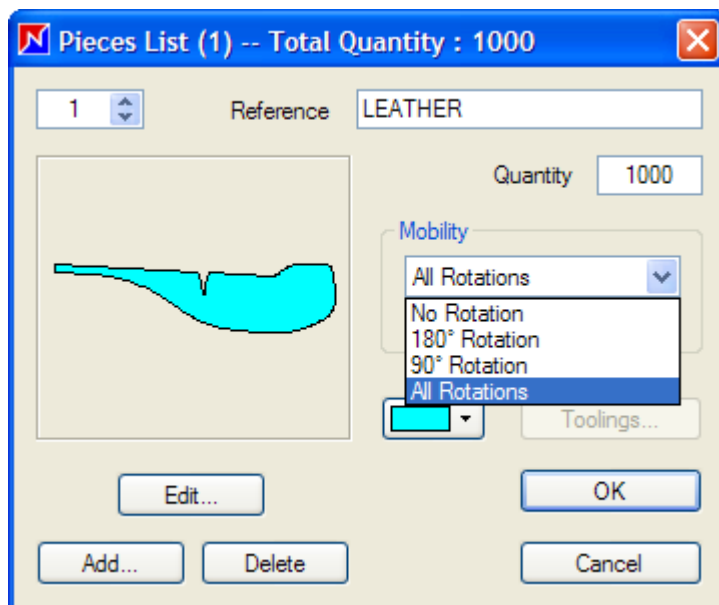
Rotation parameter selection

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VI. PANEL STOCKS FOLLOW UP

OptiNest II is both multi-stocks and multi-formats :

- "**Multi-Stocks**" : It handles simultaneously several panel stocks.

- "**Multi-Formats**" :Each panel stock includes one or several formats.

The "Stock \ Panels Stocks" Menu " opens the following window, which displays all available panel stocks, and for each stock, the number of formats and panels.

A right click on a panel stock displays a contextual menu allowing to edit, delate, rename, or duplicate this stock.
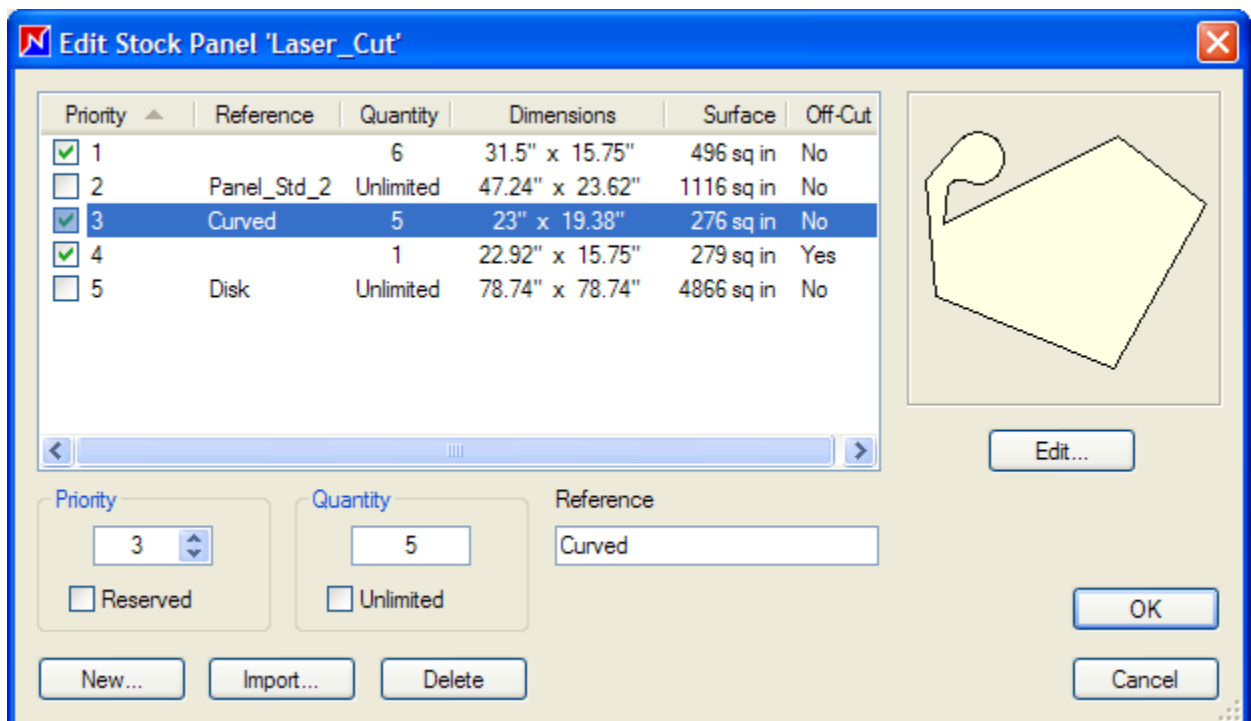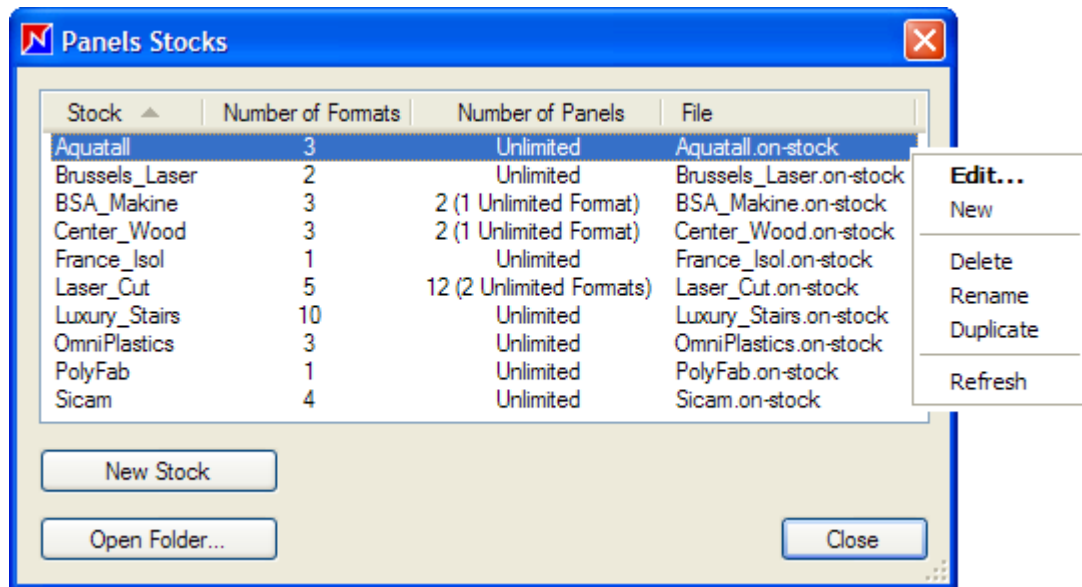

Panels may have any shape described by a DXF polyline

Off Cuts recovery

The "Stock" Menu "**Edit Panels**" and "**Deduct Panels**" Commands *(which may also be launched from the corresponding icon)*, apply to the **current stock**, as defined in the optimization parameters.

When the "**Recover Off Cuts**" option is activated, the panels deduction will first deduct used panels from the current stock, then it will add to it all recoverable off-cuts as defined by the below criteria *("Tools \ Options \ General" Menu)* :
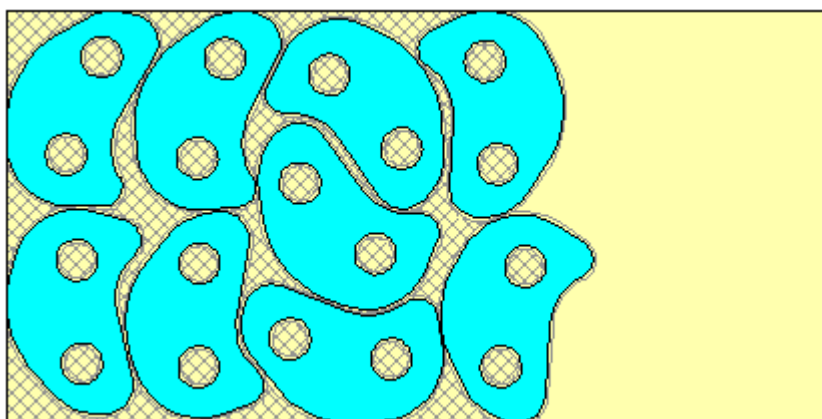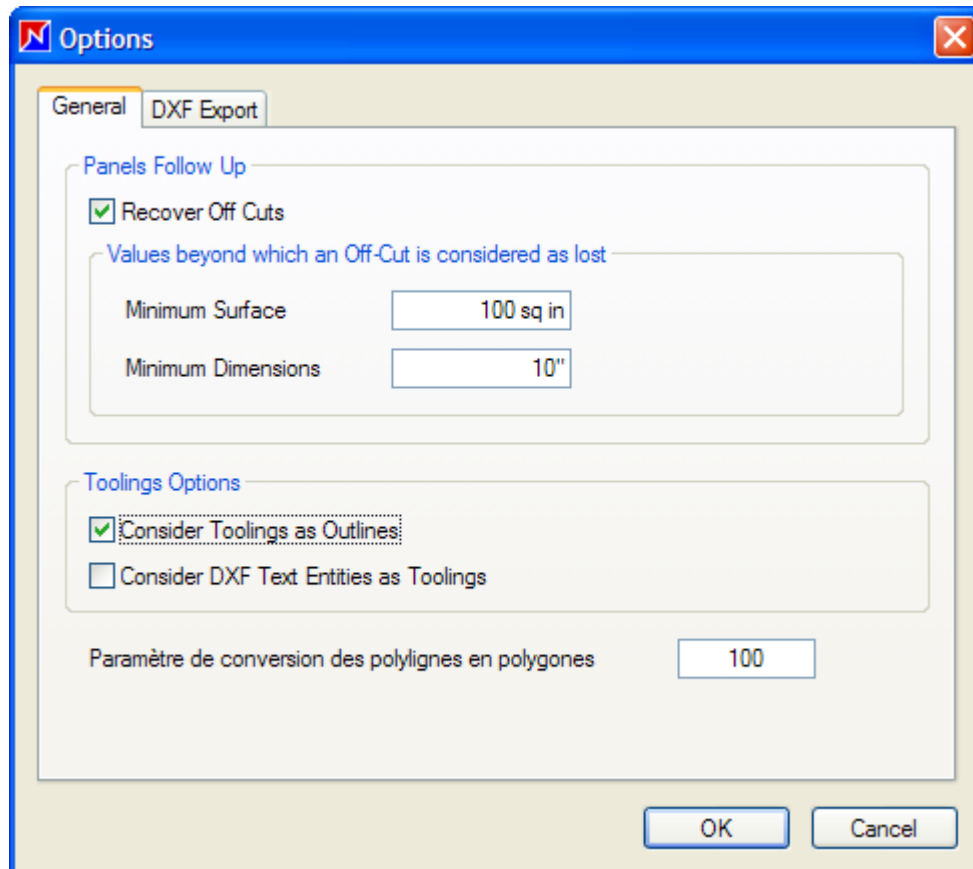

Unrecovered off-cuts are displayed in grey

VII. NESTING RESULTS

After each nesting optimization, **OptiNest II** generates several results displayed in the below window, which may be opened either through the "Optimization \ Result" Menu, or directly from the corresponding icon.

This window includes four indexes, associated to the corresponding results categories :
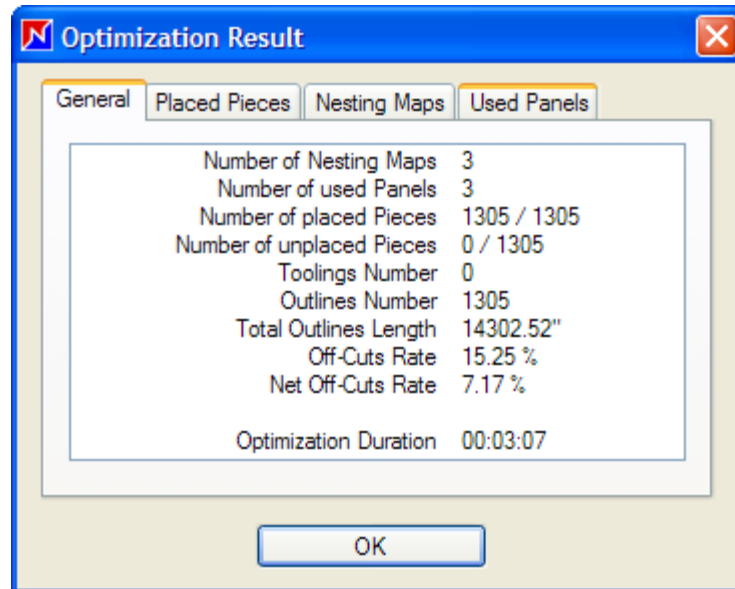

The "General" index displays the main nesting global results, and controls quickly whether all the nesting list pieces have been positionned.
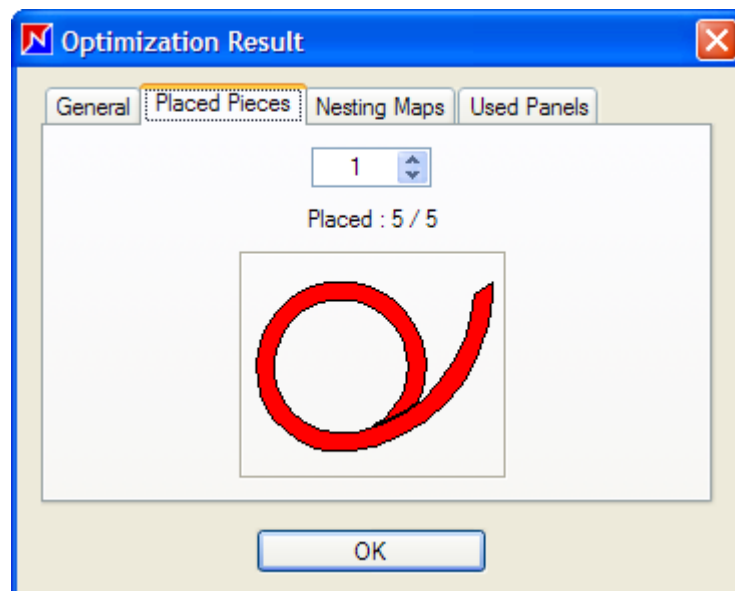
The "Placed Pieces" index displays graphically all the nesting list pieces, files them off one by one, and checks whether the requested quantity has been positioned.

The"Nesting Maps" index recapitulates each nesting map main parameters.

When a nesting map contains tooled pieces, the outlines and toolings quantities, as well as the corresponding perimeters, will be counted according to the options defined in the "Nesting maps DXF export" chapter.
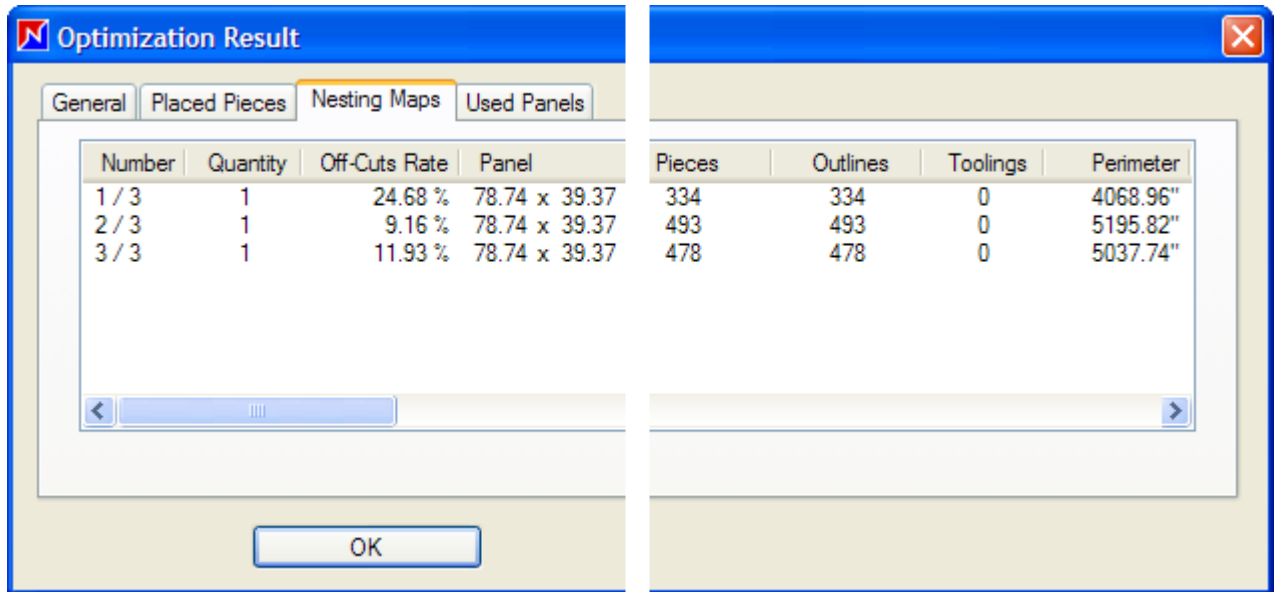
The "Used Panels" index displays the panels sum up used for this nesting, and indicates for each reference whether it correspond to a new panel, or to an off-cut recovered from a previous nesting optimization.