Tutorial 04: 2½D Design Using Boolean Operators on Closed Polygon Lists (CPL)

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Complete List of all Tutorials with Publishable MATLAB Files of this Solid-Geoemtries Toolbox

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Motivation for this tutorial: (Originally SolidGeometry 1.6 required)

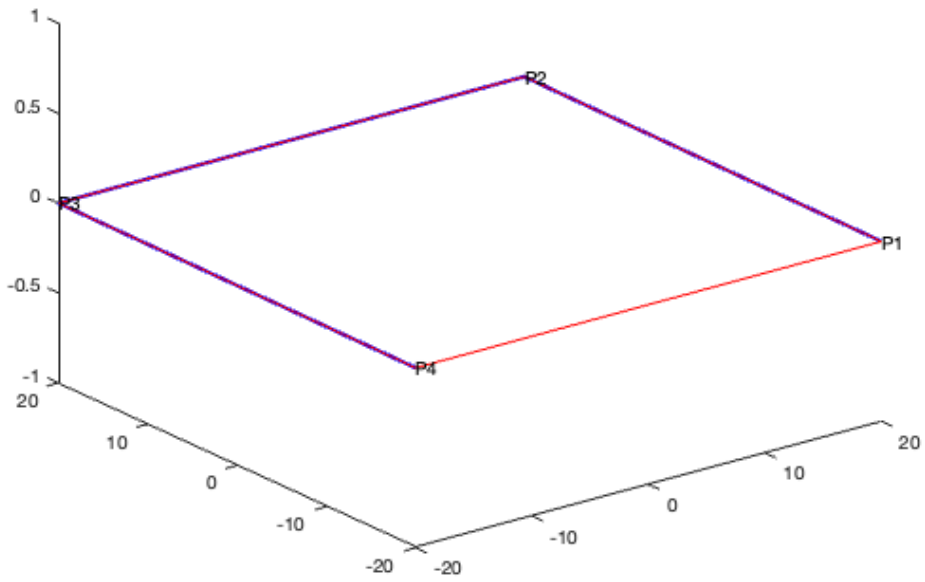
2. Moving and rotating point lists (PL) and closed polygon lists (CPL)

By using point lists (PL) and closed polybool lists (CPL) it is very convinient to design 2.5D objects. Here we see a first example to design a simple square by three function:

At the beginning we just plot simple point lists or closed polygon lists

- **PLplot** plots the point list as open contour
- **CPLplot** plots the point list as closed contour
- **textVL** plots descriptors at the points

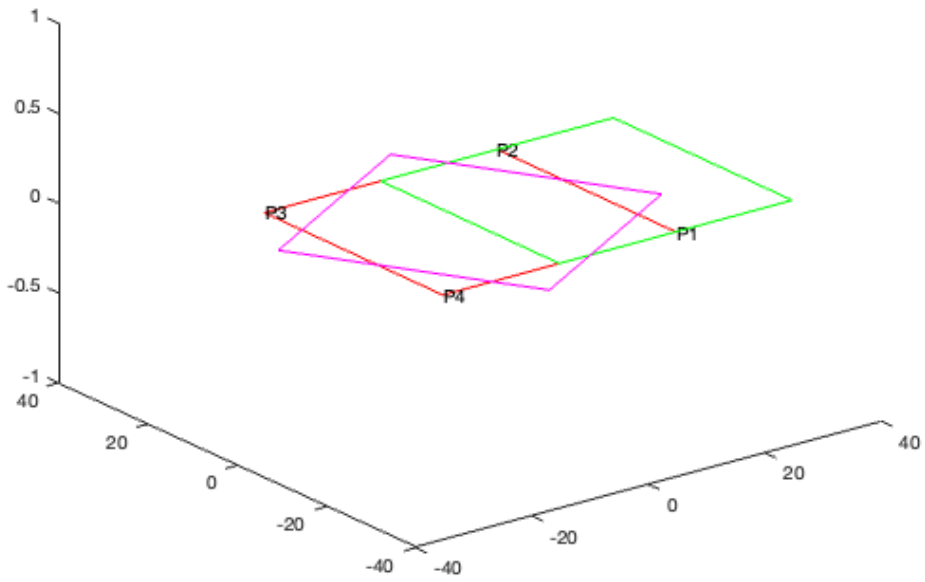
```
close all;
PLA=PLcircle(20*sqrt(2),4);             % Generate a circle with 4 point, i.e. square
PLplot(PLA,'b',2);                      % Plots the points in blue
CPLplot(PLA,'r');                       % Plots the closed polygon in red
textVL (PLA);                           % Plots point descriptors
```



Next we move the square and rotate the square

- **PLtransP** moves a point list (PL) or closed polygon list(CPL)
- **PLtransR** rotates a point list (PL) or closed polygon list(CPL)

```
close all;
CPLplot(PLA,'r');                       % Plots the closed polygon in red
textVL (PLA);                           % Plots point descriptors
CPLplot(PLtransP(PLA,[20  0]),'g');     % Plot the moved polygon in green
CPLplot(PLtransR(PLA,rot(pi/6)),'m');   % Plot the rotated polygon in magenta
```



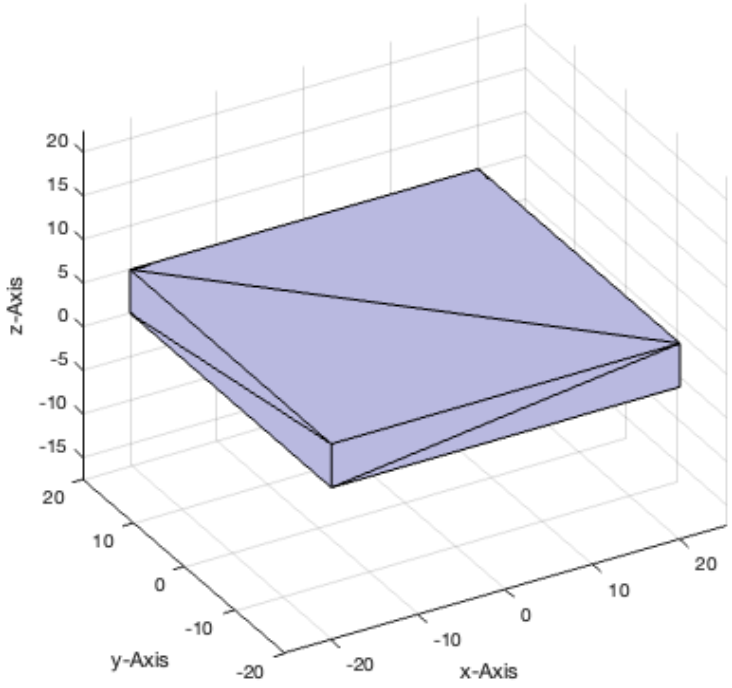
3. Simple extrusion of point lists (PL/CPL) to design 2½D solids

Next we extrude the square in 3D

- **VLFLofCPLz** extrudes point list (PL) or closed polygon list(CPL) in z

```
close all
[VL,FL]=VLFLofCPLz (PLA,5);
VLFLplot (VL,FL,'w'), axis equal, view(-30,30);
```

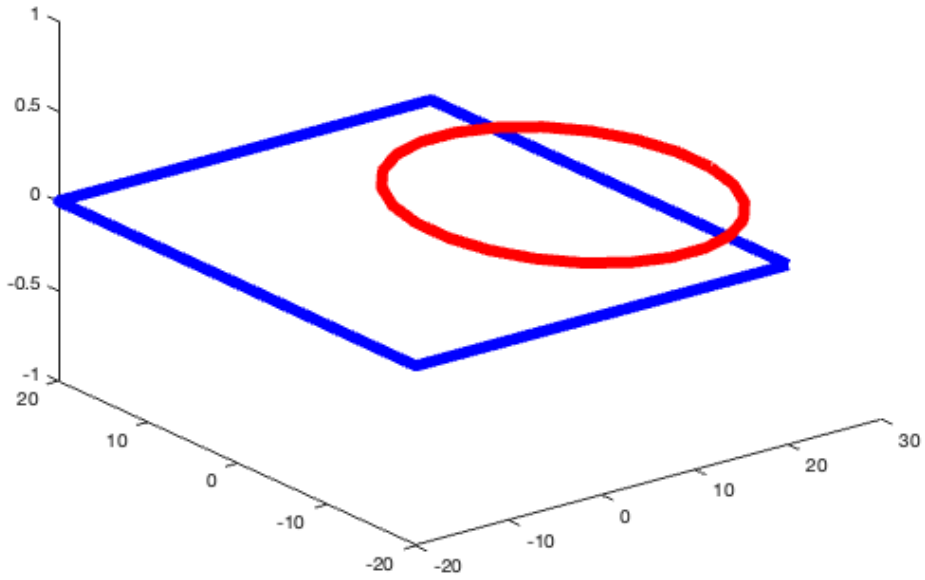
```
ans =
  Patch with properties:

    FaceColor: 'flat'
    FaceAlpha: 1
    EdgeColor: [0 0 0]
    LineStyle: '-'
        Faces: [12×3 double]
     Vertices: [8×3 double]

  Use GET to show all properties
```



4. Simple Design of 2½D solids by boolean operators for point lists (PL/CPL)

In this example we start with two point list, a square and an octaedron

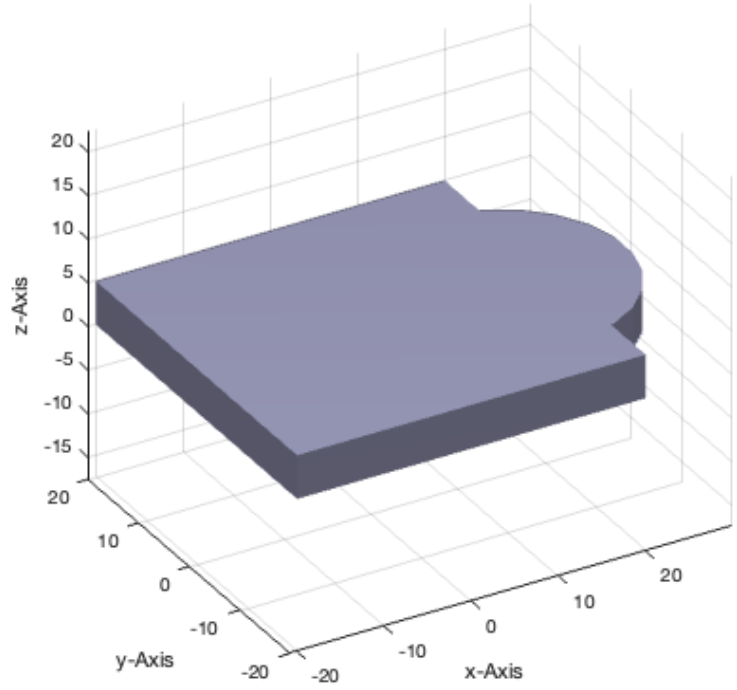
```
close all;
PLA=PLcircle(20*sqrt(2),4);
PLB=PLcircle(10*sqrt(2),24);  PLB=PLtransP(PLB,[15 0]);
CPLplot(PLA,'b',6); CPLplot(PLB,'r',6);
```



5. Unite both contours and extrusion: CPL=CPLpolybool('or',PLA,PLB)

```
close all
CPL=CPLpolybool('or',PLA,PLB); [VL,FL]=VLFLofCPLz(CPL,5);
VLFLplot (VL,FL,'w'), axis equal, view(-30,30); VLFLplotlight (1);
VLFLwriteSTL (VL,FL,'A','EXP04-unite')
```

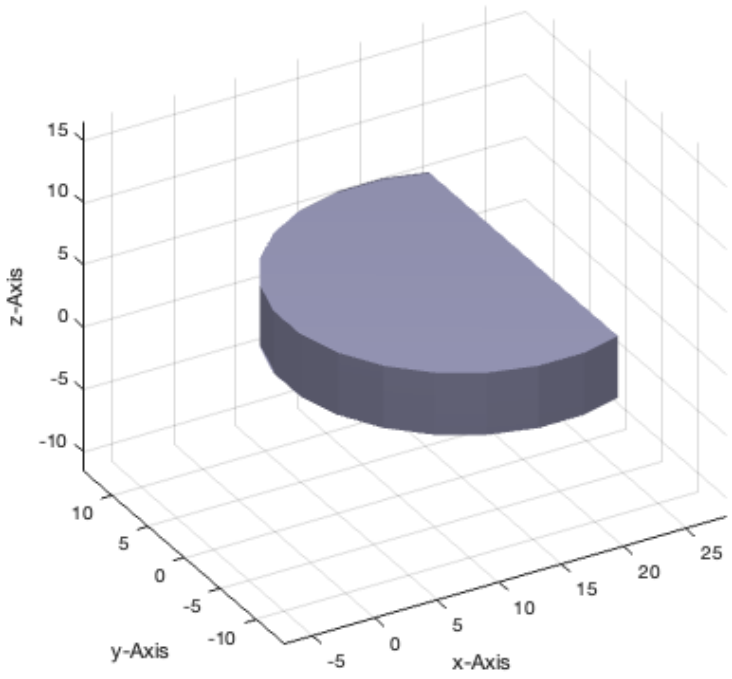
```
ans =
  Patch with properties:

    FaceColor: 'flat'
    FaceAlpha: 1
    EdgeColor: [0 0 0]
    LineStyle: '-'
        Faces: [60×3 double]
     Vertices: [32×3 double]

  Use GET to show all properties
WRITING STL FILE /Users/timlueth/Desktop/A.STL in ASCII MODE
completed.
```



6. Intersect both contours: CPL=CPLpolybool('and',PLA,PLB)

```
close all
CPL=CPLpolybool('and',PLA,PLB); [VL,FL]=VLFLofCPLz(CPL,5);
VLFLplot (VL,FL,'w'), axis equal, view(-30,30); VLFLplotlight (1);
VLFLwriteSTL (VL,FL,'A','EXP04-intersect')
```

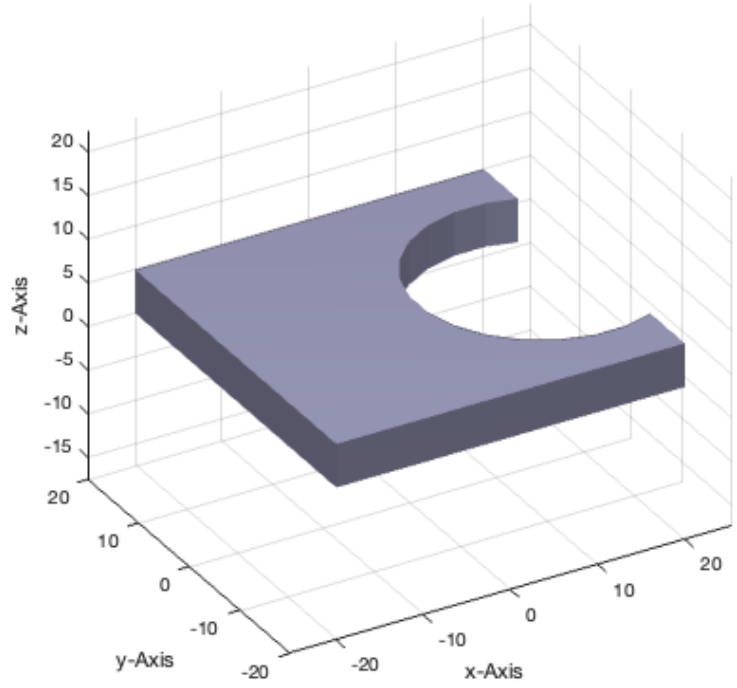
```
ans =
  Patch with properties:

    FaceColor: 'flat'
    FaceAlpha: 1
    EdgeColor: [0 0 0]
    LineStyle: '-'
        Faces: [60×3 double]
     Vertices: [32×3 double]

  Use GET to show all properties
WRITING STL FILE /Users/timlueth/Desktop/A.STL in ASCII MODE
completed.
```



7. Substract contour B from A: CPL=CPLpolybool('-',PLA,PLB)

```
close all
CPL=CPLpolybool('-',PLA,PLB); [VL,FL]=VLFLofCPLz(CPL,5);
VLFLplot (VL,FL,'w'), axis equal, view(-30,30); VLFLplotlight (1);
VLFLwriteSTL (VL,FL,'A','EXP04-AminusB')
```

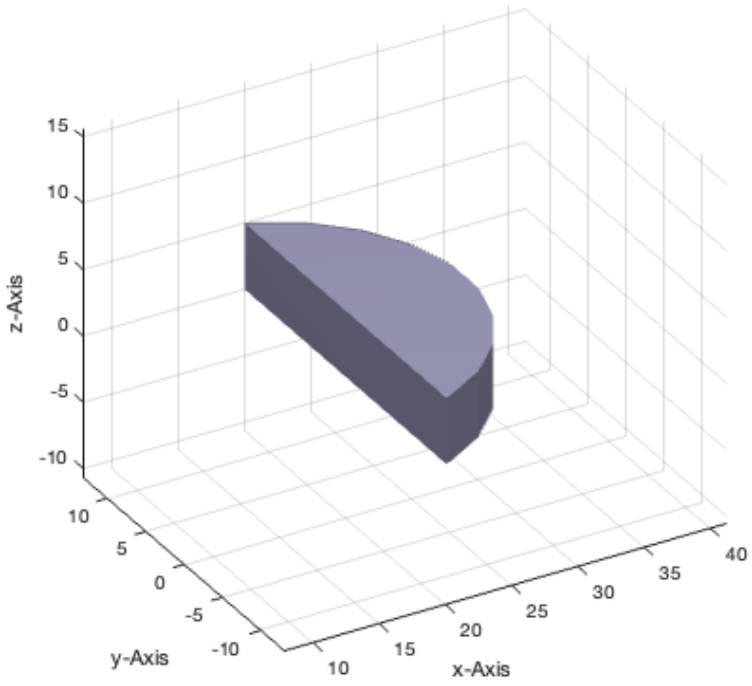
```
ans =
  Patch with properties:

    FaceColor: 'flat'
    FaceAlpha: 1
    EdgeColor: [0 0 0]
    LineStyle: '-'
        Faces: [76×3 double]
     Vertices: [40×3 double]

  Use GET to show all properties
WRITING STL FILE /Users/timlueth/Desktop/A.STL in ASCII MODE
completed.
```



8. Substract contour A from B: CPL=CPLpolybool('-',PLB,PLA)

```
close all
CPL=CPLpolybool('-',PLB,PLA); [VL,FL]=VLFLofCPLz(CPL,5);
VLFLplot (VL,FL,'w'), axis equal, view(-30,30); VLFLplotlight (1);
VLFLwriteSTL (VL,FL,'EXP04-AminusB')
```

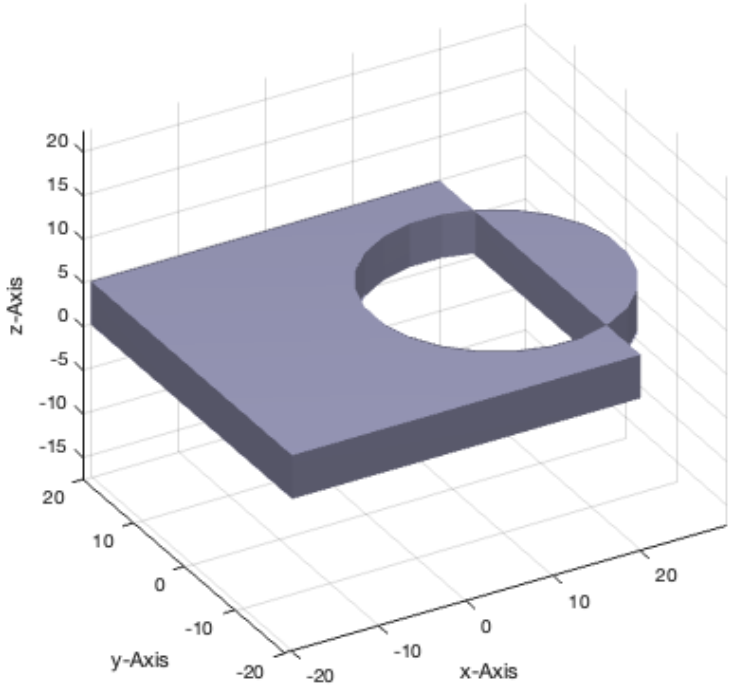
```
ans =
  Patch with properties:

    FaceColor: 'flat'
    FaceAlpha: 1
    EdgeColor: [0 0 0]
    LineStyle: '-'
        Faces: [44×3 double]
     Vertices: [24×3 double]

  Use GET to show all properties
WRITING STL FILE /Users/timlueth/Desktop/EXP04-AminusB.STL in ASCII MODE
completed.
```



9. Exclusive or of contour A and B: CPLpolybool('xor',PLB,PLA)

```
close all
CPL=CPLpolybool('xor',PLB,PLA); [VL,FL]=VLFLofCPLz(CPL,5);
VLFLplot (VL,FL,'w'), axis equal, view(-30,30); VLFLplotlight (1);
VLFLwriteSTL (VL,FL,'EXP04-AxorB')
% VLFLviewer(VL,FL);
```

```
ans =
  Patch with properties:

    FaceColor: 'flat'
    FaceAlpha: 1
    EdgeColor: [0 0 0]
    LineStyle: '-'
        Faces: [120×3 double]
     Vertices: [60×3 double]

  Use GET to show all properties
WRITING STL FILE /Users/timlueth/Desktop/EXP04-AxorB.STL in ASCII MODE
completed.
```



10. Checking the solid volumes for 3D printing

During the last extrusion we got a warning from a Delaunay-triangulation during the extrusion function VLFLofCPLz. This is typically a warning that somehow the final part cannot be printed with a 3D printing process such as FDM,SLS,3DP etc. Here in this case, the result of xor were two parts that touch each other at two edges. Such a part cannot be printed. The reason behind is called non-manifold edge problem. There are also problems with non manifold points and non-manifold facets.

```
VLFLchecker (VL,FL);
```

```
VLFLchecker: 60 vertices and 120 facets.
    0 FACET PROBLEMS DETECTED (ERRORS)
    0 VERTEX PROBLEMS DETECTED (OBSOLETE WARNING)
    4 EDGE PROBLEMS DETECTED (NON MANIFOLD WARNING)
    0 SOLID/EDGE PROBLEMS DETECTED (OPEN SOLID WARNING)
```

Final remarks on toolbox version and execution date

```
VLFLlicense
```

```
This VLFL-Lib, Rel.  (2023-Oct-03), is for limited non commercial educational use only!
Licensee: Tim Lueth (Development Version)!
Please contact Tim Lueth, Professor at TU Munich, Germany!
WARNING: This VLFL-Lib (Rel. ) license will exceed at 06-Jul-2078 07:10:40!
Executed 03-Oct-2023 07:10:42 by 'timlueth' on a MACI64 using Mac OSX 13.6 | R2023a Update 5 | SG-Lib 5.4
======================================== Used Matlab products: ========================================
database_toolbox
distrib_computing_toolbox
fixed_point_toolbox
image_toolbox
map_toolbox
matlab
```

```
optimization_toolbox
pde_toolbox
phased_array_system_toolbox
signal_blocks
signal_toolbox
simmechanics
simscape
simulink
statistics_toolbox
==========================================================================================================
```

- *Tim Lueth, tested and compiled on OSX 10.7.5 with Matlab 2014b on 2014-11-21*
- *Mattias Traeger, executed and published on 64 Bit PC using Windows with Matlab 2014b on 2014-11-21*

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