

Tutorial 79: Design of gear boxes with planar circular gears

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

The following topics are covered and explained in the specific tutorials:

- Tutorial 01: First Steps Using the VLFL-Toolbox for Solid Object Design
- Tutorial 02: Using the VLFL-Toolbox for STL-File Export and Import
- Tutorial 03: Closed 2D Contours and Boolean Operations in 2D
- Tutorial 04: 2½D Design Using Boolean Operators on Closed Polygon Lists (CPL)
- Tutorial 05: Creation, Relative Positioning and Merging of Solid Geometries (SG)
- Tutorial 06: Relative Positioning and Alignment of Solid Geometries (SG)
- Tutorial 07: Rotation of Closed Polygon Lists for Solid Geometry Design
- Tutorial 08: Slicing, Closing, Cutting and Separation of Solid Geometries
- Tutorial 09: Boolean Operations with Solid Geometries
- Tutorial 10: Packaging of Sets of Solid Geometries (SG)
- Tutorial 11: Attaching Coordinates Frames to Create Kinematik Models
- Tutorial 12: Define Robot Kinematics and Detect Collisions
- Tutorial 13: Mounting Faces and Conversion of Blocks into Lightweight-structures
- Tutorial 14: Manipulation Functions for Closed Polygons and Laser Cutting (SVG)
- Tutorial 15: Create a Solid by 2 Closed Polygons
- Tutorial 16: Create Tube-Style Solids by Succeeding Polygons
- Tutorial 17: Filling and Bending of Polygons and Solids
- Tutorial 18: Analyzing and modifying STL files from CSG modeler (Catia)
- Tutorial 19: Creating drawing templates and dimensioning from polygon lines
- Tutorial 20: Programmatically Interface to SimMechanics Multi-Body Toolbox
- Tutorial 21: Programmatically Convert Joints into Drives (SimMechanics)
- Tutorial 22: Adding Simulink Signals to Record Frame Movements
- Tutorial 23: Automatic Creation of a Missing Link and 3D Print of a Complete Model
- Tutorial 24: Automatic Creation of a Joint Limitations
- Tutorial 25: Automatic Creation of Video Titels, Endtitels and Textpages
- Tutorial 26: Create Mechanisms using Universal Planar Links
- Tutorial 27: Fourbar-Linkage: 2 Pose Syntheses and Linkage Export for 3D Printing
- Tutorial 28: Fourbar-Linkage: 3 Pose Syntheses and Linkage Export for 3D Printing
- Tutorial 29: Create a multi body simulation using several mass points
- Tutorial 30: Creating graphical drawings using point, lines, surfaces, frames etc.
- Tutorial 31: Importing 3D Medical DICOM Image Data and converting into 3D Solids
- Tutorial 32: Exchanging Data with a FileMaker Database
- Tutorial 33: Using a Round-Robin realtime multi-tasking system
- Tutorial 34: 2D Projection Images and Camera Coordinate System Reconstruction
- Tutorial 35: Creation of Kinematic Chains and Robot Structures
- Tutorial 36: Creating a Patient-Individual Arm-Skin Protector-Shell
- Tutorial 37: Dimensioning of STL Files and Surface Data
- Tutorial 38: Some more solid geometry modelling function

- Tutorial 39: HEBO Modules robot design
- Tutorial 40: JACO Robot Simulation and Control
- Tutorial 41: Inserting Blades, Cuts and Joints into Solid Geometries
- Tutorial 42: Performing FEM Stress and Displacement Analysis and Structural Optimization of Solids
- Tutorial 43: Performing FEM Structural Optimization (CAO) and Topological Optimization (SKO) of Solids
- Tutorial 44: Creation of solids and kinematics from 3D curves and transformation matrices
- Tutorial 45: Creation of Solids using the SG-Coder - SGofCPLcommand
- Tutorial 46: Creating Fischertechnik compatible gear boxes using SGofCPLcommand
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- Tutorial 49: Generation of non circular gear pairs by Yannick Krieger/Sebastian Baumgartner
- Tutorial 50: Pose samples and fourbar design
- Tutorial 50: CVLof2CPLzcorrelate and SGof2CPLzcorrelate
- Tutorial 51: Creating Parallel Tasks for batch processing
- Tutorial 52: CPL Buffers and cw/ccw Orientation
- Tutorial 53: SKOL - Soft Kill Option for Large Displacement by Yilun Sun
- Tutorial 54: Automated Design of Precision Joints by Screws or Ball Bearings
- Tutorial 55: Automated Design of Manipulators with Screws or Ball Bearing
- Tutorial 56: Checking Functions for Solids
- Tutorial 57: Processing Stacks of Slices = CVLz
- Tutorial 58: Integrating joints into solids
- Tutorial 59: Integrating arbitrary joints into solids
- Tutorial 60: Facet generation for arbitrary contours in 3D space
- Tutorial 61: FeeTech Servo Toolbox
- Tutorial 62: Design of Monolithic Snake-like Manipulators
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- Tutorial 64: Relative spatial arrangement of CPL contours
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- Tutorial 69: Design of a 4Bar Linkage for a Hook Fixation
- Tutorial 70: Design of a 4Bar Linkage for a Walking Mechanisms
- Tutorial 71: Design of a 4Bar Linkage for a Walking Mechanisms
- Tutorial 72: Design of a 4Bar Linkage for a Hook block
- Tutorial 79: Design of gear boxes with planar circular gears

Motivation for this tutorial: (Originally SolidGeometry 5.4 required)

This tutorial shows how the gears can be designed from several gears connected in series or even stacked and driven by a motor

```
function VLFL_EXP79
```

Design of a gear with even or odd number of teeth using SGgearDINrot

The SGgearDINrot function generates not only the geometry of a gear, but also the coordinate systems to arrange subsequent gears accordingly. There is a baseframe "B" for the axis assembly as well as a followerframe "FG" for the moving tooth space and "FT" for the moving tooth

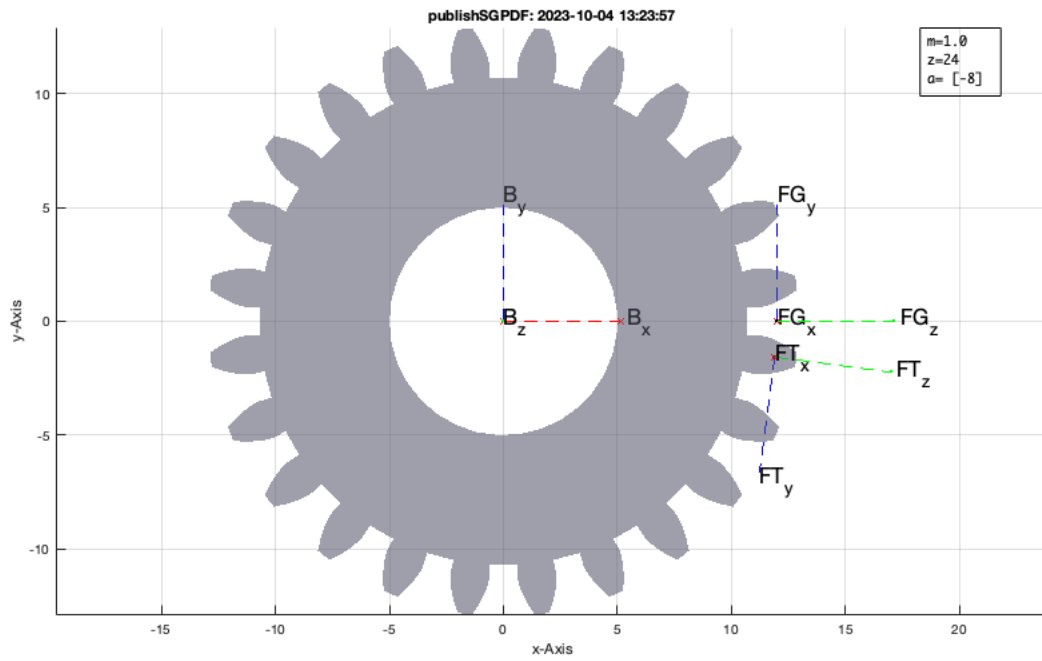
```
% SG,al]=SGgearDINrot([m,z,R,h,tig,al])
```

```
SGgearDINrot(1,24); SG=ans
```

SG =

```
struct with fields:

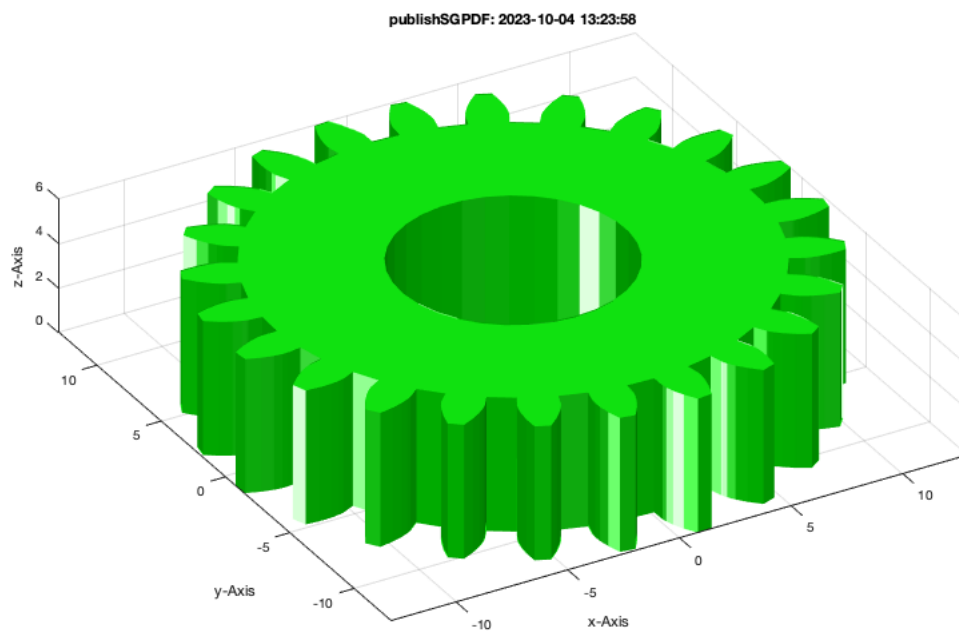
    VL: [738×3 double]
    FL: [1476×3 double]
    Tname: {'B' 'FG' 'FT'}
    T: {[4×4 double] [4×4 double] [4×4 double]}
    TFIL: {[ ] [ ] [ ]}
```



Rotating a gear (or any solid) in a figure using the SG-Lib

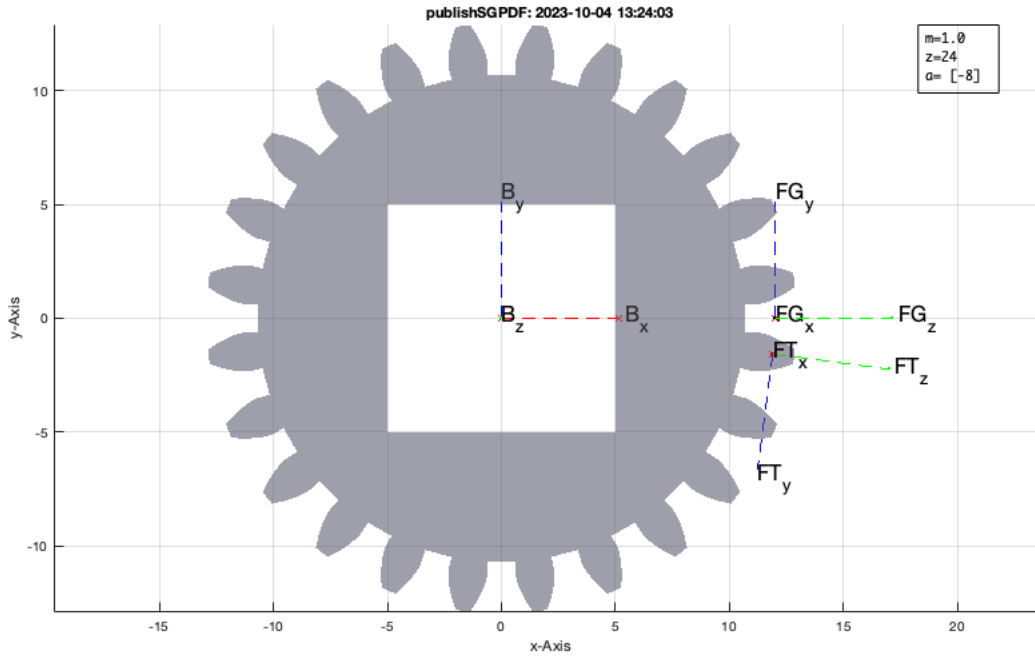
```

SGfigure(-30,30);
Videoquickanimatego('',{SGTplotalpha(SG,'g'),' ',0.1});
  
```



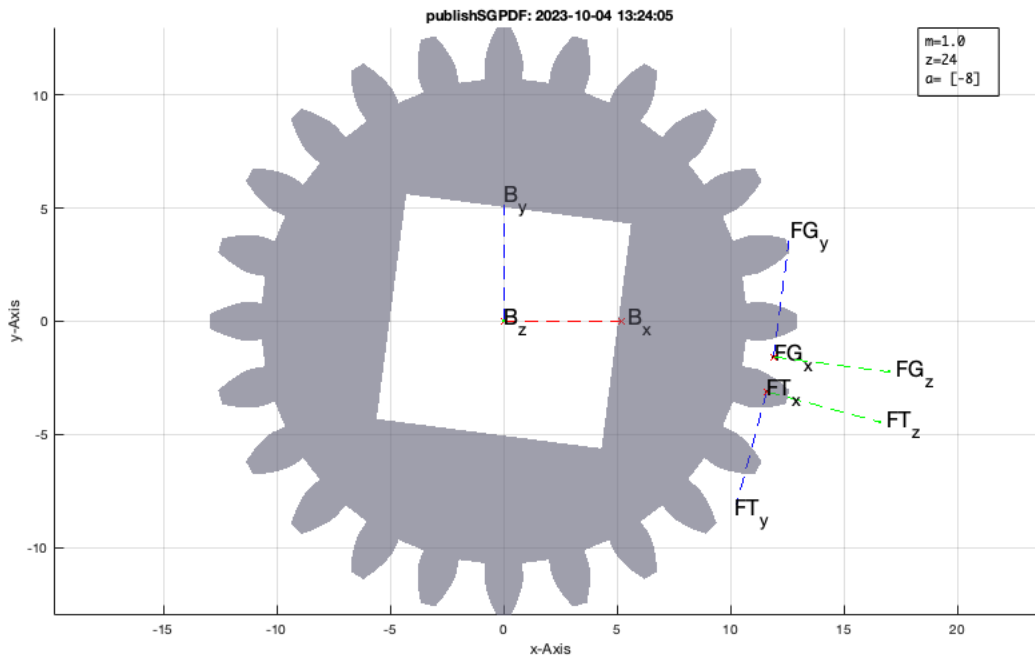
Creating a shaft axle

```
SGgearDINrot(1,24,PLsquare(10),6);
```

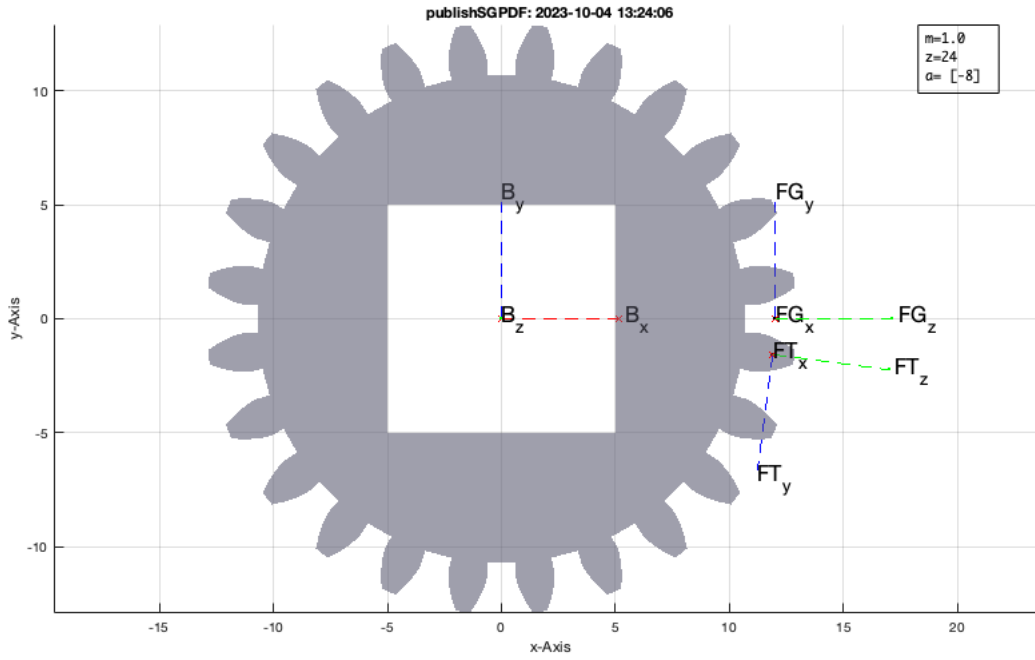


Changing Gap and Tooth similar to the old function SGgearDINrot

```
SGgearDINrot(1,24,PLsquare(10),6,true); % Tooth to the right
```

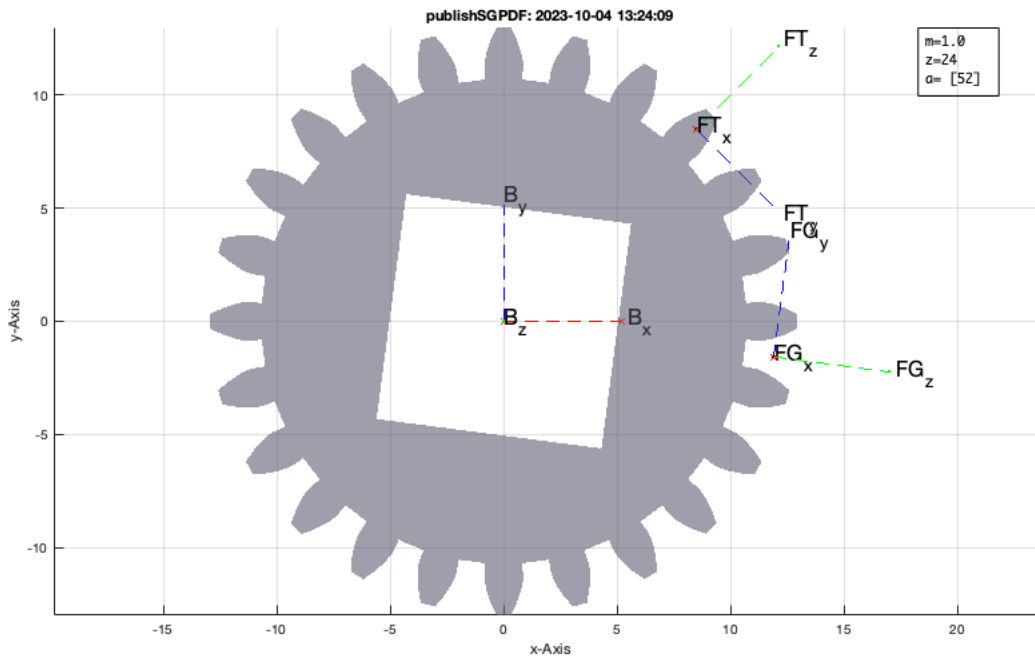


```
SGgearDINrot(1,24,PLsquare(10),6,false); % Gap to the right
```

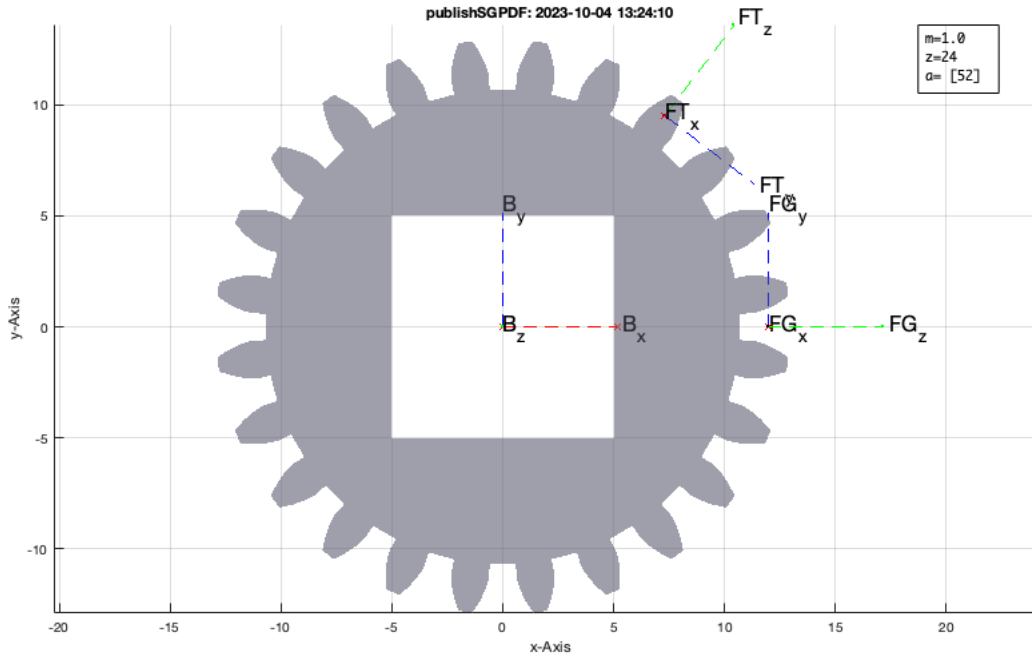


Creating Frames in to preplanned directions

```
SGgearDINrot(1,24,PLsquare(10),6,true,pi/3); % Tooth frame is 60 degree up (or as best a s possible)
```



```
SGgearDINrot(1,24,PLsquare(10),6,false,pi/3); % Tooth frame is 60 degree up (or as best a s possible)
```



Design Gear Chains or Boxes

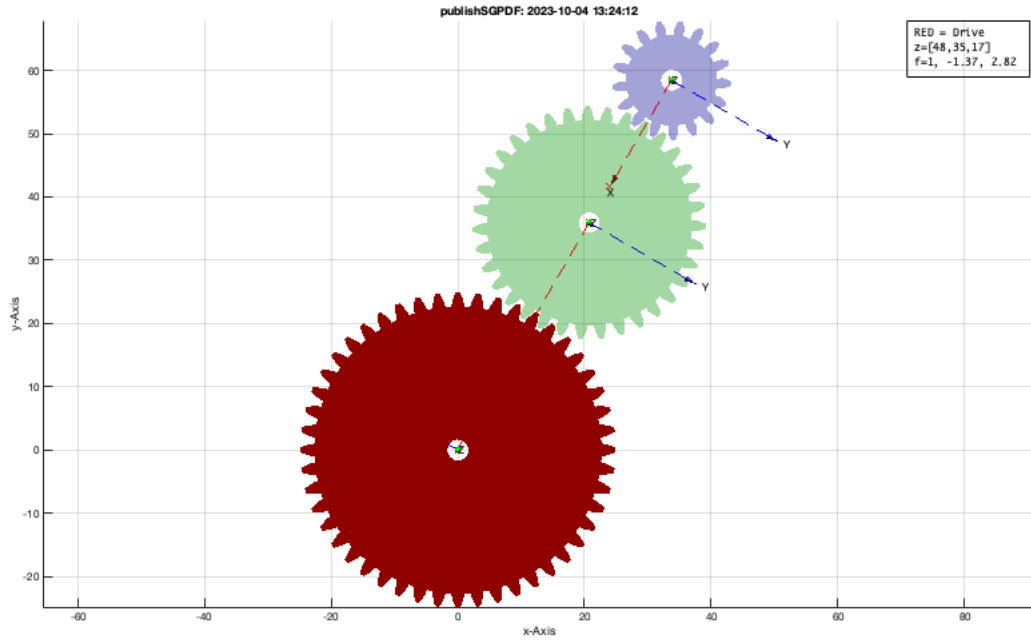
- The module is 1
- The height is 5mm
- The axis hole is 2.5mm
- There is no rack
- The tooth sequence is [48 35 17]
- The gears should follow in approximately straight line
- The last gear should be at an angle of 60 degrees to the first gear

```
SGgearchain([1 5 1.25 0],[48 35 17],0,pi/3);
```

```
SGgearchain: > SGgearchain([1 5 1.25 0],[48 35 17],0,1.05);
```

```
SGgearchain: Gear Ratio is [1.00,-1.37,2.82]
```

```
SGwriteMultipleSTL: Writing 3 STL files in <a href = "matlab: openbydoubleclick ('/Users/timlueth/Desktop/STLMult Gearchain')">/Users/timlueth/Desktop
```



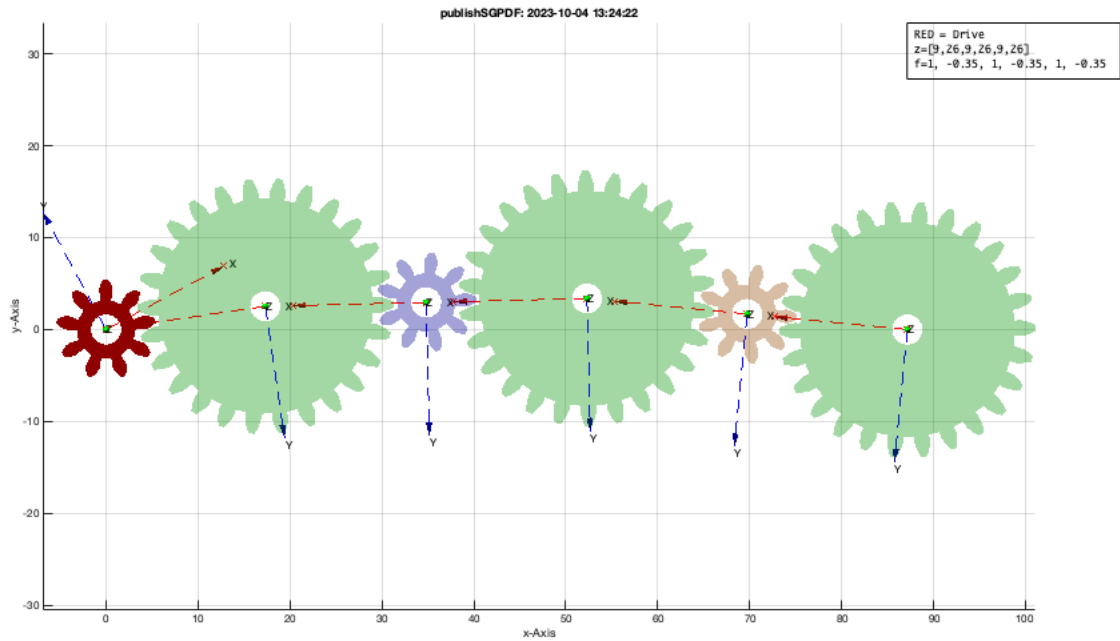
Design chained gear boxes

```
SGgearchain([1 5 1.25 0],[9 26 9 26 9 26],'',0);
```

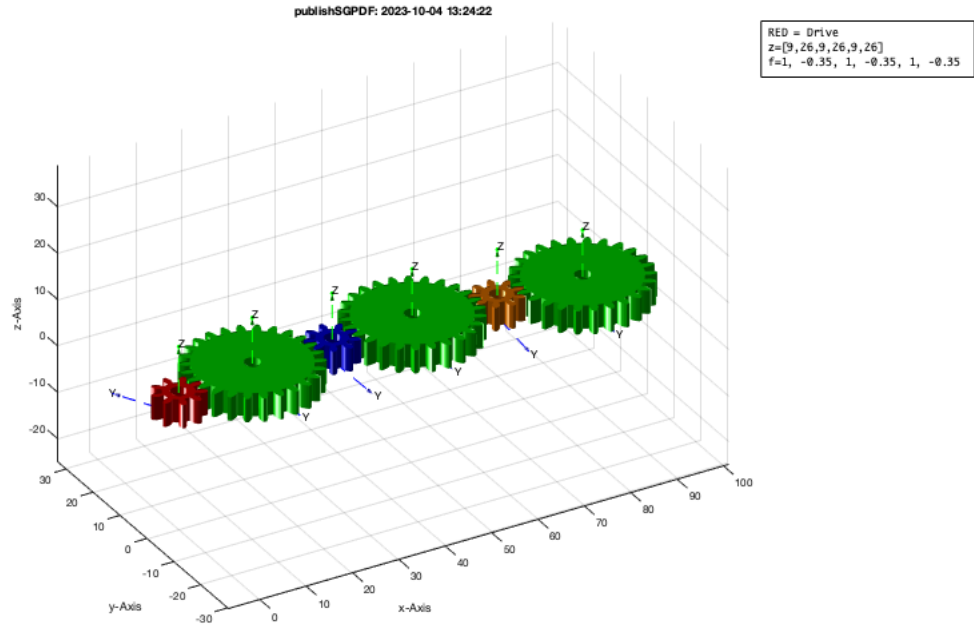
```
SGgearchain > SGgearchain([1 5 1.25 0],[9 26 9 26 9 26],0,0);
```

```
SGgearchain: Gear Ratio is [1.00,-0.35,1.00,-0.35,1.00,-0.35]
```

```
SGwriteMultipleSTL: Writing 6 STL files in <a href = "matlab: openbydoubleclick ('/Users/timlueth/Desktop/STLMult Gearchain')">/Users/timlueth/Desktop
```



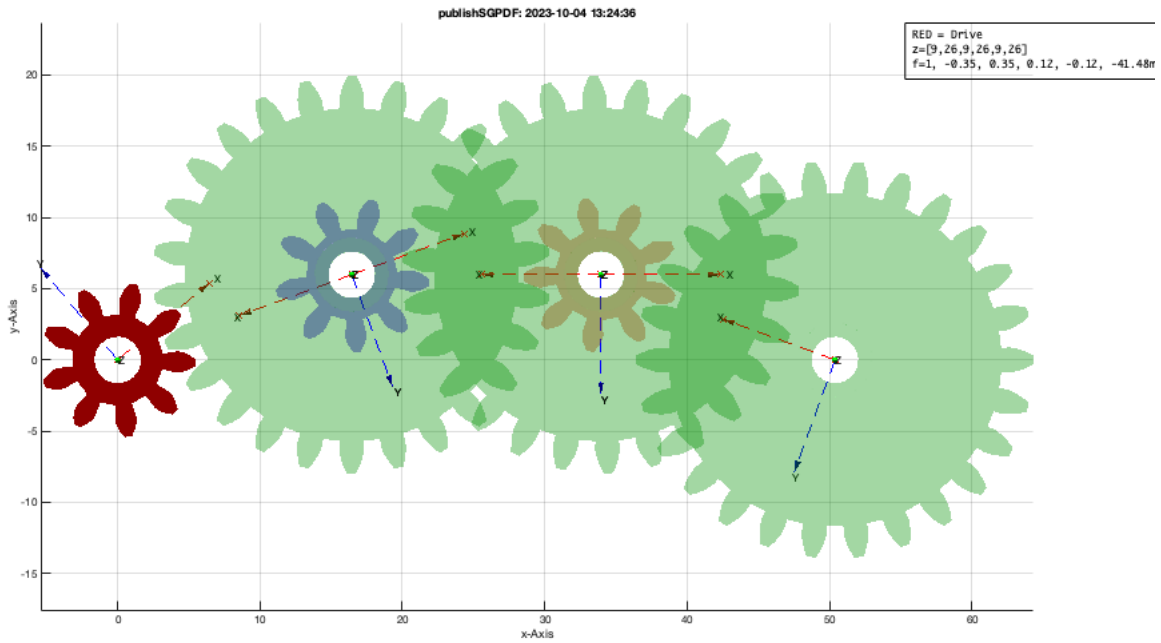
```
view(-30,30); VLFLplotlight(1,1)
```

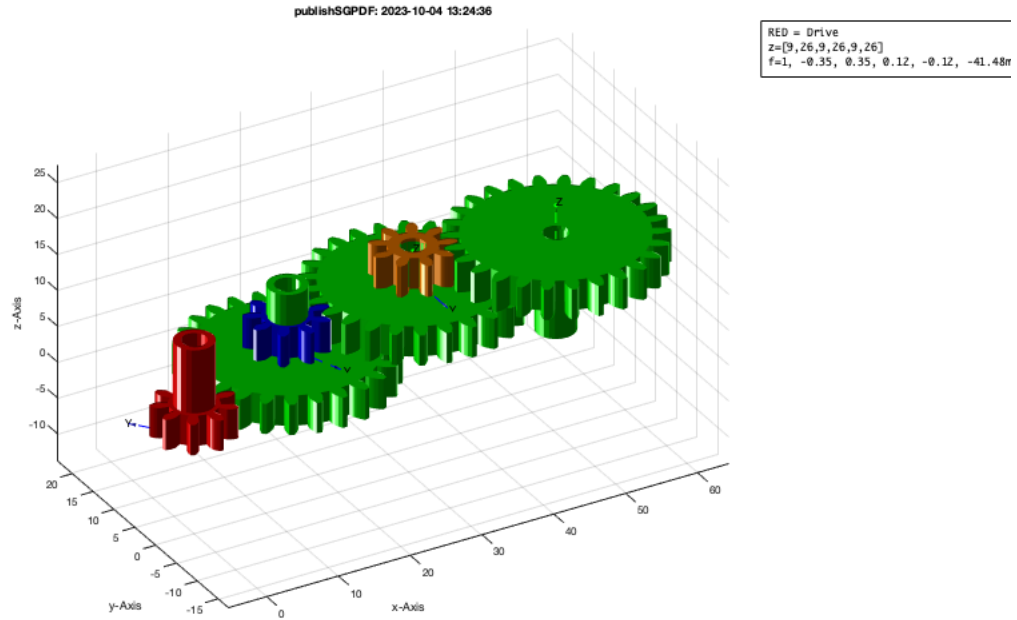
Design stacked gear boxes

```
SGgearchain([1 5 1.25 0],[9 26 9 26 9 26],'',0,'stack');
```

```
SGgearchain: > SGgearchain([1 5 1.25 0],[9 26 9 26 9 26],0,0,'stack');
SGgearchain: Gear Ratio is [1.00,-0.35,0.35,0.12,-0.12,-0.04]
SGwriteMultipleSTL: Writing 4 STL files in <a href = "matlab: openbydoubleclick ('/Users/timlueth/Desktop/STLMult Gearchain')">/Users/timlueth/Desktop
```



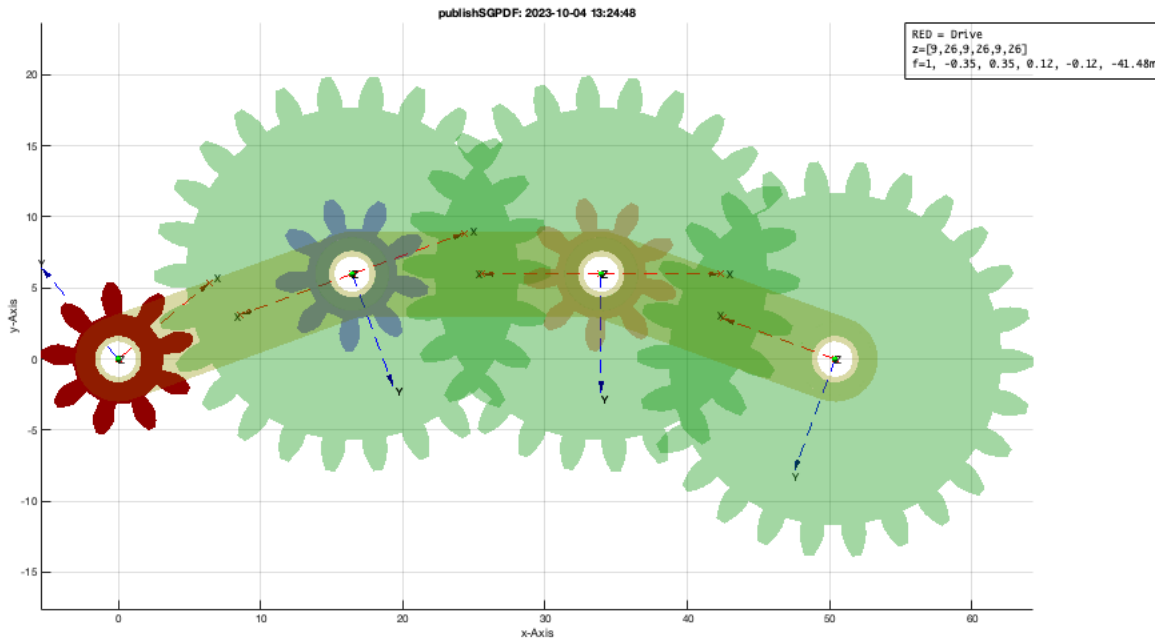
```
view(-30,30); VLFLplotlight(1,1)
```



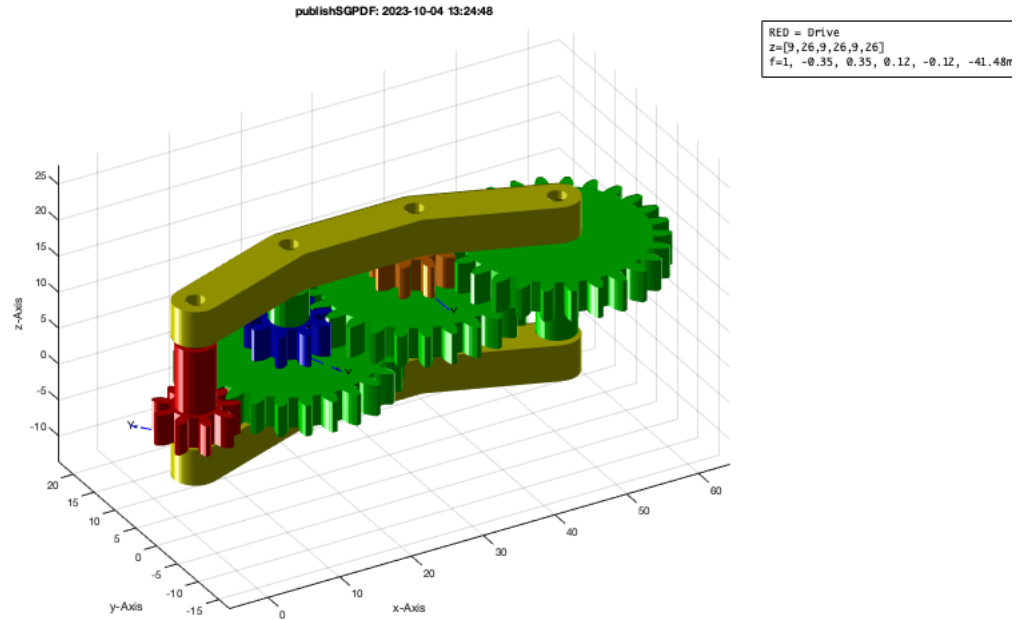
Design stacked gearboxes with a rack

```
SGgearchain([1 5 1.25 5],[9 26 9 26 9 26],'',0,'stack','rack','box');
```

```
SGgearchain: > SGgearchain([1 5 1.25 5],[9 26 9 26 9 26],0,0,'stack','rack');
SGgearchain: Gear Ratio is [1.00,-0.35,0.35,0.12,-0.12,-0.04]
SGwriteMultipleSTL: Writing 6 STL files in <a href = "matlab: openbydoubleclick ('/Users/timlueth/Desktop/STLMult Gearchain')">/Users/timlueth/Desktop
```



```
view(-30,30); VLFLplotlight(1,1)
```



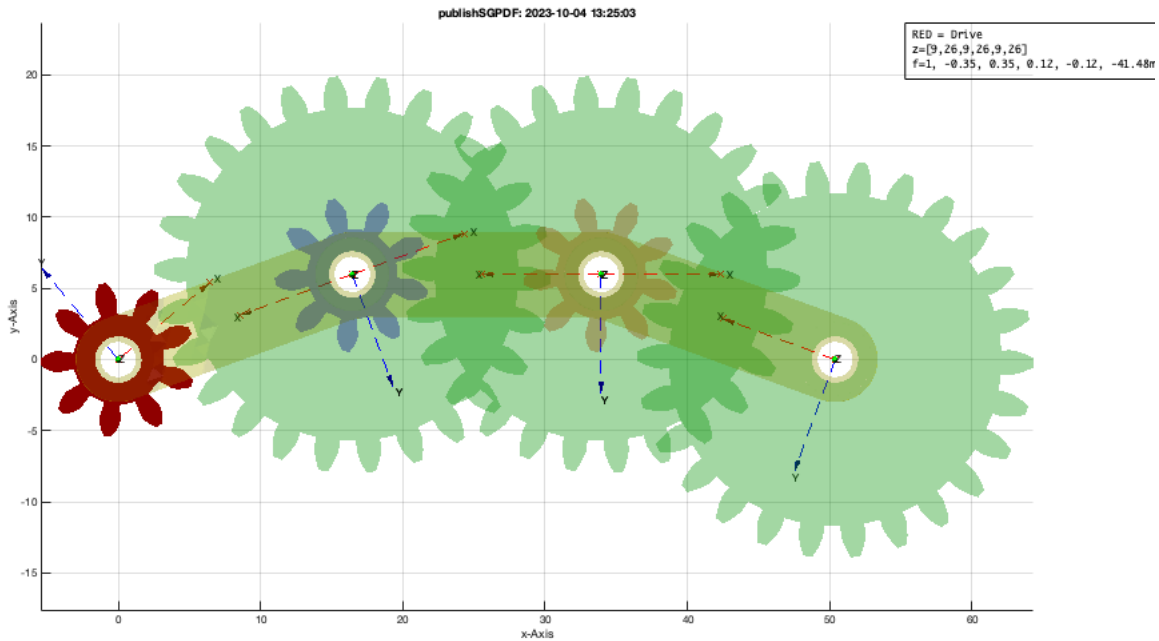
Design stacked gearboxes with a rack and a crank

```
SGgearchain([1 5 1.25 5],[9 26 9 26 9 26]','','0','stack','rack','box','crank');
```

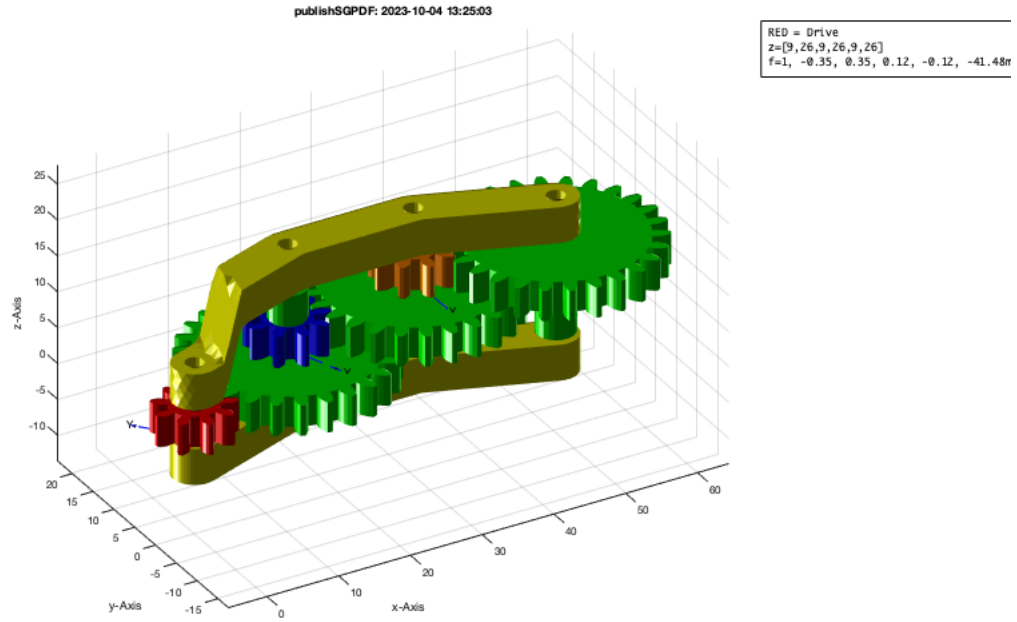
```
SGgearchain: > SGgearchain([1 5 1.25 5],[9 26 9 26 9 26],0,0,'stack','rack');
```

```
SGgearchain: Gear Ratio is [1.00,-0.35,0.35,0.12,-0.12,-0.04]
```

```
SGwriteMultipleSTL: Writing 6 STL files in <a href = "matlab: openbydoubleclick ('/Users/timlueth/Desktop/STLMult Gearchain')">/Users/timlueth/Desktop
```



```
view(-30,30); VLFLplotlight(1,1)
```



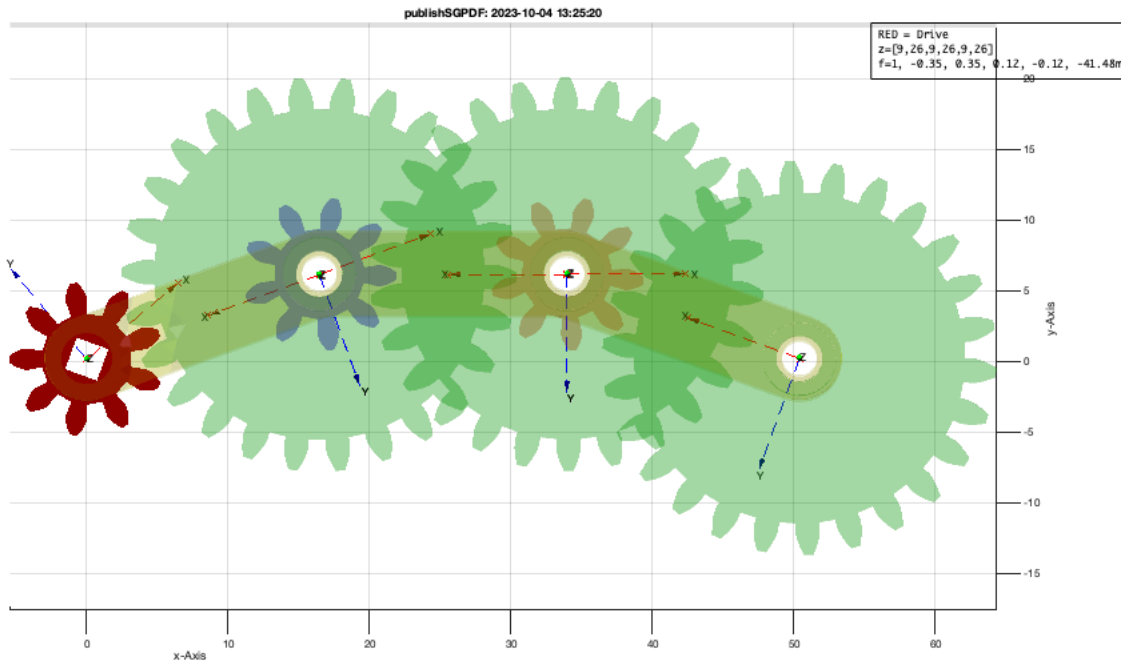
Design stacked gearboxes with a rack and a shaft

```
SGgearchain([1 5 1.25 5],[9 26 9 26 9 26],'',0,'stack','rack','box','crank','shaft',PLsquare(2));
```

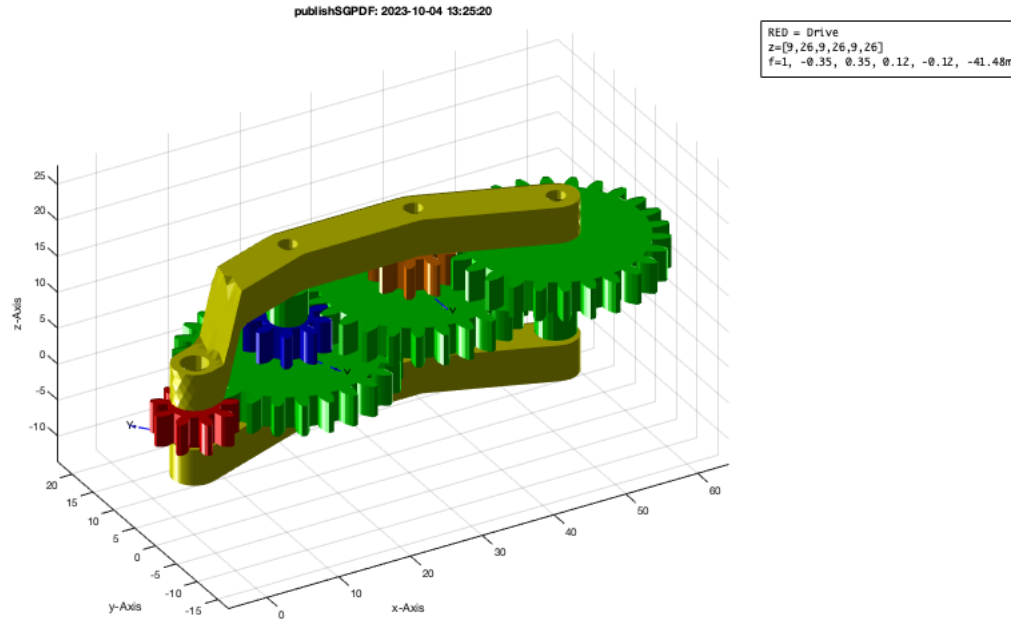
```
SGgearchain: > SGgearchain([1 5 1.25 5],[9 26 9 26 9 26],0,0,'stack','rack');  

SGgearchain: Gear Ratio is [1.00,-0.35,0.35,0.12,-0.12,-0.04]  

SGwriteMultipleSTL: Writing 6 STL files in <a href = "matlab: openbydoubleclick ('/Users/timlueth/Desktop/STLMult Gearchain')">/Users/timlueth/Desktop
```



```
view(-30,30); VLFLplotlight(1,1)
```

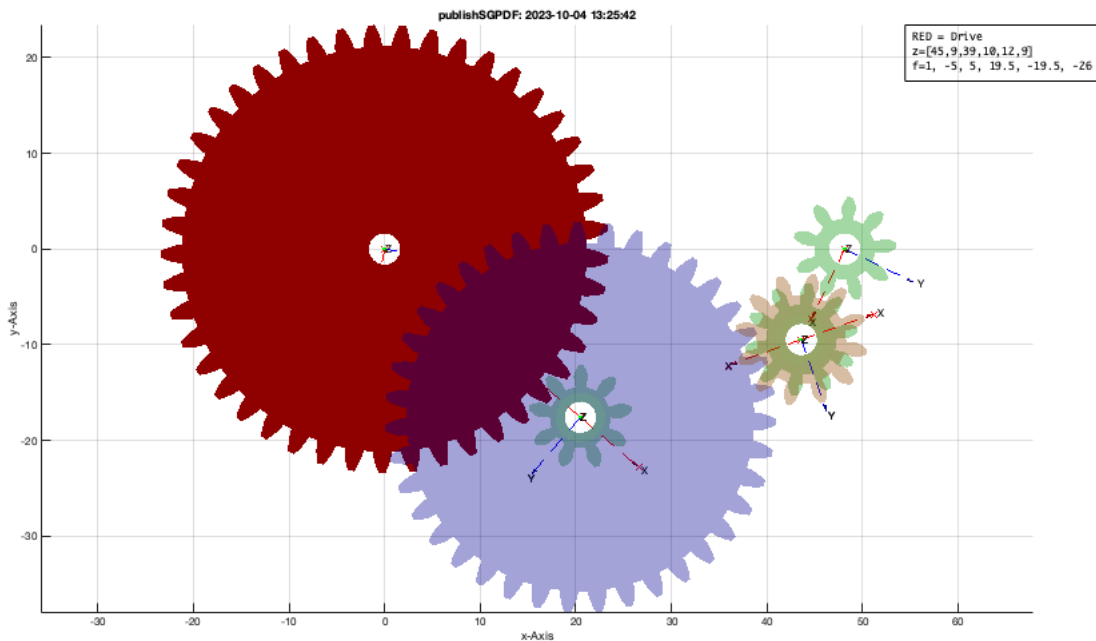


Automstic design of gear boxes with three steps

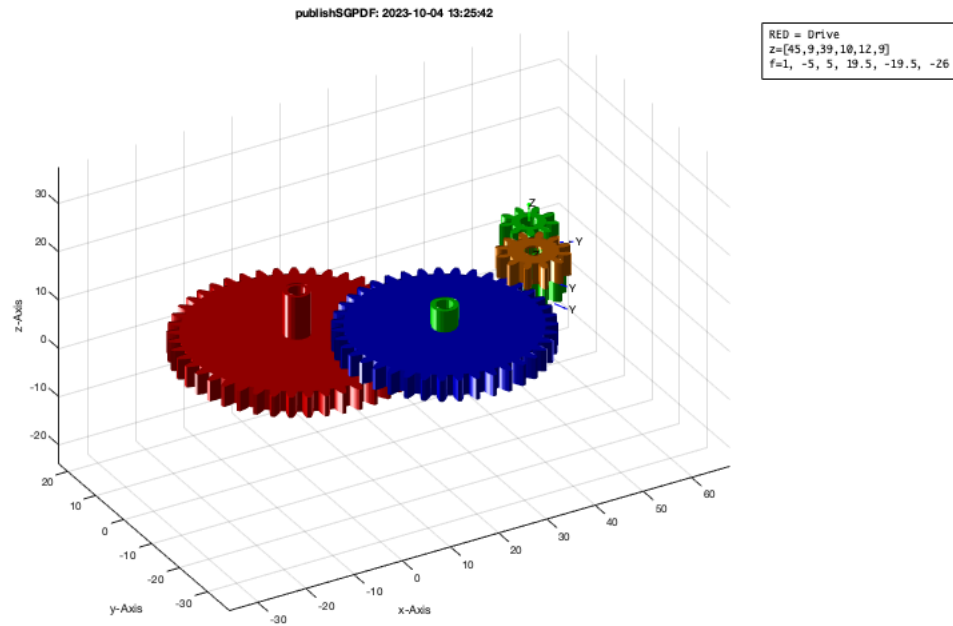
SGgearratio(26,3)

```

SGgearratio: There are up to 3 layers to consider
SGgearratio: Checking 27.27M solutions for 6 gears takes time
SGgearratio: SGgearchain(1,[45,9,39,10,12,9],repmat(pi/3,1,6),0,'stack'); % Ratio is 26 with error of 0
FLrepair: (SGremsurfedgepoints) 1 open triangle(s) closed.
FLrepair: (SGremsurfedgepoints) No open boundaries finally exist!
SGgearchain: > SGgearchain([1 5 1.25 0],[45 9 39 10 12 9],[1.05 1.05 1.05 1.05 1.05 1.05],0,'stack');
SGgearchain: Gear Ratio is [1.00,-5.00,5.00,19.50,-19.50,-26.00]
SGwriteMultipleSTL: Writing 4 STL files in <a href = "matlab: openbydoubleclick ('/Users/timlueth/Desktop/STLMult Gearchain')">/Users/timlueth/Desktop
ans =
    45     9     39    10    12     9
    
```



```
view(-30,30); VLFLplotlight(1,1)
```



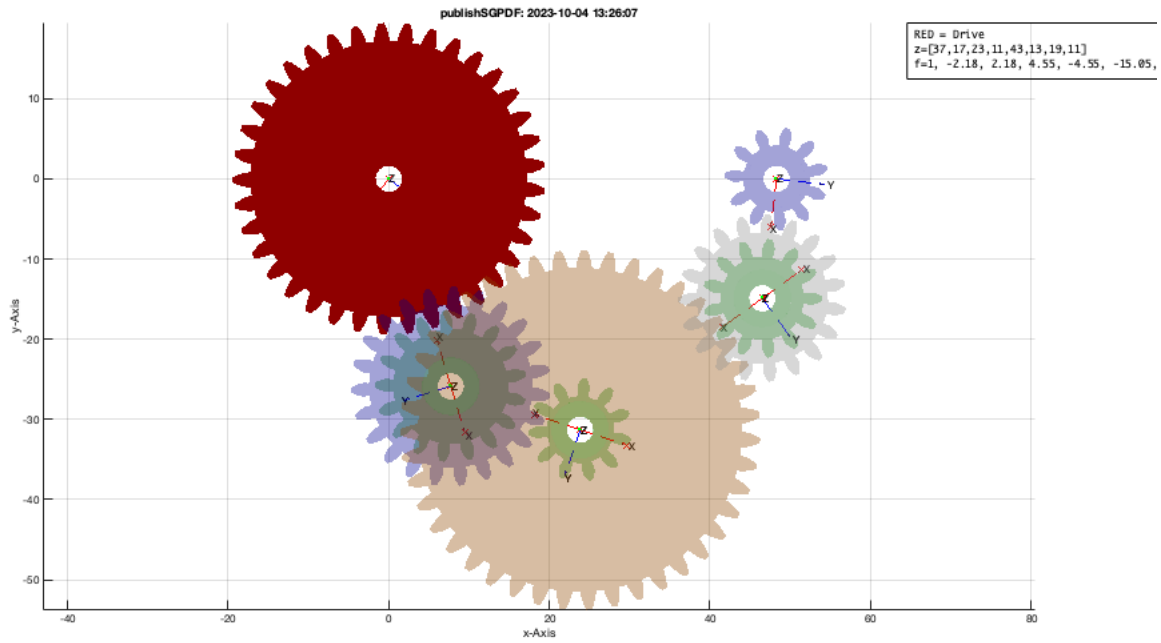
Automstic design of gear boxes with four steps

```
SGgearratio(26,4)
```

```
SGgearratio: There are up to 4 layers to consider
SGgearratio: Checking 126.25M solutions for 8 gears takes time
SGgearratio: SGgearchain(1,[37,17,23,11,43,13,19,11],repmat(pi/3,1,8),0,'stack'); % Ratio is 26 with error of 1.44μ
FLrepair: (SGremsurfedgepoints) 1 open triangle(s) closed.
FLrepair: (SGremsurfedgepoints) No open boundaries finally exist!
FLrepair: (SGremsurfedgepoints) No open boundaries finally exist!
FLrepair: (SGremsurfedgepoints) 2 open triangle(s) closed.
FLrepair: (SGremsurfedgepoints) No open boundaries finally exist!
FLrepair: (SGremsurfedgepoints) 1 open triangle(s) closed.
FLrepair: (SGremsurfedgepoints) No open boundaries finally exist!
SGgearchain: > SGgearchain([1 5 1.25 0],[37 17 23 11 43 13 19 11],[1.05 1.05 1.05 1.05 1.05 1.05 1.05 1.05],0,'stack');
SGgearchain: Gear Ratio is [1.00,-2.18,2.18,4.55,-4.55,-15.05,15.05,26.00]
SGwriteMultipleSTL: Writing 5 STL files in <a href = "matlab: openbydoubleclick ('/Users/timlueth/Desktop/STLMult Gearchain')">/Users/timlueth/Desktop

ans =

    37    17    23    11    43    13    19    11
```



```
view(-30,30); VLFLplotlight(1,1)
```

