Exercise 10: Packaging of Sets of Solid Geometries (SG)

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1. Summary of the already explained aspects of the VLFL-Toolbox

In examples 1-9 we've learned about:

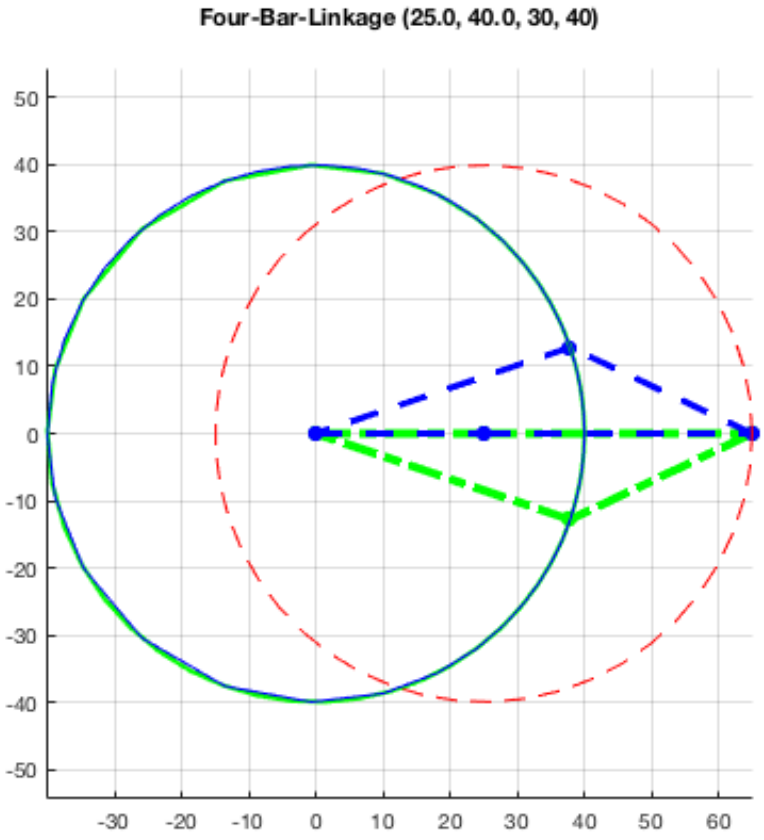
- *Point lists* (PL), *Vertex lists* (VL), *Facet lists* (VL), *Edge lists* (EL)
- Functions to import, check, and export of *STL-File* data
- Functions for generating text strings as solid volumes
- *Closed polygon lists* (CPL) for boolesche operations of contours
- 2.5D extrusion of closed polyogon list (CPL) to *Solid Geometries* (SG)
- Spatial transformation and merging of solid geometry sets
- Relative positioning of solids geometries and Boolean operations on Solids

2. The four-bar-linkage kit as example for a set of multiple solids

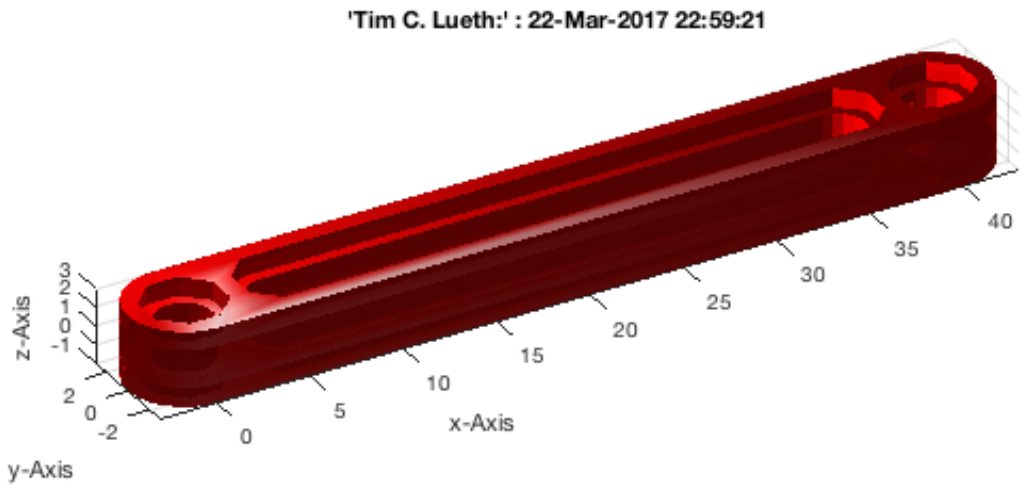
A very interesting mechanism in mechanics is the four-bar-linkage. It consists of four bars that are linked together by 4 rotatorial joints. Such a mechanism can be built by 4 different elememts

1. Bar: The basic mechanic link
2. Bolt: A simple bolt that allows rotation
3. Shaft: A simple shaft that transfer torque
4. Spacer: A simple element that is required to achieve parallel bars

```
close all;
fourBarLinkage (25,40,30,40);
```




```
fourBarLinkageKit ('Bar',40);
```

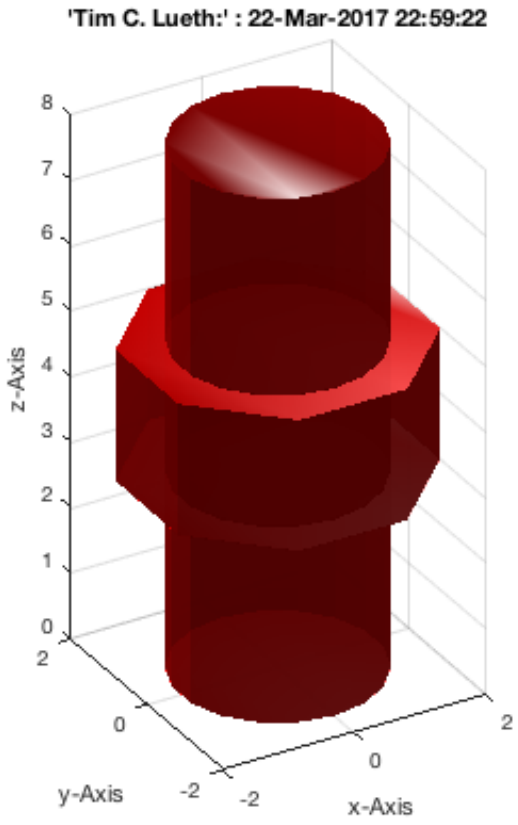



```
fourBarLinkageKit ('Bolt');
```

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```
fourBarLinkageKit ('Shaft');
```




```
fourBarLinkageKit ('Spacer');
```

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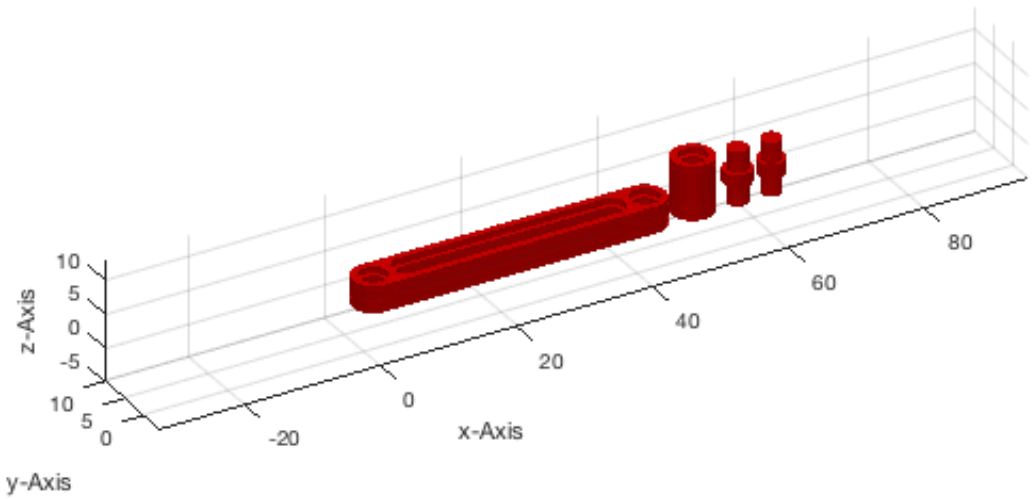
3. Packaging a set of solid geometries in a volume

For a four-bar-linkage we need 4 bars and 4 bolts and may be 2 spacer and 2 shafts. For this purpose there is one function

- **SGpacking** arranges several solid geometries side by side in a volume

```
close all;
A=fourBarLinkageKit ('Bar',40);
B=fourBarLinkageKit ('Bolt');
C=fourBarLinkageKit ('Shaft');
D=fourBarLinkageKit ('Spacer');
SG=SGpacking({A,B,C,D});
SGplot(SG); view (-30,30); VLFLplotlight (1,0.9); zoompatch;
```

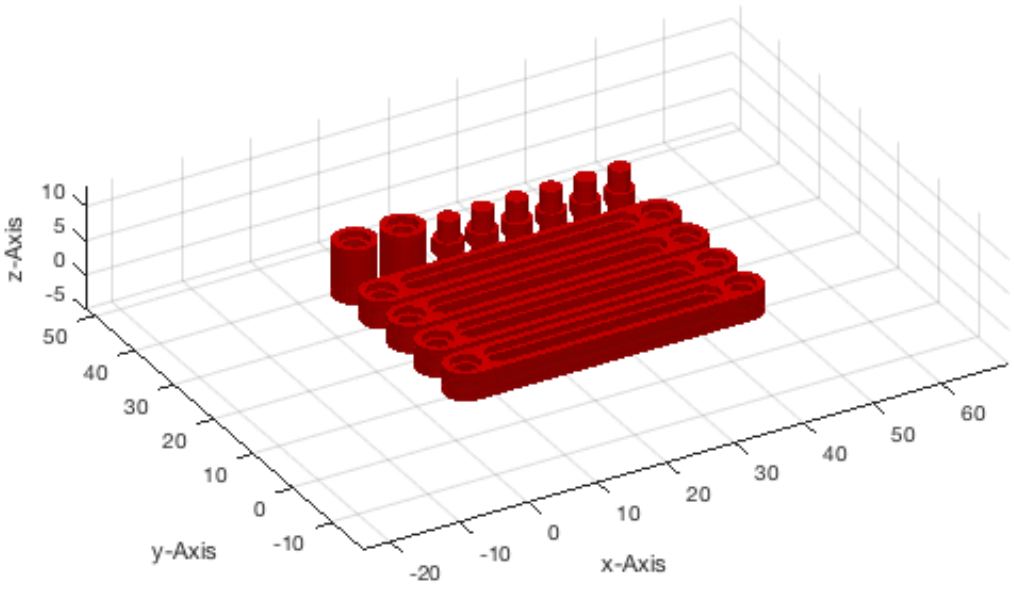
```
Packing 4 objects (h=23):
```



Similar it is possible to pack several objects of the same kind into the volume and also to define the dimensions of the packing volume. Typically the z-coordiante of the volume specification is unlimited or much bigger than the xy-coordinats.

```
close all;
SG=SGpacking({A,A,A,A,B,B,B,B,C,C,D,D},[50,50,1000]);
SGplot(SG); view (-30,30); VLFLplotlight (1,0.9); zoompatch;
```

```
Packing 12 objects (h=43):
```



4. Using container/collections insted of itemizing the solids

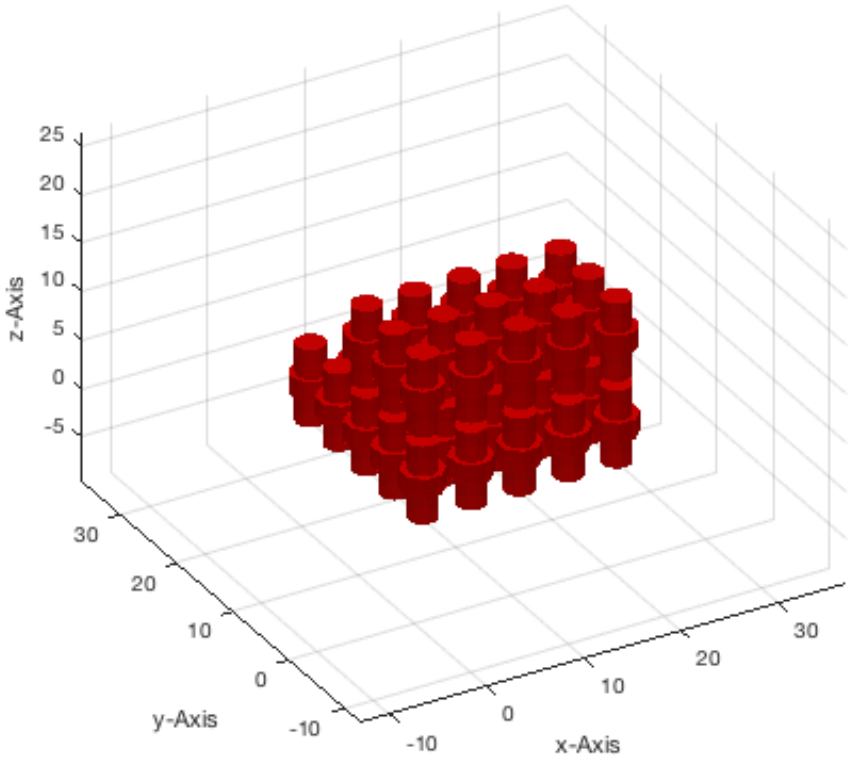
In many cases we are not interested to list the items in the source code but to create a structure containing all objects we want to pack later Therefor, we need a data structure that allows to collect several solids into something like a container. This can be done by the following functions:

- **SGCaddSG** Add a single solid geometry to a collection
- **SGCaddSGn** Add multiple copies of a single solid geometry to a collection

```
close all
SGC=[];                                              % Create a Solid Geometry Collection
SGC=SGCaddSGn(SGC,fourBarLinkageKit ('Bolt'),20);    % Add 20 bolt to the container
SGC=SGCaddSGn(SGC,fourBarLinkageKit ('Shaft'),20);   % Add 20 shafts to the container

SG=SGpacking(SGC,[30, 30 ,1000]);                    % SGpacking accepts also SGC structs
SGplot(SG); view (-30,30); VLFLplotlight (1,0.9); zoompatch;
```

```
Packing 40 objects (h=38): ....................
```

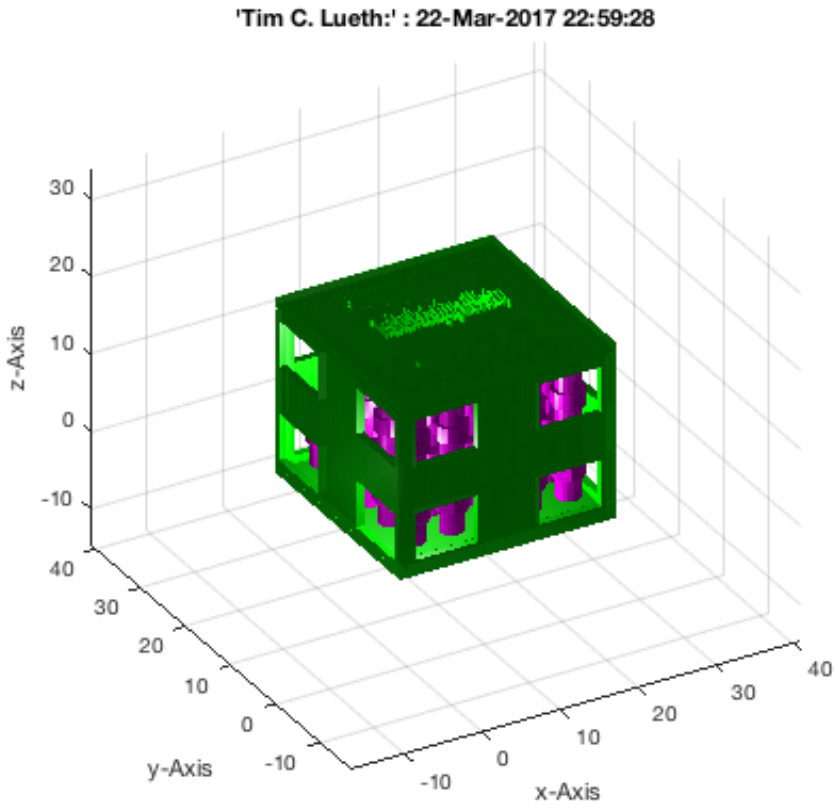


5. Create boxes around the packed solids for the final 3D print job

To handle the print job in a convinient way, it makes sense to create a box around the parts and also to write on top of the cover the content or the intended use of the box plus may by a date.

```
close all;
SGboxing(SG,[],[],'.\nTest for Packaging and Boxing\n.');
view (-30,30); VLFLplotlight (1,0.9); zoompatch;
```

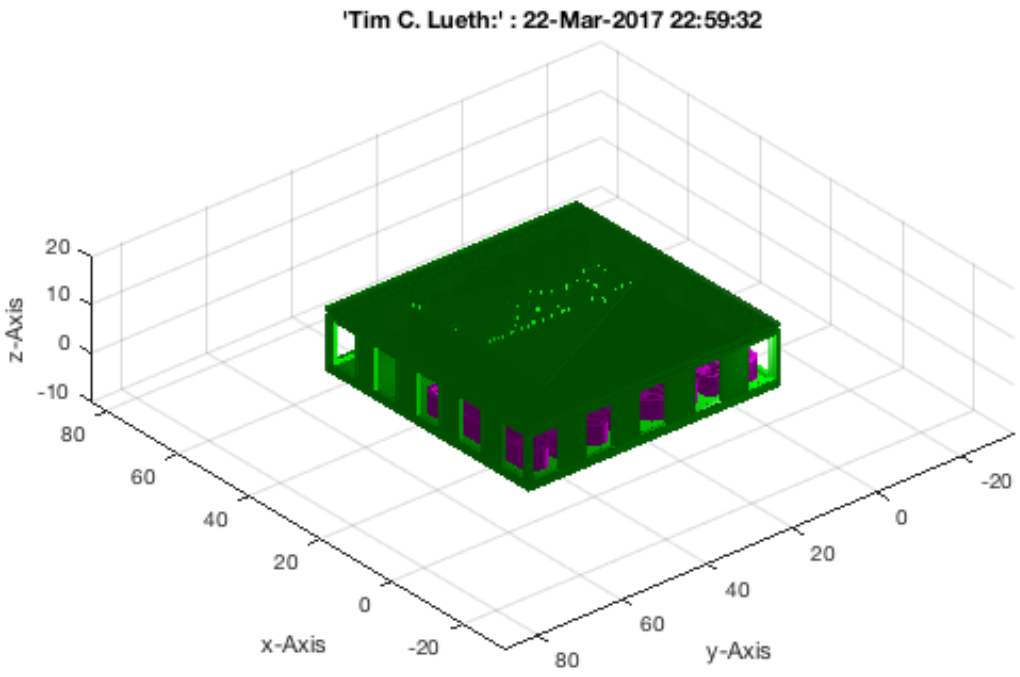
```
==>TEXT GENERATION..Analyze union areas for 60 facets:
Major union vectors: 6 found with maximum size of 1757.
Finally 2 union areas found with size > 100
Text attached to union Nr: 2
..finished!
```



6. Create the four-bar-linkage kit as print job

```
close all;
SGC=[];
SGC=SGCaddSGn(SGC,fourBarLinkageKit ('Bar',25),2);
SGC=SGCaddSGn(SGC,fourBarLinkageKit ('Bar',35),2);
SGC=SGCaddSGn(SGC,fourBarLinkageKit ('Bar',40),4);
SGC=SGCaddSGn(SGC,fourBarLinkageKit ('Bolt'),4);
SGC=SGCaddSGn(SGC,fourBarLinkageKit ('Shaft'),4);
SGC=SGCaddSGn(SGC,fourBarLinkageKit ('Spacer'),4);
SGA=SGpacking(SGC,[55, 60 ,100]);
SGB=SGboxing(SGA,[],[],'.\nTim Lueth''s Linkage Kit\n.');
VLFLfigure(SGA); SGplot(SGB,'g');
SG=SGcat(SGA,SGB); view (-130,30); VLFLplotlight (1,0.9); zoompatch;
SGwriteSTL(SG,'EXP10: Four-Bar-Linkage-Kit');
```

```
Packing 20 objects (h=57): ....................
==>TEXT GENERATION..Analyze union areas for 60 facets:
4 Dimension warnings
Major union vectors: 6 found with maximum size of 7157.
Finally 22 union areas found with size > 100
Text attached to union Nr: 2
..finished!
1000..2000..3000..4000..5000..6000..7000..8000..9000..10000..11000..12000..
```



Final remarks on toolbox version and execution date

```
VLFLlicense
```

```
This VLFL-Lib, Rel. 3.6 (2017-Mar-23), is for limited non commercial educational use only!
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======================================== Used Matlab products: ============================
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map_toolbox
matlab
simmechanics
simscape
simulink
================================================================================================
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```

- *Tim Lueth, tested and compiled on OSX 10.7.5 with Matlab 2014b on 2015-06-08*
- *Christina Friedrich, executed and published on 64 Bit PC using Windows with Matlab 2015a on 2015-06-17*

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