SwiftComp™

# TexGen4SC User's Manual

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Xin Liu & Wenbin Yu

Multiscale StructuralMechanics

PURDUE™ AERONAUTICS & ASTRONAUTICS

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# 1.0 GENERAL INFORMATION

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Based on the recently discovered Mechanics of Structure Genome (MSG), SwiftComp™ provides an efficient and accurate approach for modeling composite materials and structures. It can be used either independently as a tool for virtual testing of composites or as a plugin to power conventional FEA codes with high-fidelity multiscale modeling for composites. SwiftComp™ implements a true multiscale theory which assures the best models at a given level of efficiency to capture both anisotropy and heterogeneity of composite constituents at the microscopic scale. SwiftComp™ enables engineers to model composites as a black aluminum, capturing details as needed and affordable. This saves orders of magnitude in computing time and resources without sacrificing accuracy, while enabling engineers to tackle complex problems effectively.

TexGen is open source software licensed under the General Public License developed at the University of Nottingham for modelling the geometry of textile structures. Taking the advantages of the geometry generation by TexGen and constitutive modeling by SwiftComp, TexGen4SC provides a fast and easy way to predict properties for textile composites.

TexGen4SC keeps all the capabilities of original TexGen, and add two functions: (1) Create input file for SwiftComp and (2) Run SC homogenization. For the users who are not familiar with TexGen, the link http://texgen.sourceforge.net/index.php/Documentation will give detailed instructions about how to use TexGen.

In this manual, we will only show how to use TexGen4SC to perform SwiftComp homogenization analysis to compute effective properties for textile composites generated using TexGen.

# 2.0 EXAMPLE 1

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We will use a simple example to show how to perform homogenization analysis for predicting properties of textile composites generated by TexGen. First, launch the tool through https://cdmhub.org/resources/1220 (see Fig. 2-1).

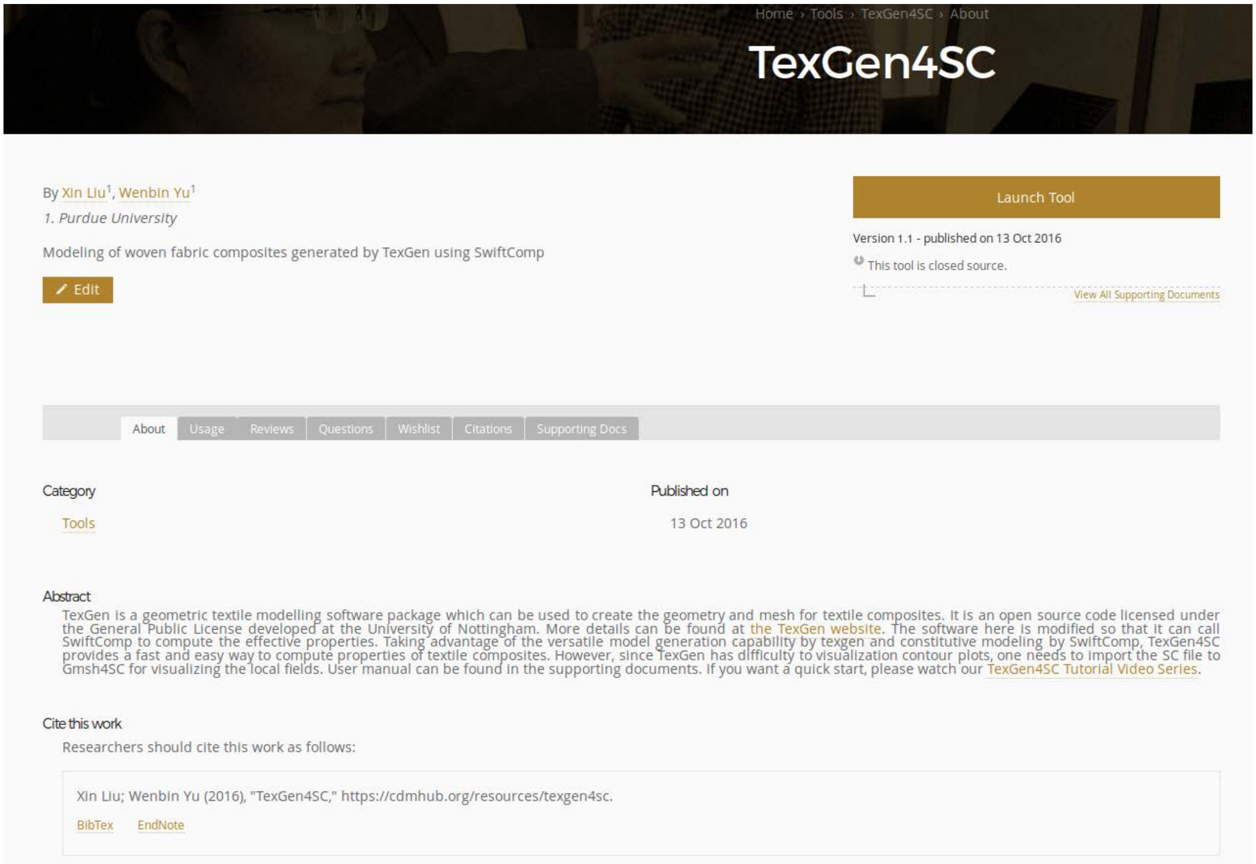
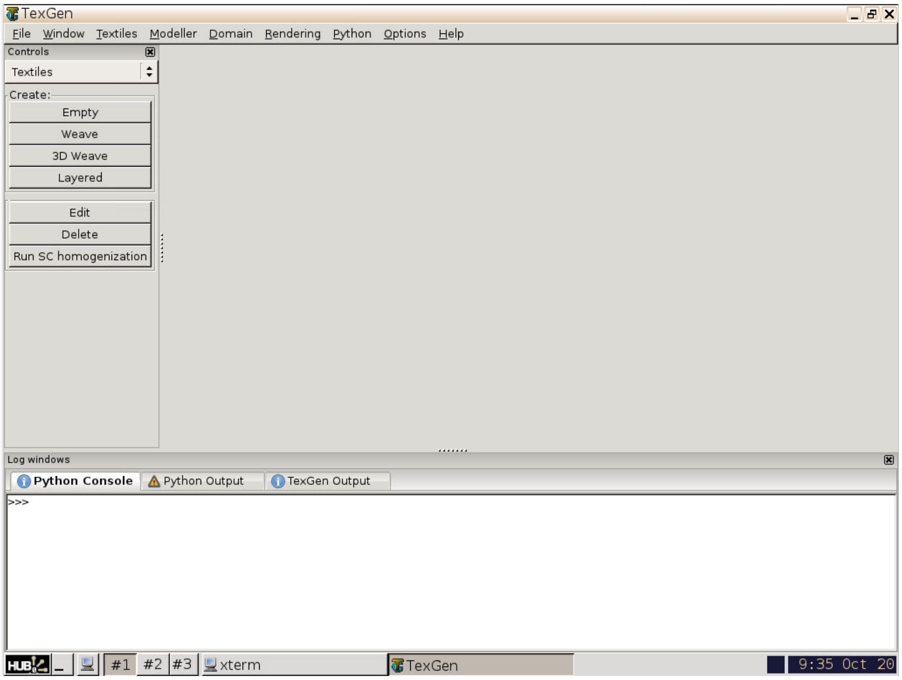



Fig. 2-1

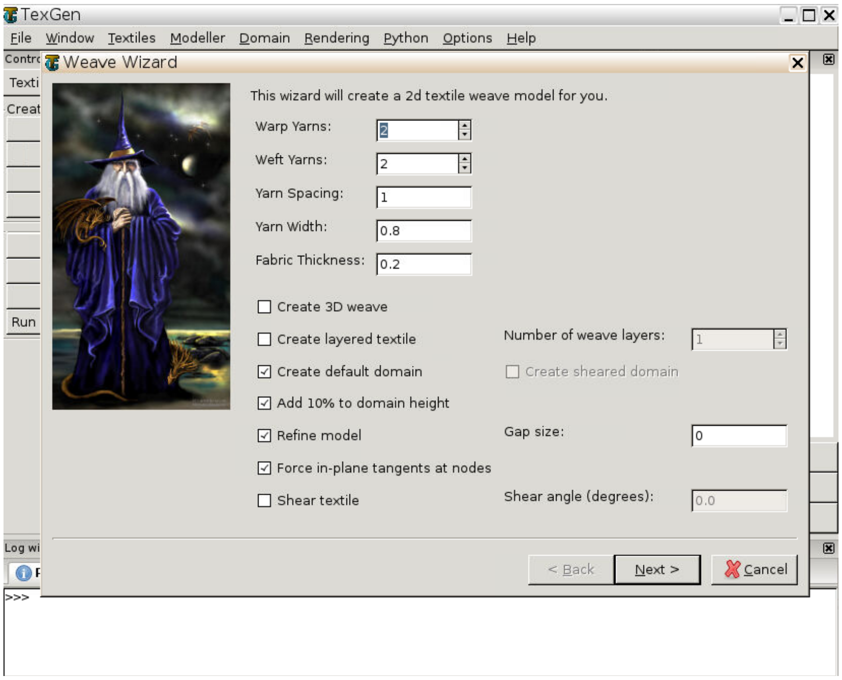
## 2.1 Create 2D Weave

Click "Weave" button as shown in Figure 2-2. Input the geometry information of the weave composites you want to analyze (see Fig. 2-3). Click next, then users can change the weave pattern (see Fig. 2-4) by clicking on the yarns. Click OK, then a simply plain weave composites is created (see Fig. 2-5). **Note there are some displaying issues but they will not affect the calculation. When the model is generated, users just need to click the main window then the model will show normally.**



TexGen
File Window Textiles Modeller Domain Rendering Python Options Help
Controls
Textiles
Create:
Empty
Weave
3D Weave
Layered
Edit
Delete
Run SC homogenization
Log windows
Python Console
Python Output
TexGen Output
>>>
#1 #2 #3 xterm
TexGen
9:35 Oct 20


Fig. 2-2



TexGen
File Window Textiles Modeller Domain Rendering Python Options Help
Weave Wizard
This wizard will create a 2d textile weave model for you.
Warp Yarns: 2
Weft Yarns: 2
Yarn Spacing: 1
Yarn Width: 0.8
Fabric Thickness: 0.2
Create 3D weave
Create layered textile
Number of weave layers: 1
Create default domain
Create sheared domain
Add 10% to domain height
Refine model
Gap size: 0
Force in-plane tangents at nodes
Shear textile
Shear angle (degrees): 0.0
< Back
Next >
Cancel
>>>


Fig. 2-3

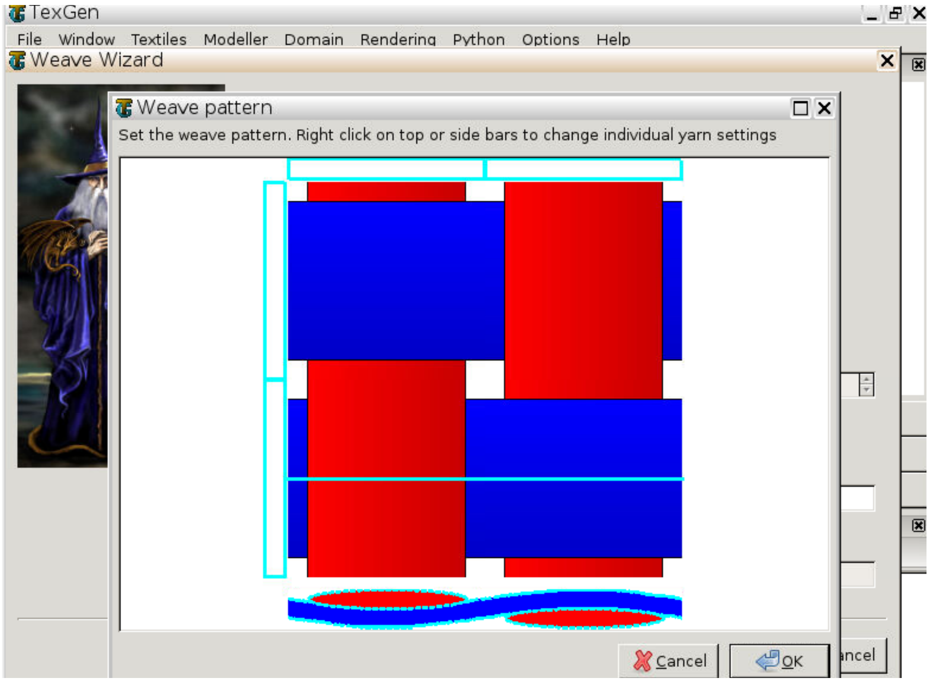



Fig. 2-4

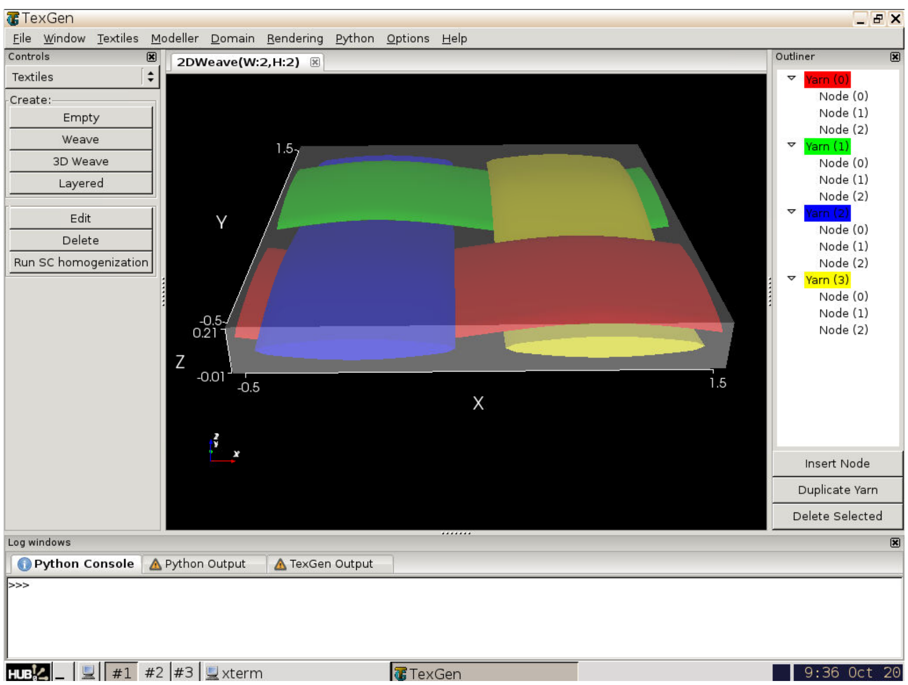



Fig. 2-5

Users can also change the default material properties of matrix and yarns. For matrix properties, users can directly click "Modeller->Assign Matrix Properties" (see Fig. 2-6). Note that TexGen assumes isotropic matrix properties. It can be relaxed to be anisotropic if needed. For yarn properties, users need to first choose the yarn either through the main window or the Outliner, then the chosen yarn would become grey, and an arrow will show at that yarn (see Fig. 2-7).

Then users can go to "Modeller->Assign Yarn Properties" to change the default properties (see Fig. 2-8). Repeating the procedure for all the yarns.

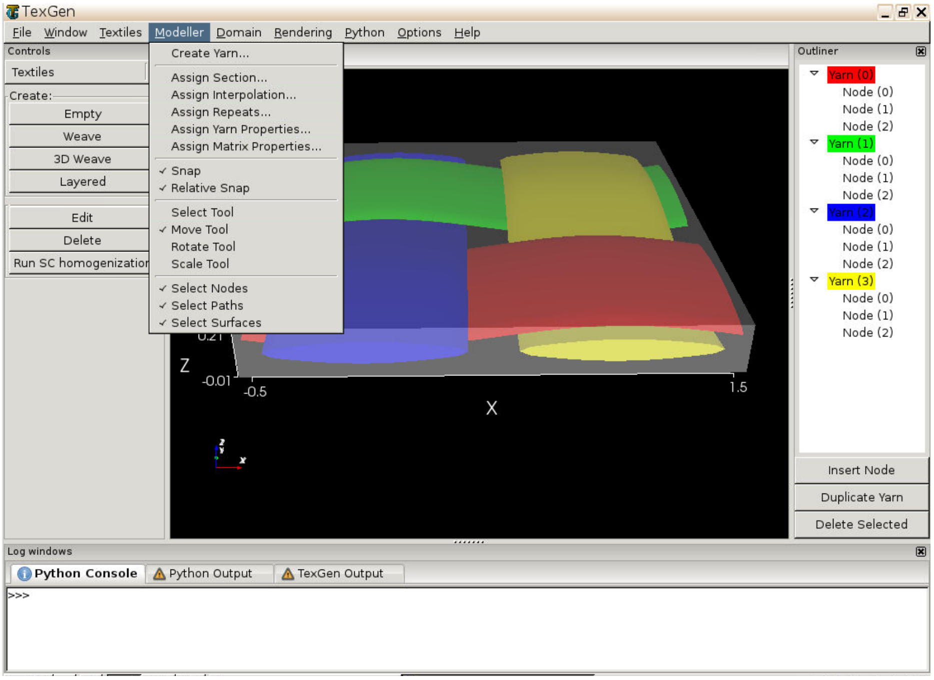


Fig. 2-6

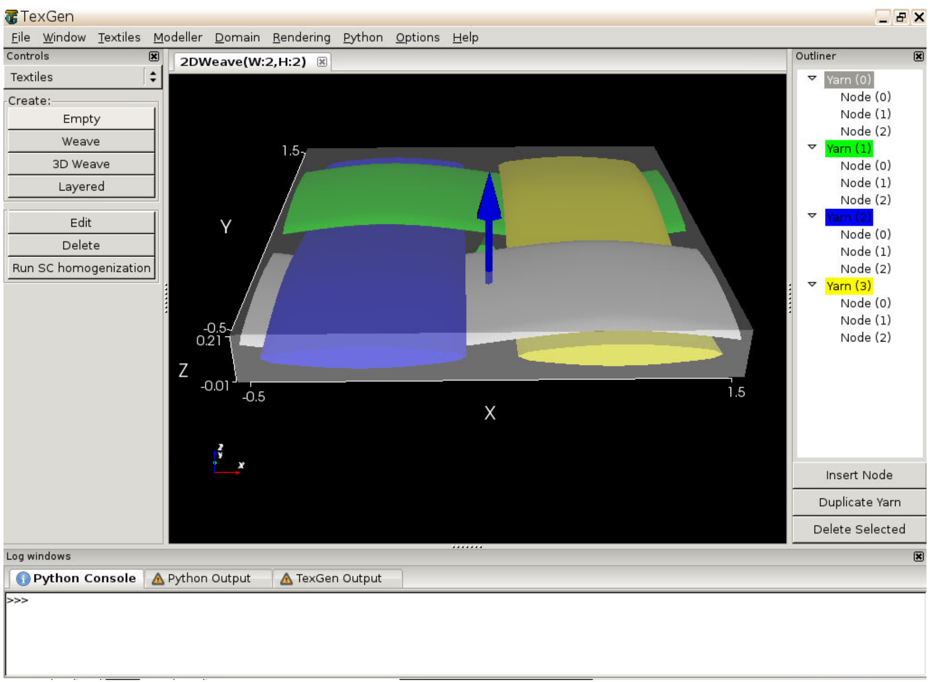


Fig. 2-7

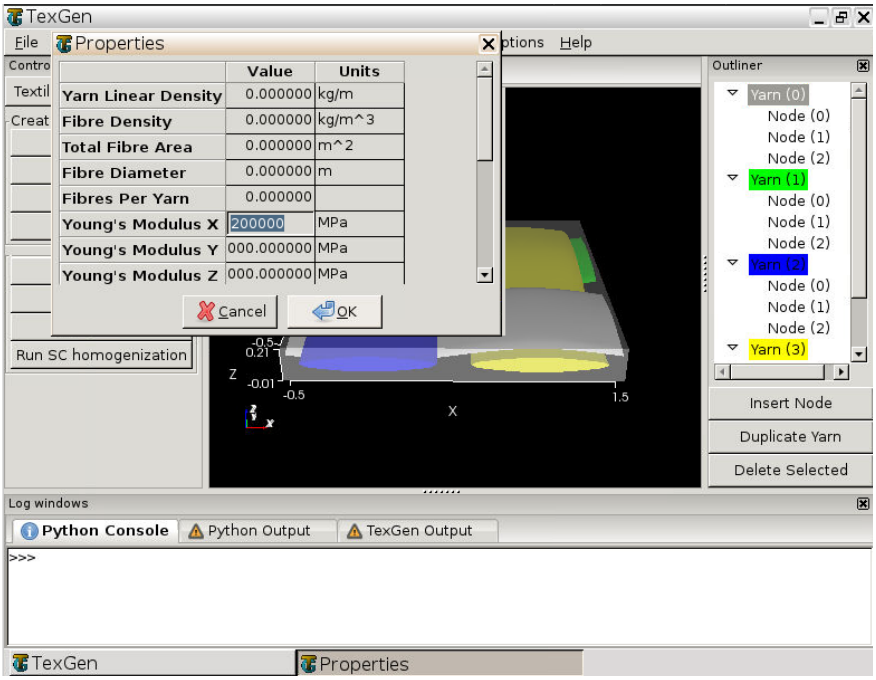



Fig. 2-8

## 2.3 Export SwiftComp File

Once the model is ready, users need to export the model to SwiftComp input file (see Fig. 2-9).

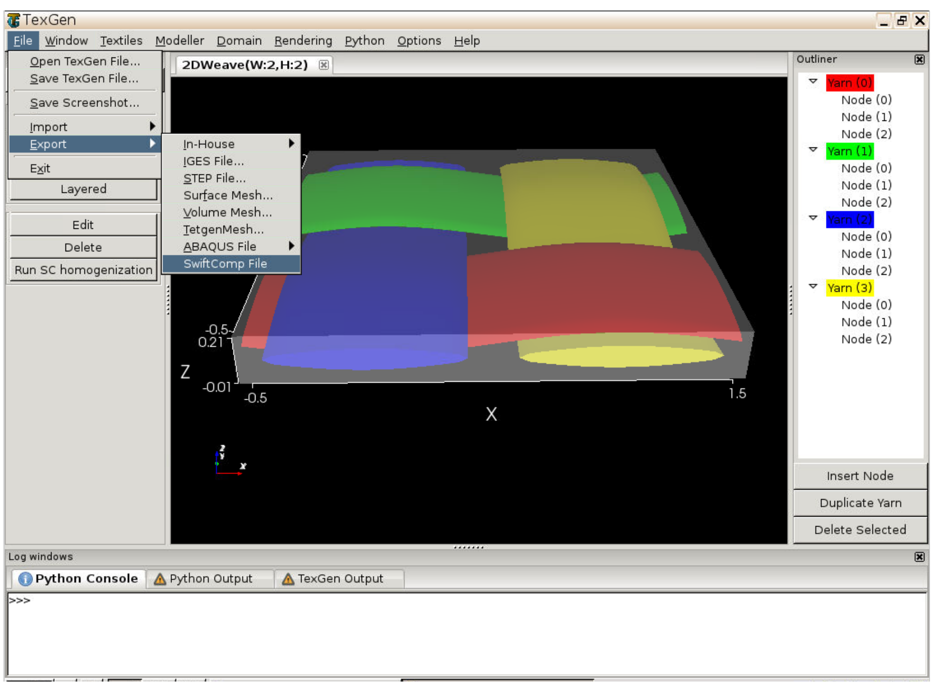



Fig. 2-9

Users can set different mesh size by changing “Voxel Count”. Users can also choose different models according to different needs. Now TexGen4SC provides Elastic and Thermoelastic analysis for Solid model and Plate/Shell model (see Fig. 2-10). The differences between models and other references can be found in the manual of SwiftComp (https://cdmhub.org/resources/scstandard/supportingdocs). Click Finish to generate SwiftComp input file. Then save the model as with a file name chosen by the user (see Fig. 2-11).

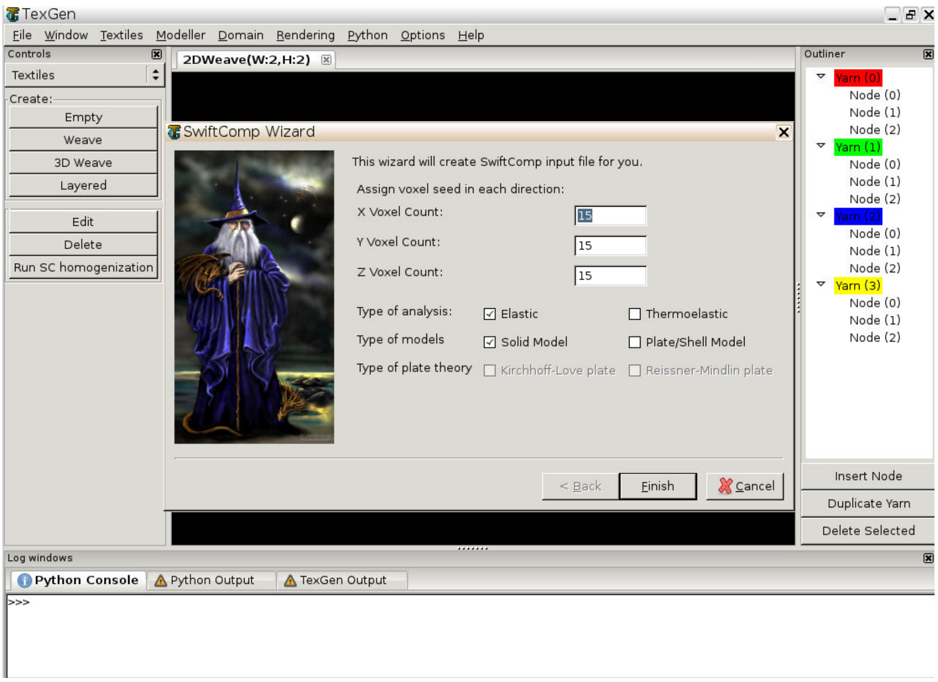


Fig. 2-10

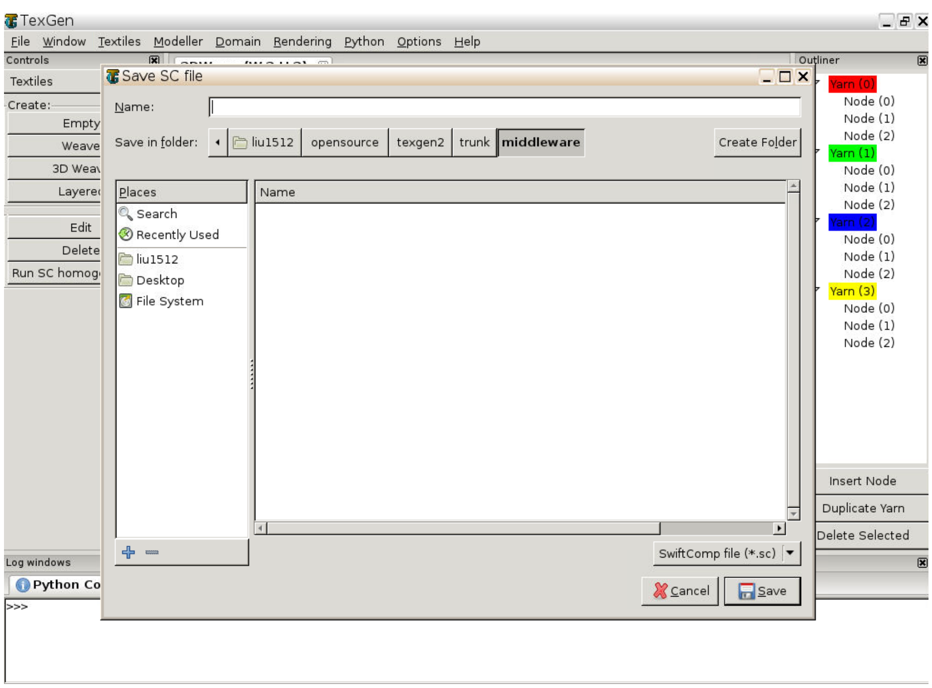


Fig. 2-11

## 2.3 Run SwiftComp Homogenization

Once the input file for SwiftComp is generated, users can click “Run SC homogenization” function to perform homogenization analysis of weave fabric composites. Then the effective material properties are automatically pop up after the calculation is done (see Fig. 2-12).

```
sc1.sc.k
The Effective Stiffness Matrix
-------------------------------------------
  4.9953832E+10  8.1353274E+09  2.6950020E+09 -3.9065377E+05 -4.1659280E+04 -7.5156010E+04
  8.1353274E+09  4.9953539E+10  2.6950348E+09 -3.1881465E+05  3.5045718E+05  4.1313671E+04
  2.6950020E+09  2.6950348E+09  6.1946985E+09 -1.5410817E+04  6.4433206E+03 -9.0681352E+02
 -3.9065377E+05 -3.1881465E+05 -1.5410817E+04  2.3945477E+09 -1.8751667E+03 -1.5320225E+04
 -4.1659280E+04  3.5045718E+05  6.4433206E+03 -1.8751667E+03  2.3945439E+09  1.9099660E+04
 -7.5156010E+04  4.1313671E+04 -9.0681352E+02 -1.5320225E+04  1.9099660E+04  2.9691299E+09

The Engineering Constants (Approximated as Orthotropic)
-------------------------------------------------------
 E1  =   4.7787516E+10
 E2  =   4.7787201E+10
 E3  =   5.9446297E+09
 G12 =   2.9691299E+09
 G13 =   2.3945439E+09
 G23 =   2.3945477E+09
 nu12=   1.4273684E-01
 nu13=   3.7295136E-01
 nu23=   3.7295782E-01

The Effective Compliance Matrix
-------------------------------------------
  2.0925967E-11 -2.9869065E-12 -7.8043680E-12  2.9660202E-15  8.2221265E-16  5.6887537E-16
 -2.9869065E-12  2.0926105E-11 -7.8045545E-12  2.2486153E-15 -3.0936320E-15 -3.6913235E-16
 -7.8043680E-12 -7.8045545E-12  1.6821906E-10 -1.2297180E-15  5.5382024E-16 -3.7585579E-17
  2.9660202E-15  2.2486153E-15 -1.2297180E-15  4.1761540E-10  3.2674312E-16  2.1548685E-15
  8.2221265E-16 -3.0936320E-15  5.5382024E-16  3.2674312E-16  4.1761606E-10 -2.6863526E-15
  5.6887537E-16 -3.6913235E-16 -3.7585579E-17  2.1548685E-15 -2.6863526E-15  3.3679900E-10


Effective Density =   0.0000000E+00
```

Fig. 2-12

If users want to perform dehomogenization analysis to get local stress and strain distribution, they need to use import file function in Gmsh4SC. Detailed instructions can be found in the Gmsh4SC manual (https://cdmhub.org/resources/scstandard/supportingdocs).