

Geometric Modelling of Textiles

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Supervised by
Professor Andrew Long
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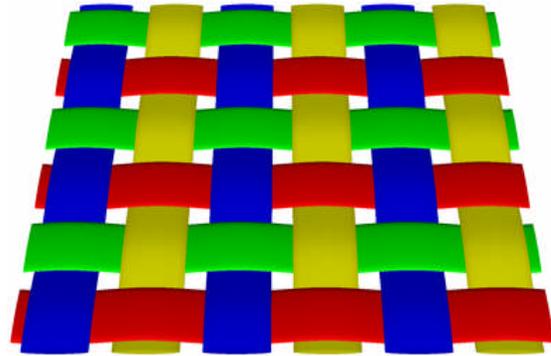


Introduction

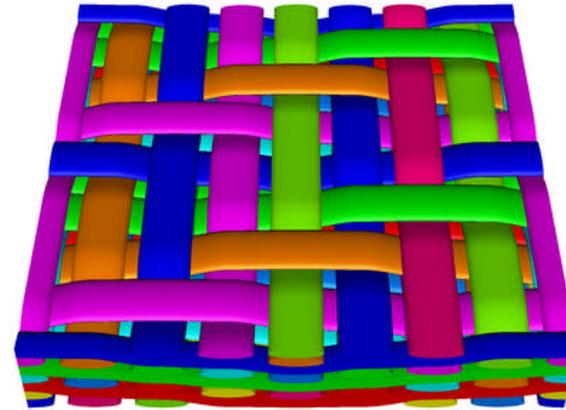
Geometric modelling

- Types of textile architecture
- Modelling strategy
- Implementation (TexGen)
 - GUI
 - Python interface
- Current developments
- Applications
- Distribution

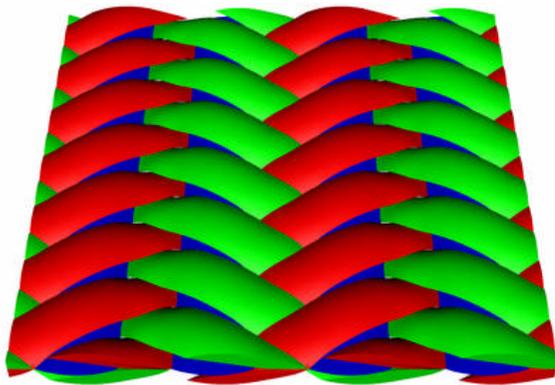
Types of textile architecture



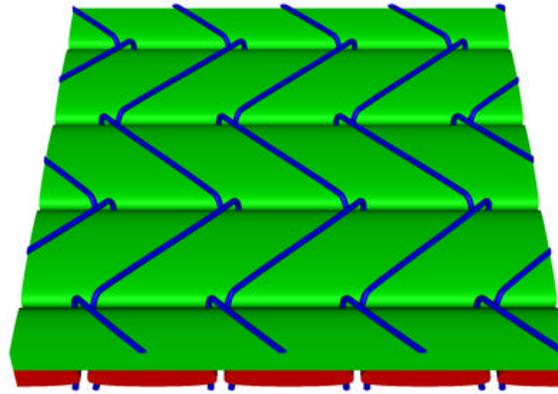
2D Weave



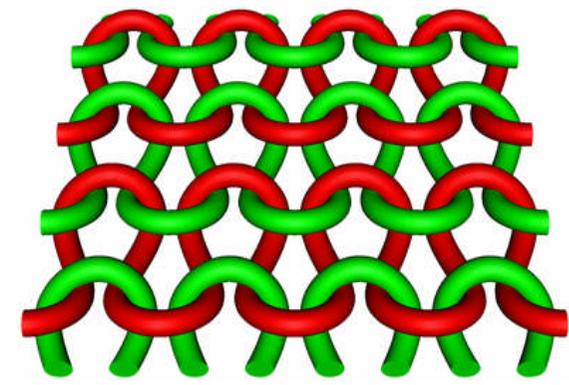
3D Weave



Triaxial braid



Non-crimp fabric

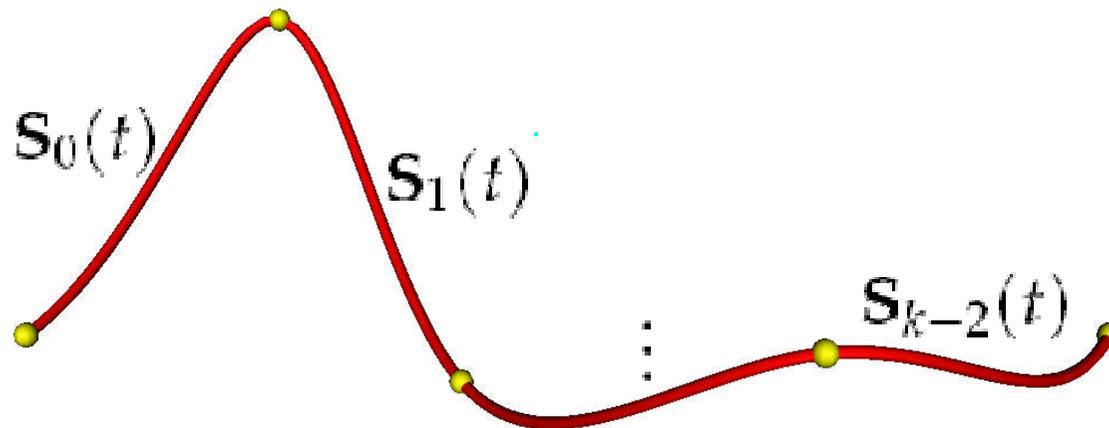


Weft-knit

Modelling strategy

- Yarn centreline represented by a spline

$$\mathbf{S}(t) = \begin{cases} \mathbf{S}_0(t) & \text{if } t_0 \leq t < t_1 \\ \mathbf{S}_1(t) & \text{if } t_1 \leq t < t_2 \\ \vdots & \\ \mathbf{S}_{k-2}(t) & \text{if } t_{k-2} \leq t \leq t_{k-1} \end{cases}$$



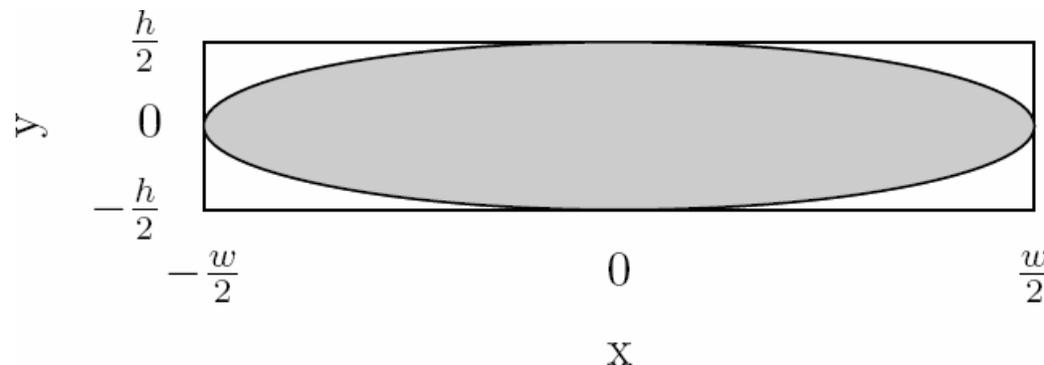
Modelling strategy

- Yarn cross-section defined as a parametric equation in two dimensions

Ellipse

$$C(t)_x = \frac{w}{2} \cos(2\pi t) \quad 0 \leq t \leq 1$$

$$C(t)_y = \frac{h}{2} \sin(2\pi t) \quad 0 \leq t \leq 1$$



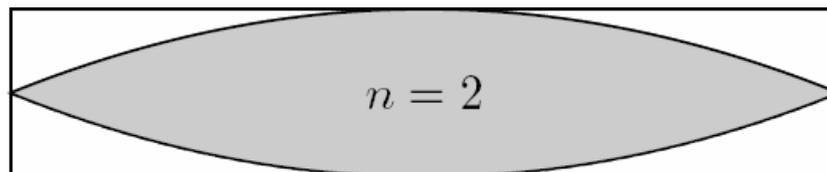
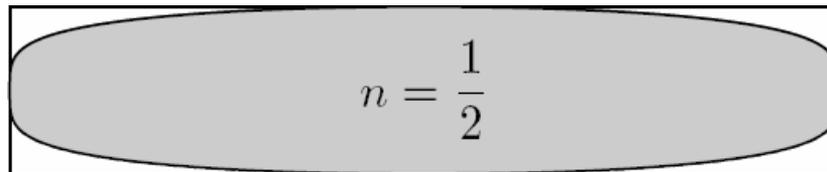
Modelling strategy

- Yarn cross-section defined as a parametric equation in two dimensions

Power ellipse

$$C(t)_x = \frac{w}{2} \cos(2\pi t) \quad 0 \leq t \leq 1$$

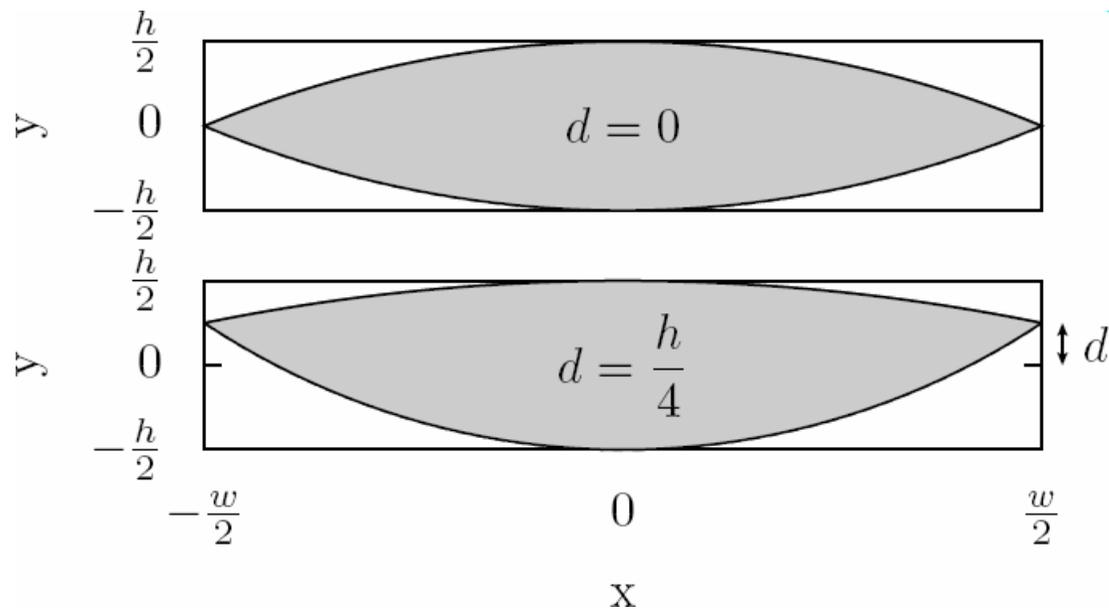
$$C(t)_y = \begin{cases} \frac{h}{2} (\sin(2\pi t))^n & \text{if } 0 \leq t \leq 0.5 \\ -\frac{h}{2} (-\sin(2\pi t))^n & \text{if } 0.5 \leq t \leq 1 \end{cases}$$



Modelling strategy

- Yarn cross-section defined as a parametric equation in two dimensions

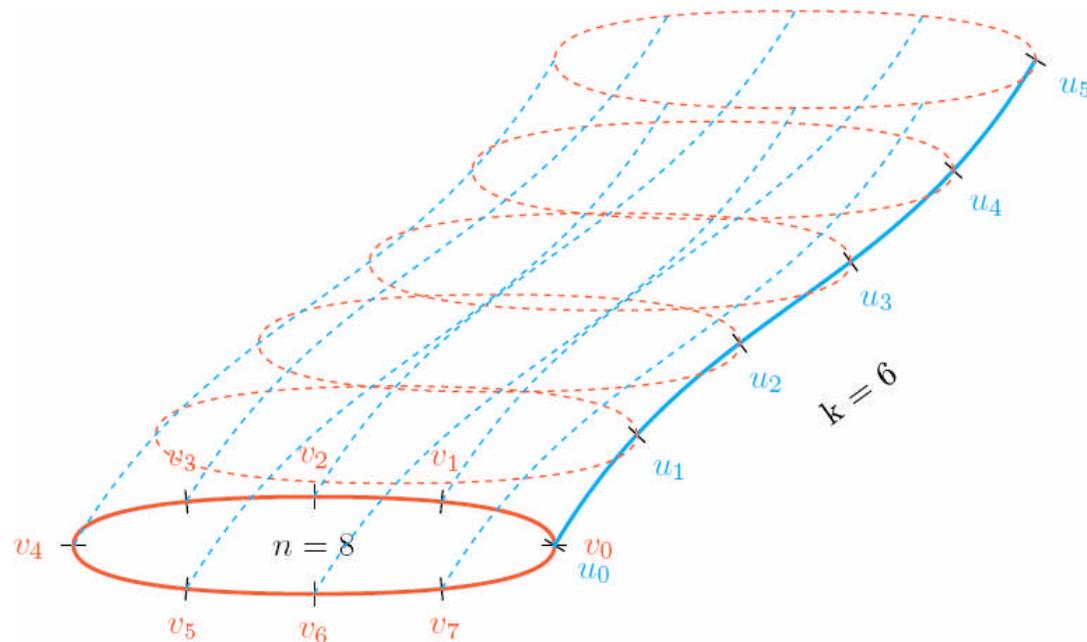
Lenticular



Modelling strategy

- Yarn surface is defined as a parametric equation of two variables combining the centreline and cross-section equations

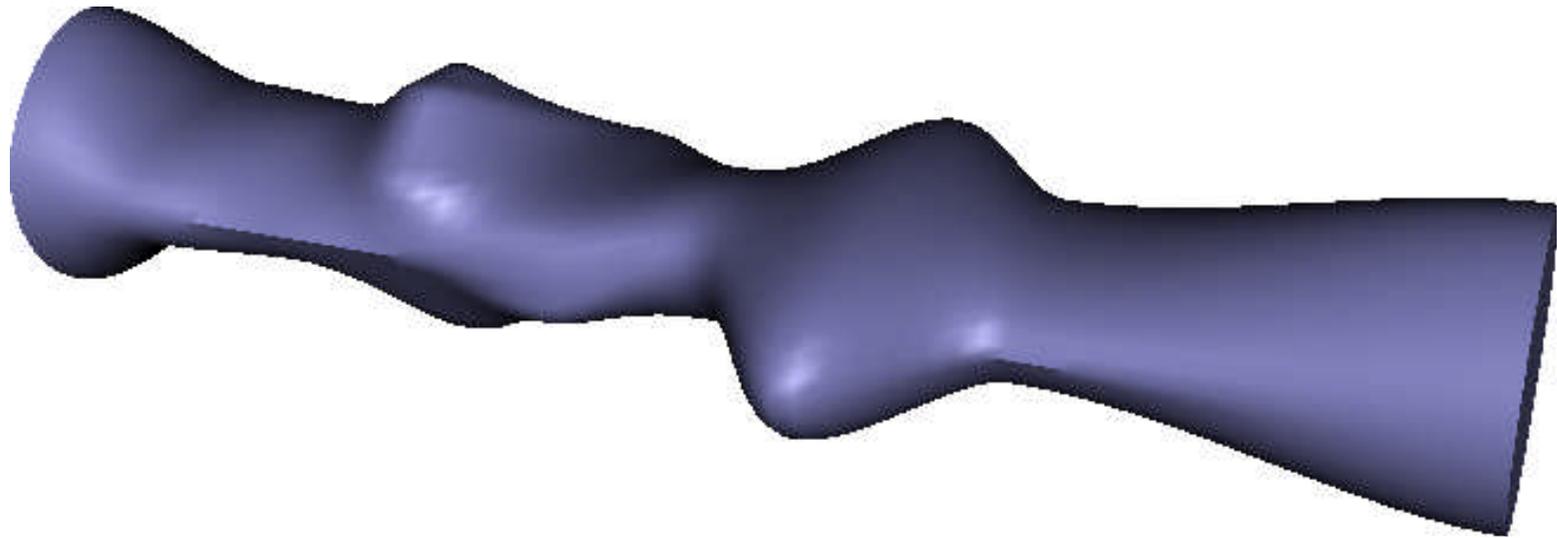
$$\mathbf{P}(u, v) = \mathbf{S}(u) + (\mathbf{C}(u, v)_x \vec{\mathbf{X}}'(u) + \mathbf{C}(u, v)_y \vec{\mathbf{Y}}'(u))$$





Modelling strategy

- Yarn with varying cross-section along its length demonstrating modelling flexibility

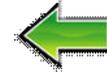




Progress

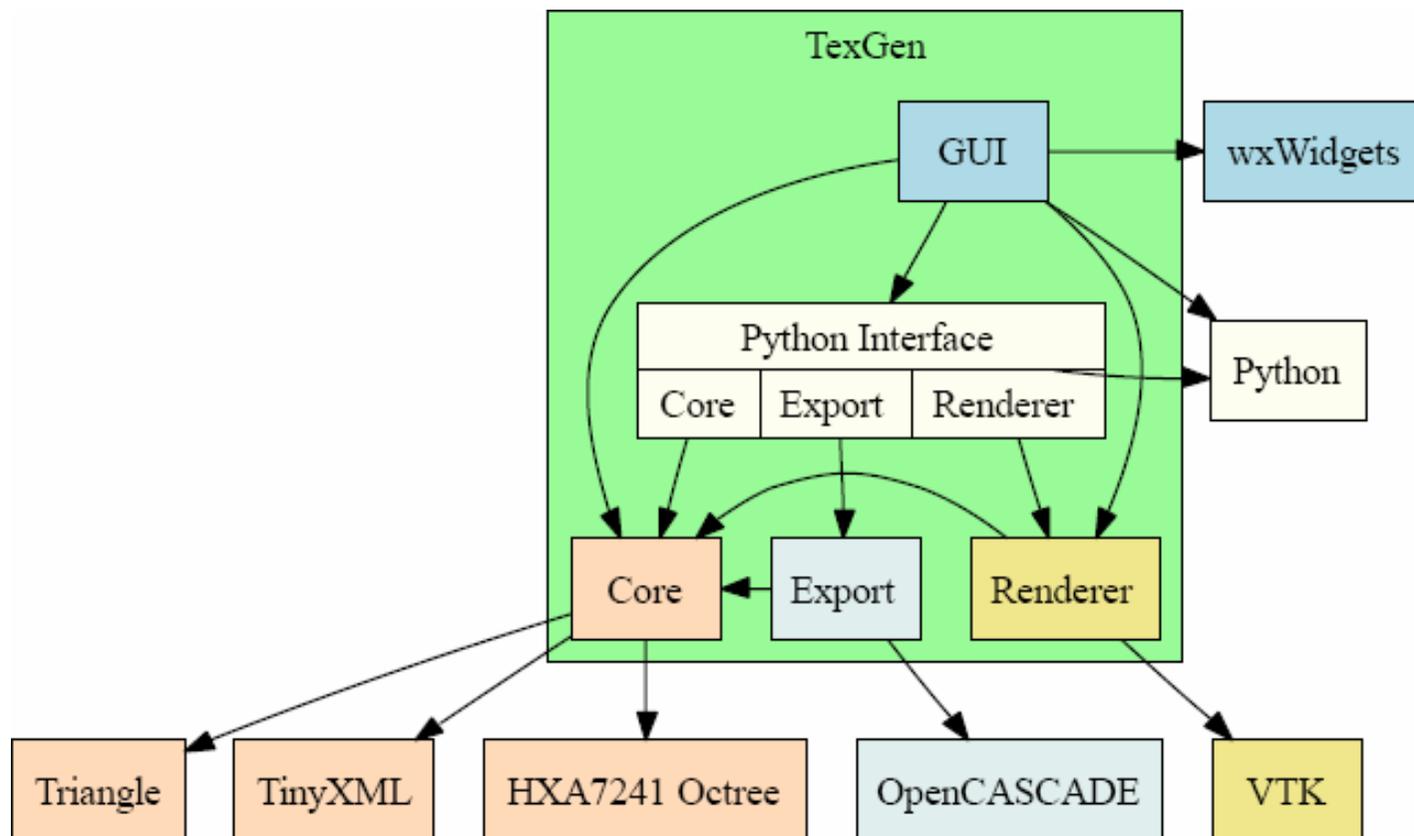
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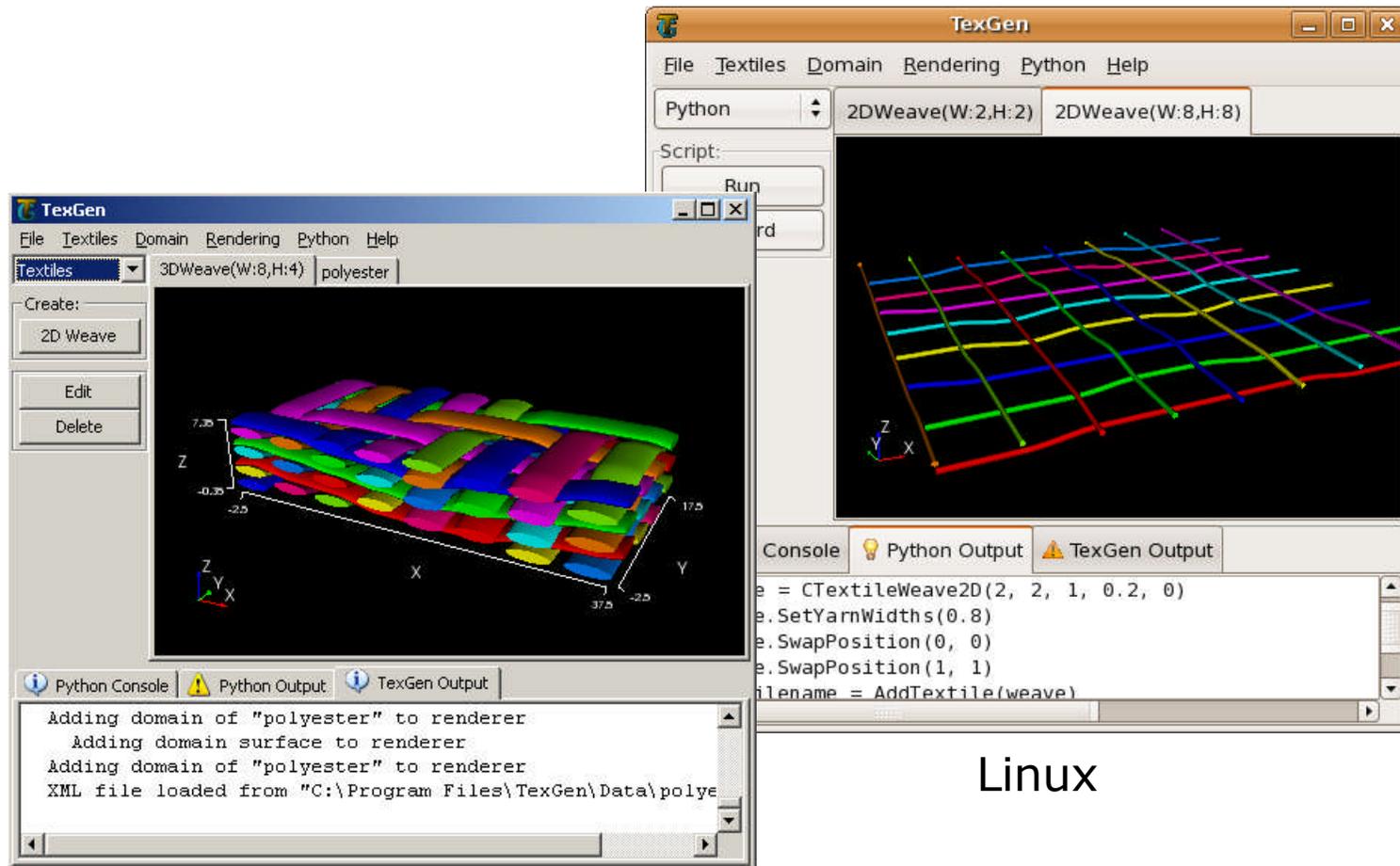


Implementation

- Written in C++ with the use of various 3rd party open source libraries



Graphical user interface



Windows

Linux



Python interface

- Python is a popular high-level programming language
- Ideal for batch processing and automation of tasks commonly performed manually



Progress

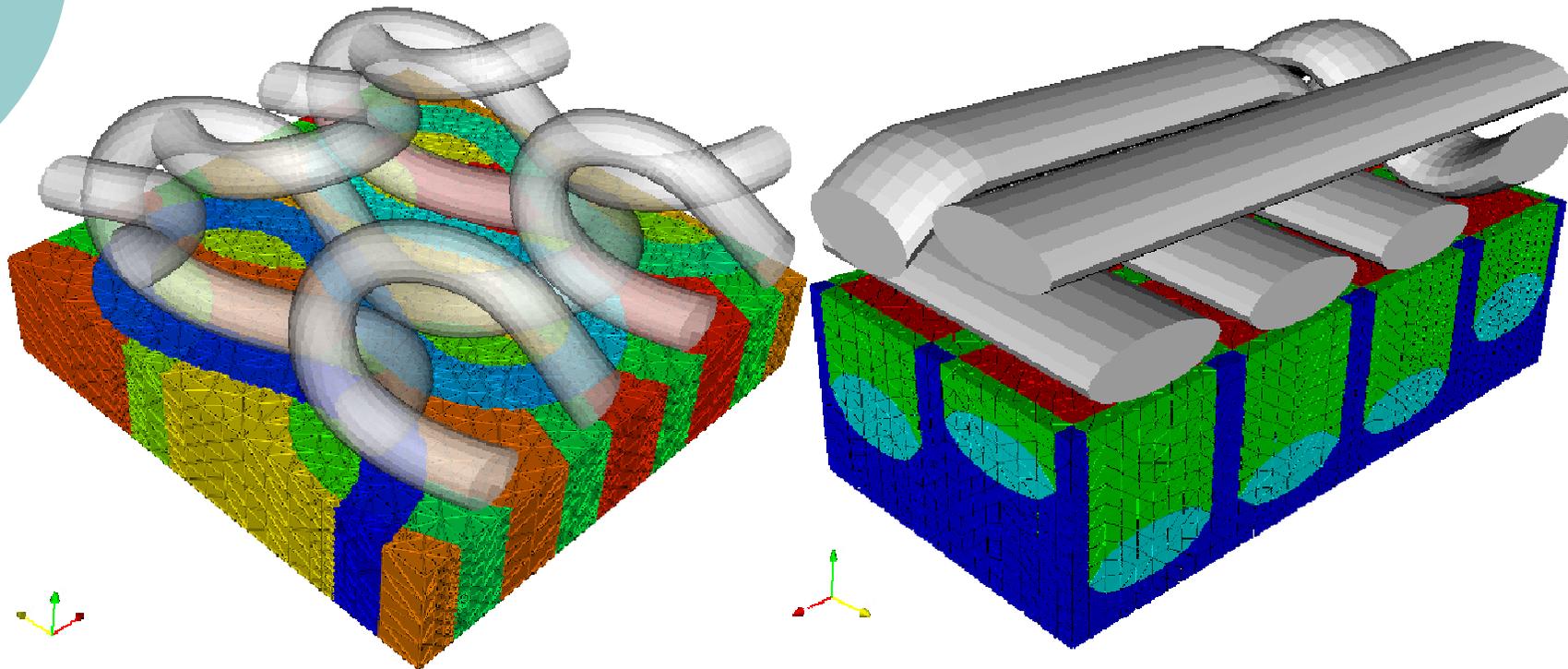
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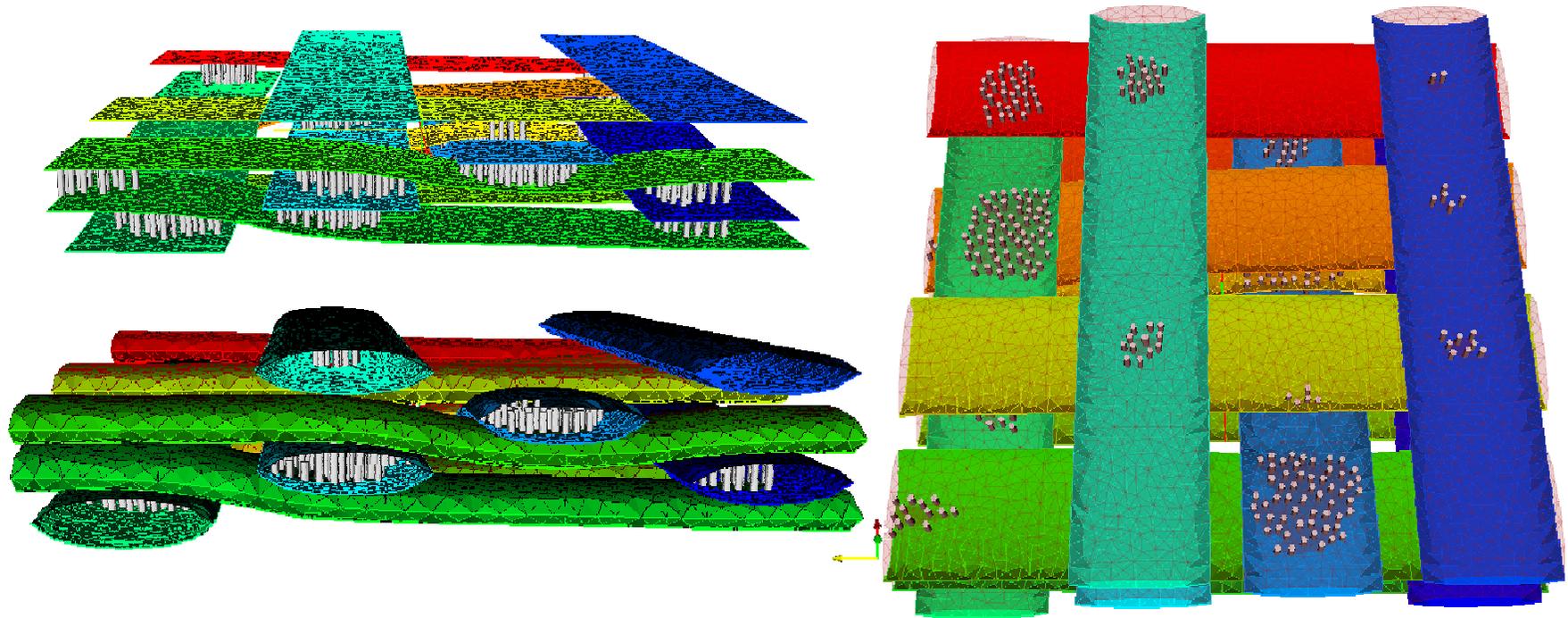
Current developments

- Volume meshing algorithm implemented in TexGen



Current developments

- Geometry solving algorithm using a combination of spring elements to model contact forces and plate elements to model yarn bending





Applications

- Textile mechanics
- Textile permeability
- Textile composites mechanics
- Textile composite heat transfer
- Textile composite viscous forming
- ...



Distribution

- TexGen released as open source software licensed under GNU Public License (GPL)
- Hosted on SourceForge: a collaborative revision control and software development management system.

<http://texgen.sourceforge.net/>



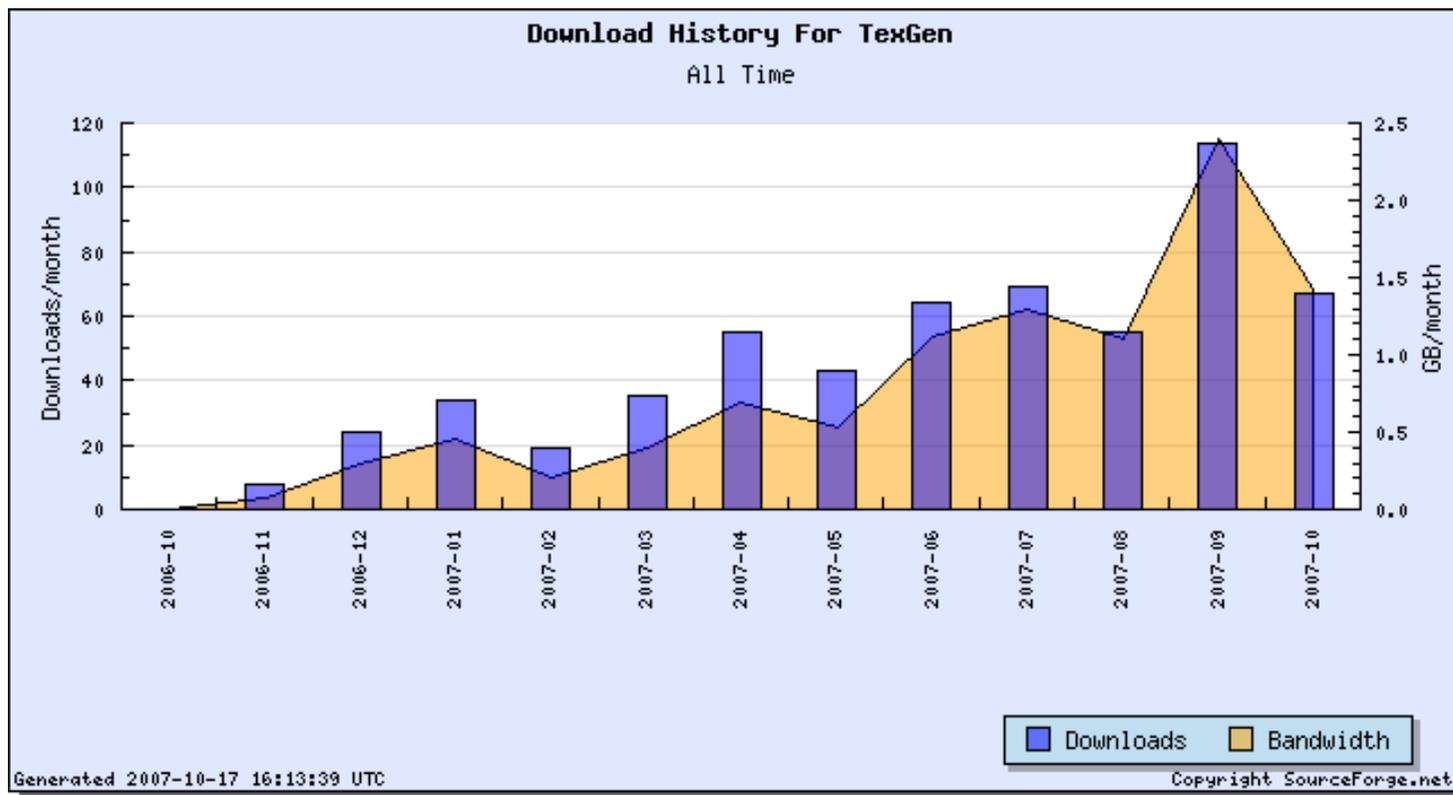
Distribution

Online facilities:

- Wiki website containing TexGen documentation, applications and user submitted scripts in the future.
- Forum for discussion, help and feedback.
- Subversion version control.
- Download mirrors located all around the world.
- Tracker system for feature requests, bug reports and user submitted patches.

Distribution

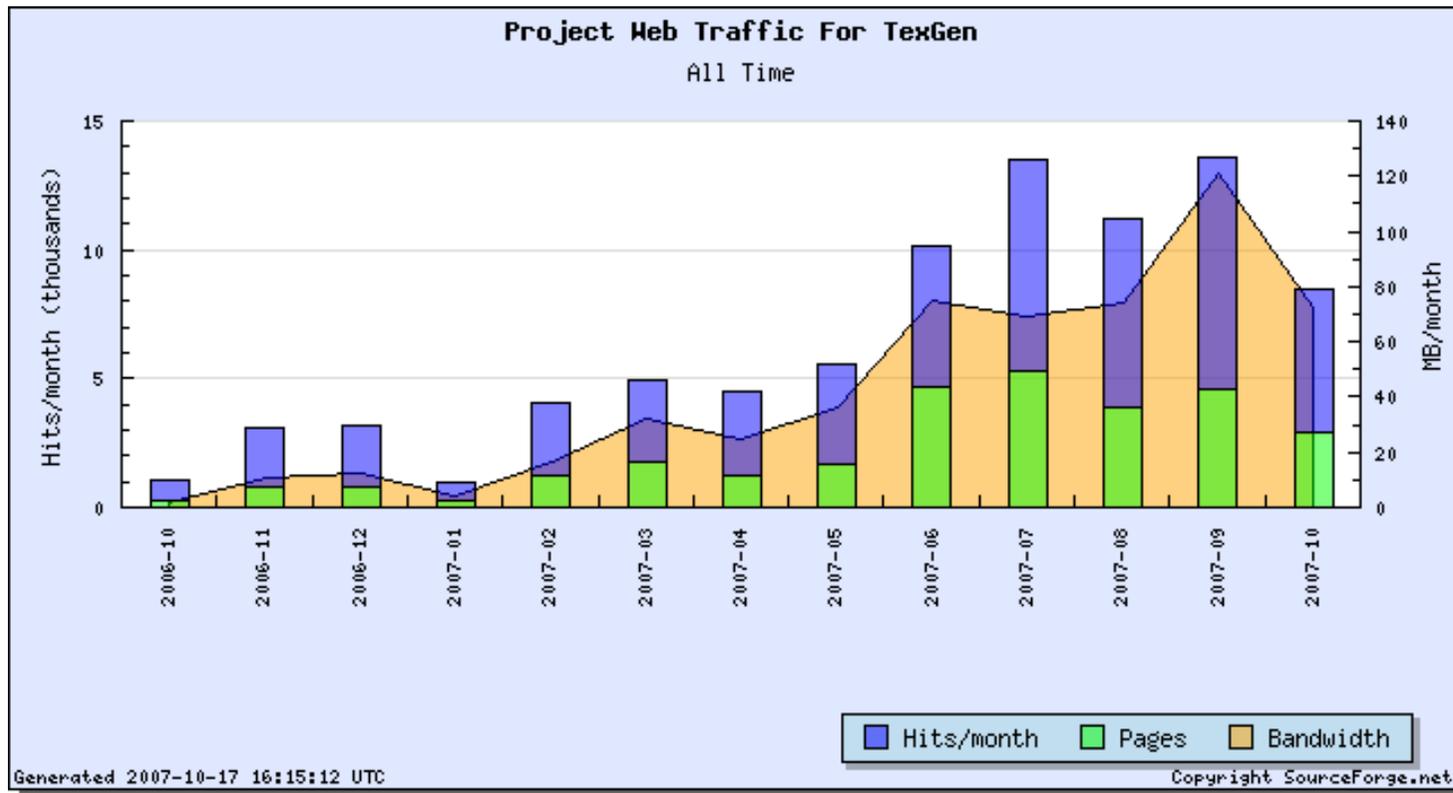
SourceForge statistics



Total downloads since October 2006: 587

Distribution

SourceForge statistics



Total website hits since October 2006: 84,076



Conclusions

- A geometric modelling software packaged named TexGen has been developed and distributed over the internet as open source for all to use, extend and/or modify.