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

2015-08-06: Tim C. Lueth, MIMED - Technische Universität München, Germany (URL: http://www.mimed.de) - Last Change: 2017-07-07

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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 2.4 required)

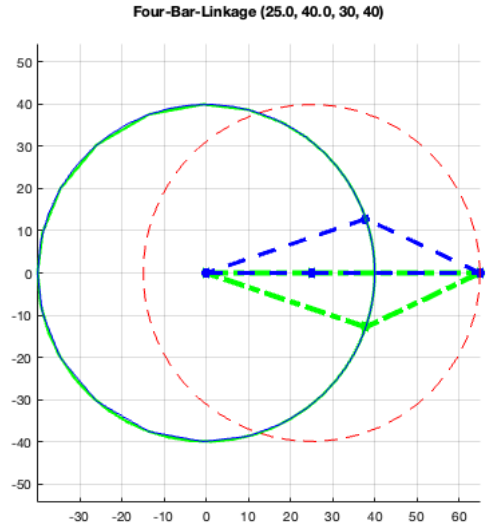
2. The four-bar-linkage kit as example for a set of multiple solids

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

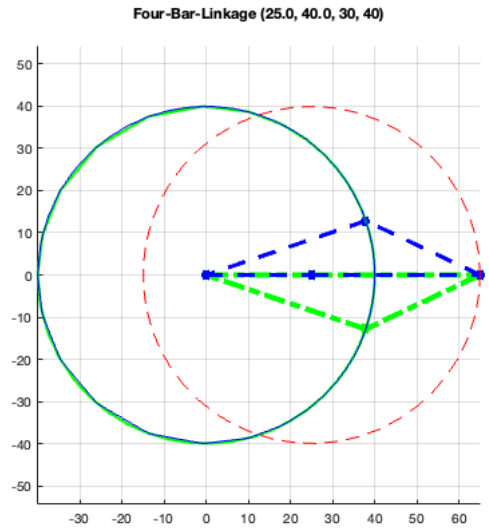
```
close all;
```

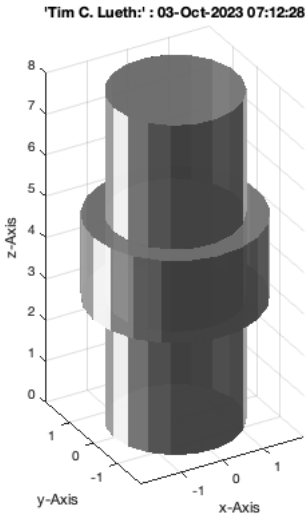
```
fourBarLinkage (25,40,30,40);
```



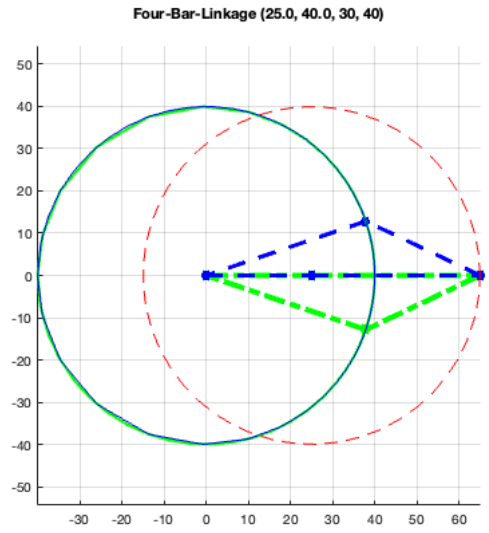

```
fourBarLinkageKit ('Bar',40);
```

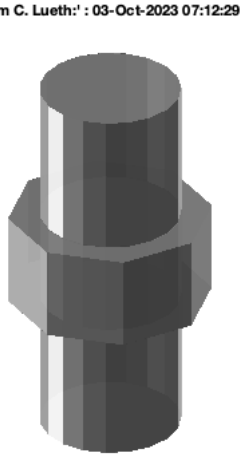

```
fourBarLinkageKit ('Bolt');
```



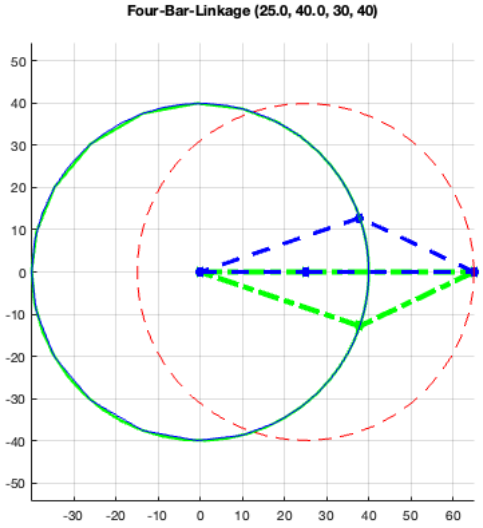


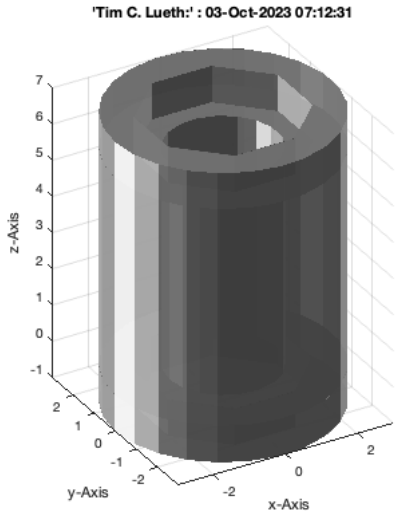

```
fourBarLinkageKit ('Shaft');
```






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





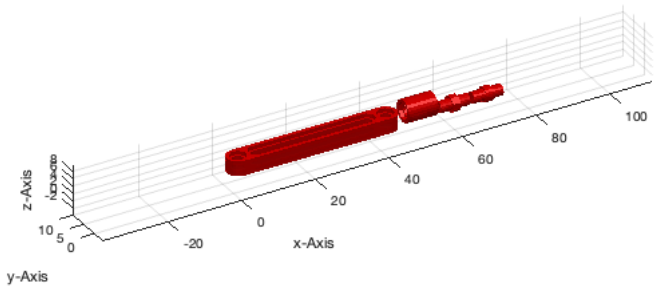
3. Packaging a set of solid geometries in a volume

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;
```

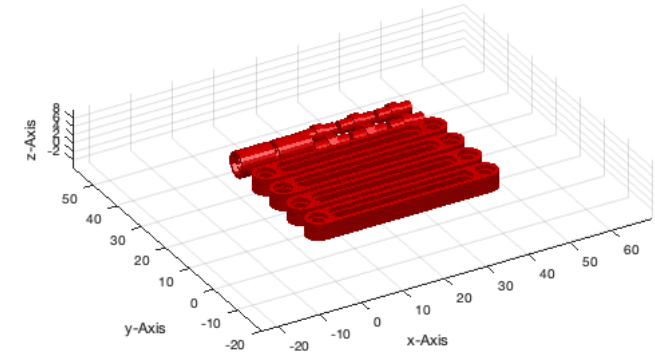
```
binpacking3D: Packing 4 objects (h=24):
```



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;
```

```
binpacking3D: Packing 12 objects (h=45):
```



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:

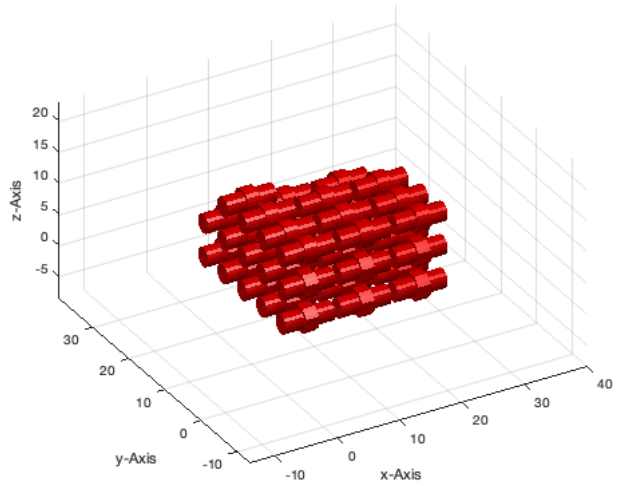
- **SGCaddSG** Add a single solid geometry to a collection
- **SGCaddSGn** Add multiple copies of a single solid geometry to a collection

```
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;
```

```
binpacking3D: Packing 40 objects (h=48):
........................
```

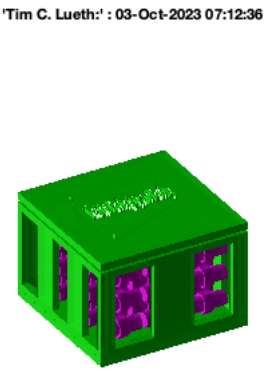


5. Create boxes around the packed solids for the final 3D print job

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;
```

```
VLFLtextattachVLUL: Text ".
Test for Packaging and Boxing
." attached to union Nr: 2
```

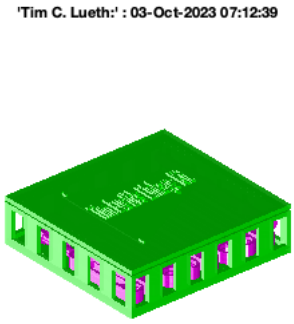


6. Create the four-bar-linkage kit as print job

```
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');
```

```
binpacking3D: Packing 20 objects (h=58):
...................VLFLtextattachVLUL: Text ".
Tim Lueth's Linkage Kit
." attached to union Nr: 2
publishSGPDF:<a href = "matlab: openbydoubleclick ('/Users/timlueth/Desktop')">/Users/timlueth/Desktop/</a><a href = "matlab: openbydoubleclick ('/User
```



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 07:12:40!
Executed 03-Oct-2023 07:12:42 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 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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