Installation Overview

Requirements:
GL Frontier requires Rhino 7 or later to function

Rhino Install Steps:
1. Download Rhino
2. Download Frontier
3. Make sure downloaded files are unblocked*
4. UnZip Frontier folder
5. Drag .rhp file into Rhino viewport
6. Re-launch Rhino
7. Type "VoxelLoft" in command bar
8. When the license key prompt is present, paste your key in
9. Enjoy!

Grasshopper Install Steps
1. Download Rhino
2. Download Frontier
3. Make sure downloaded files are unblocked*
4. UnZip Frontier folder
5. Place "Frontier.gha" in Grasshopper's "Component Folder"
// Grasshopper >> File >> Special Folders >> Components Folder
6. Re-launch Rhino
7. Type "VoxelLoft" in command bar
8. When the license key prompt is present, paste your key in
9. Enjoy!

**Please note that applying a license key to Rhino or Grasshopper will allow tool access
For additional installation questions, please email support@generallattice.com

Methodology Overview

Background:

The future of manufacturing is undeniably digital and demands an evolving toolset with increasingly powerful and agile capabilities. Built to answer the demands of digital manufacturing, GL Frontier augments existing CAD platforms, providing extensible toolkits that deliver next generation functionality.

Frontier's first toolkit is the Lattice Toolkit for Rhino. The Lattice Toolkit is the result of several years of research and development aimed at achieving one goal, create an intuitive way to quickly model complex lattices that can interact with traditional solid/surface parts (BREP data).

Objectives:

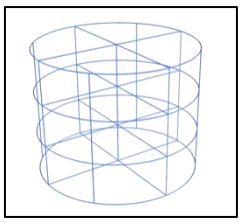
- Generate solid lattice bodies (BREP, SubD, Mesh) that can be manipulated within Rhino/Grasshopper
- Optimize AM workflow by enabling rapid iteration and exploration of lattice structures within a parametric, CAD environment
- Remove the pains of mesh errors and repairs by creating ready-to-print files from within CAD
- Go directly from Frontier to your slicer, by-passing the need for import/export to expensive mesh repair software

Workflow:

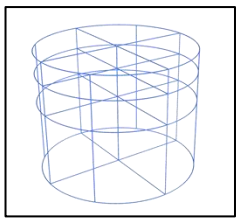
Frontier is built on General Lattice's Complex-Voxel Modeling (CVM™) core.

CVM™ works in six main stages:

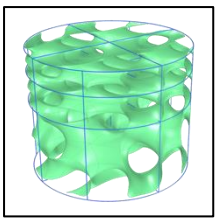
1. Generate a three-dimensional voxel grid
2. Adjust and manipulate voxel grid
3. Choose a base unit-cell geometry
4. Map unit-cell to voxel grid
5. Thicken lattice structure
6. Dictate geometrical data type of lattice



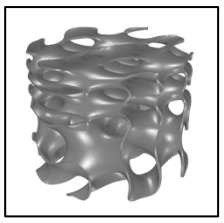
Stage 1



Stage 2



Stage 3 & 4



Stage 5 & 6

Lattice Toolkit

Overview

The Lattice Toolkit is a set of lattice generation tools developed by General Lattice for Rhinoceros and Grasshopper. The Lattice Toolkit has two sets of toolboxes, one for Rhino and one for Grasshopper. The toolboxes are designed to work together with one-to-one commands and can be used together between Rhino and Grasshopper.

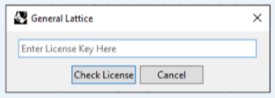
Rhino Tools:

License Key

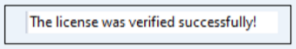
When calling a Rhino or Grasshopper command for the first time, Rhino will launch a window asking for Frontier License Key -- Paste-- Happy Latticing!

Inputs:

Name	Description
Rhino prompt	Paste Frontier license key



Output Example:



VoxelExtrude

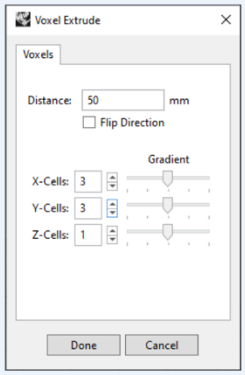
Create a CVM™ voxel grid from a planar surface and an extrusion distance

Inputs:

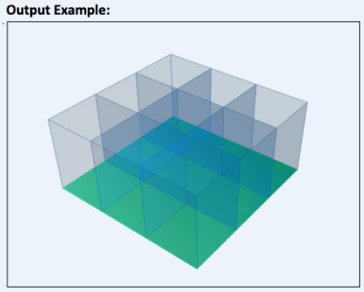
Name	Description
Rhino prompt	Select planar surface
Distance	Extrusion distance along surface normal
X-Cells:	Number of voxels in X direction
Y-Cells:	Number of voxels in Y direction
Z-Cells:	Number of voxels in Z direction
X Gradient	Value between 0-200 driving voxel size
Y Gradient	Value between 0-200 driving voxel size
Z Gradient	Value between 0-200 driving voxel size

Outputs:

Name	Description	Type
Voxel Array	CVM™ voxel grid	Surface/Curve



Output Example:



VoxelLoft

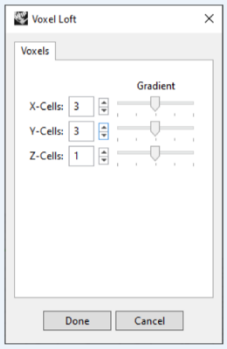
Create a CVM™ voxel grid connecting multiple input surfaces

Inputs:

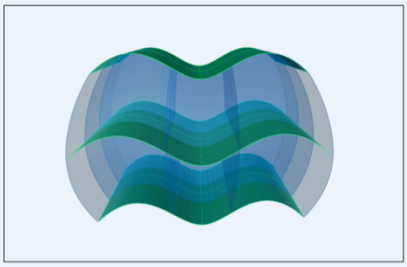
Name	Description
Rhino prompt	Select multiple surfaces
X-Cells:	Number of voxels in X direction
Y-Cells:	Number of voxels in Y direction
Z-Cells:	Number of voxels in Z direction
X Gradient	Value between 0-200 driving voxel size
Y Gradient	Value between 0-200 driving voxel size
Z Gradient	Value between 0-200 driving voxel size

Outputs:

Name	Description	Type
Voxel Array	CVM™ voxel grid	Surface/Curve



Output Example:



VoxelBBox

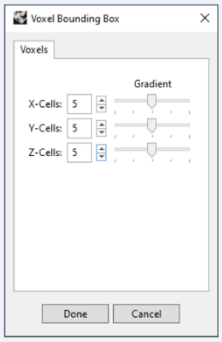
Create a CVM™ voxel grid from a bounding box around the input solid

Inputs:

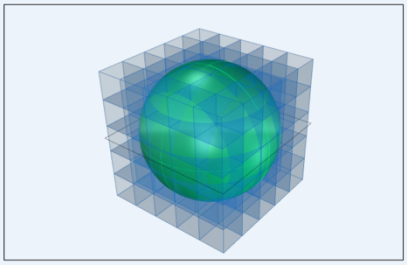
Name	Description
Rhino prompt	Input solid geometry to voxelize
X-Cells:	Number of voxels in X direction
Y-Cells:	Number of voxels in Y direction
Z-Cells:	Number of voxels in Z direction
X Gradient	Value between 0-200 driving voxel size
Y Gradient	Value between 0-200 driving voxel size
Z Gradient	Value between 0-200 driving voxel size

Outputs:

Name	Description	Type
Voxel Array	CVM™ voxel grid	Surface/Curve



Output Example:



MapToVoxels

Map selected Unit Cell to generated CVM™ voxel grid(s) to create lattice(s)

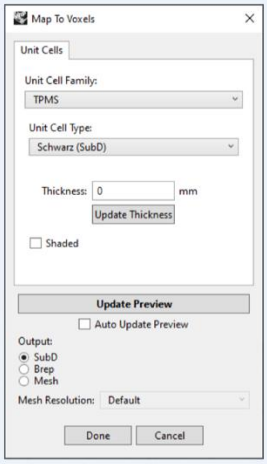
Inputs:

Name	Description
Rhino prompt	Select CVM™ voxel grid
Unit Cell Family	Shell/Member
Unit Cell Type	Geometry to map
Thickness	Thickness of shell/diameter of member
Update Thickness	Update viewport thickness
Shaded	Shade pre-baked lattice in viewport
Update Preview	Update viewport preview
Auto Update Preview	Auto update viewport preview

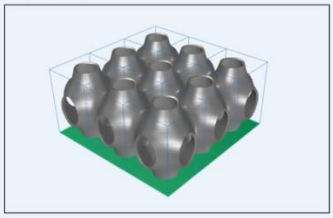
Outputs:

Name	Description	Type
Output: SubD/Brep/Mesh	Select geometry type to output to Rhino viewport	Geometry
Mesh resolution	If mesh output selected, set resolution	Mesh

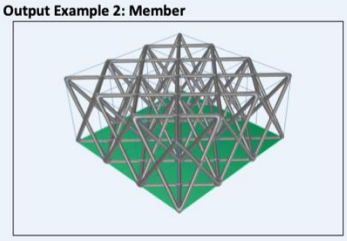
*If generating a lattice at zero thickness with a member unit cell, mapping will return the curve network



Output Example 1: Shell



Output Example 2: Member



Grasshopper Tools:

VoxelExtrude

Create a CVM™ voxel grid from a planar surface and an extrusion distance

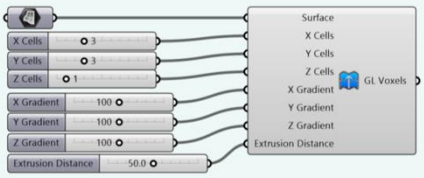
Inputs:

Name	Description	Type
Surface	Input planar surface	Surface
X Cells	Number of voxels in X direction	Integer
Y Cells	Number of voxels in Y direction	Integer
Z Cells	Number of voxels in Z direction	Integer
X Gradient	Value between 0-200 driving voxel size	Number
Y Gradient	Value between 0-200 driving voxel size	Number
Z Gradient	Value between 0-200 driving voxel size	Number
Extrusion Distance	Extrusion distance along Z axis	Number

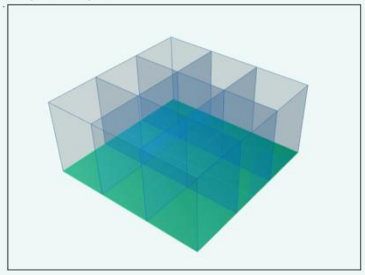
Outputs:

Name	Description	Type
Voxels	CVM™ voxel grid	Surface/Curve

Grasshopper module:



Output Example:



VoxelLoft

Create a CVM™ voxel grid connecting multiple input surfaces

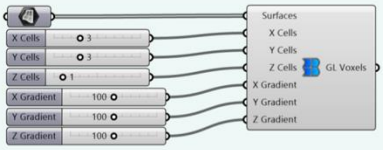
Inputs:

Name	Description	Type
Surfaces	Input multiple surfaces to voxelize	Surfaces
X Cells	Number of voxels in X direction	Integer
Y Cells	Number of voxels in Y direction	Integer
Z Cells	Number of voxels in Z direction	Integer
X Gradient	Value between 0-200 driving voxel size	Number
Y Gradient	Value between 0-200 driving voxel size	Number
Z Gradient	Value between 0-200 driving voxel size	Number

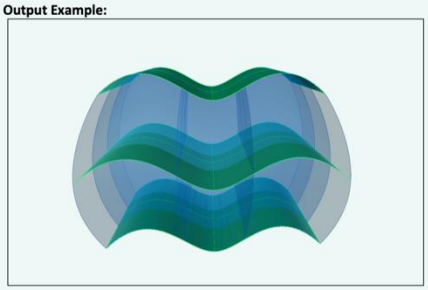
Outputs:

Name	Description	Type
Voxels	CVM™ voxel grid	Surface/Curve

Grasshopper module:



Output Example:



VoxelBBox

Create a CVM™ voxel grid from a bounding box around the input solid

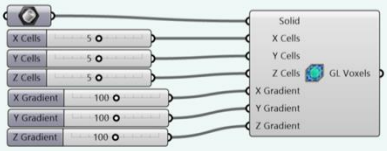
Inputs:

Name	Description	Type
Solid	Input solid geometry to voxelize	BREP
X Cells	Number of voxels in X direction	Integer
Y Cells	Number of voxels in Y direction	Integer
Z Cells	Number of voxels in Z direction	Integer
X Gradient	Value between 0-200 driving voxel size	Number
Y Gradient	Value between 0-200 driving voxel size	Number
Z Gradient	Value between 0-200 driving voxel size	Number

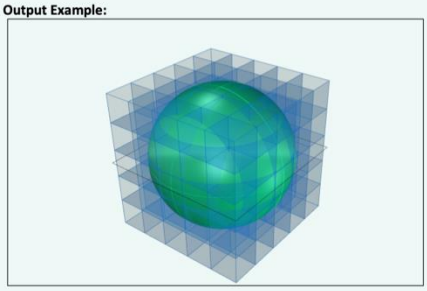
Outputs:

Name	Description	Type
Voxels	CVM™ voxel grid	Surface/Curve

Grasshopper module:



Output Example:



UnitCell

Select a Unit Cell geometry from Frontier's pre-defined shapes (shell or member) to be mapped to a CVM™ voxel grid

Inputs:

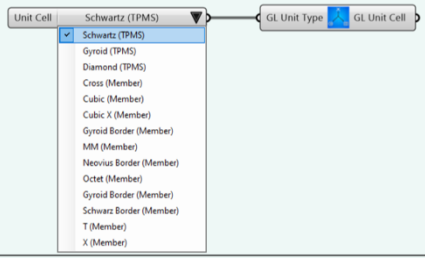
Name	Description	Type
GL Unit Type	Choose a geometry to map to a CVM™ voxel grid	Text

Outputs:

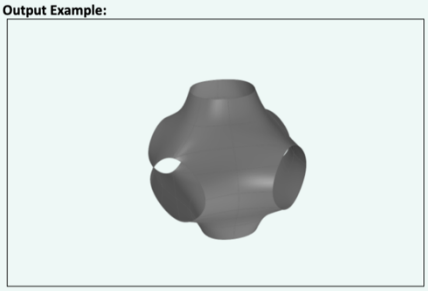
Name	Description	Type
GL Unit Cell	Unit Cell geometry to be mapped to a CVM™ voxel grid	Mesh/Curve

***For best practice, use the "Value List" component included with module**

Grasshopper module:



Output Example:



MapToVoxels

Map custom or pre-defined Unit Cell to generated CVM™ voxel grid(s) to create lattice(s)

Inputs:

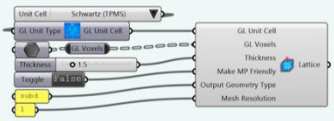
Name	Description	Type
GL Unit Cell	Input from UC Library component	Mesh(shell)/Curve
GL Voxels	CVM™ voxel grid	Surface/Curve
Thickness	Thickness of shell	Number
MP Friendly	Clean curve network for use with MP	Boolean
Geometry Type	Output lattice geometry type	Text (subd, mesh, brep)
Mesh Res.	Value between 0-3 driving mesh quality	Integer

Outputs:

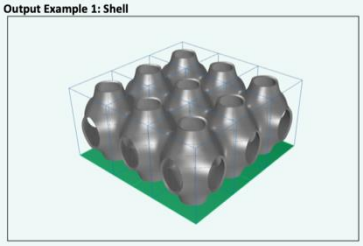
Name	Description	Type
Lattice	Map a UC to a CVM™ voxel grid, set thickness, and geometry type	Geometry

***If a curve-based Unit Cell is used, thickness, geometry type, and mesh resolution are not used**
****If a shell-based Unit Cell is used, Make MP Friendly is not used**

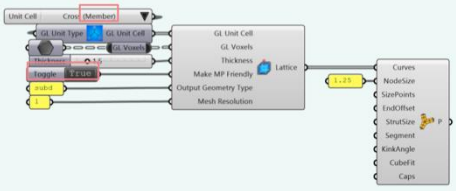
Grasshopper module:



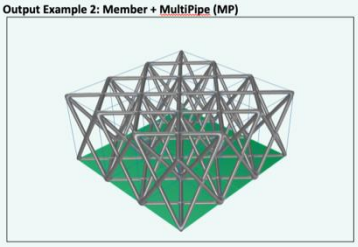
Output Example 1: Shell



Grasshopper module:



Output Example 2: Member + MultiPipe (MP)



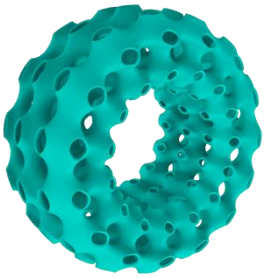
Flexible Data Conversion

Frontier's flexible data architecture allows users to choose which geometrical format is ideal for an application all within a single platform.

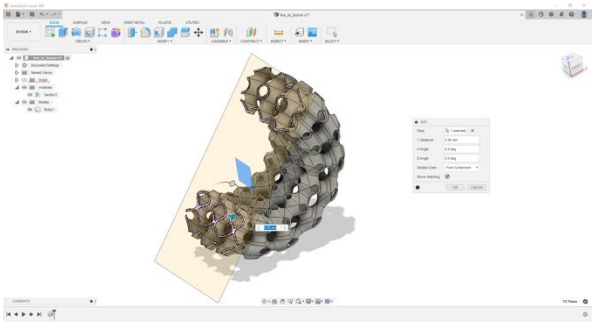
Benefits:

- Dictate shape resolution while modeling to balance between the number of voxels and computation time
- Access tools specific to certain formats within rhino
- Enables a wide range of compatible softwares, extending workflow options

Example

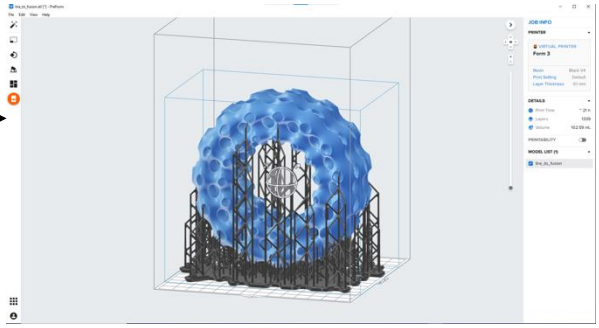


Initial CAD Model



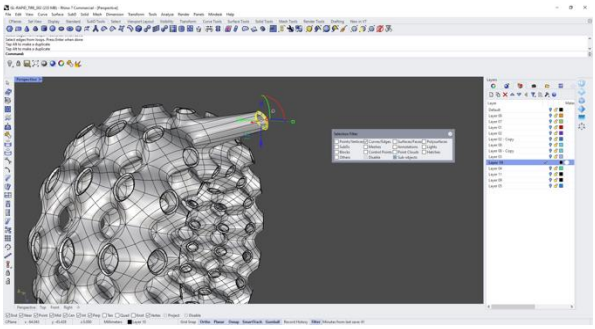
CAD Software (B-rep):
Solid Modeling

Software Examples:
Solid Works, Fusion 360, etc.



Slicing Software (Mesh):
3D Printing Preparation

Software Examples:
PreForm, Simplify3D, etc.



Sculpting Software (sub-D):
Organic Modeling

Software Examples:
Rhino, Maya, etc.