Automating Lattice Creation for Additive Manufacturing

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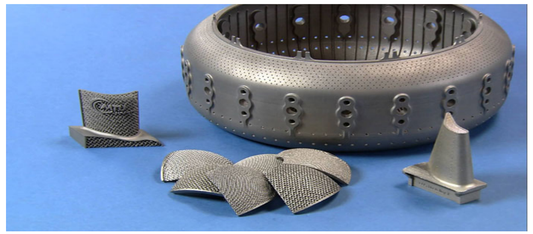
Introduction

3-D Printing in Aerospace:

- Allows for complex geometries using simple unit cells for applications



Current Problems:

- Designing the unit cells and combining them together in a modeling software such as Solidworks is a process that is time-consuming and memory draining

My approach:

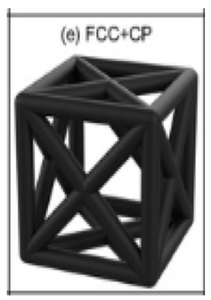
- Developing a computer script that can produce unit cells based on user generated inputs of sizes, shape, and thickness

Objectives

Goals:

- Use MATLAB to generate different types of unit cell files, primarily Simple Cubic, Face Centered Cubic, and Body Center Cubic Unit Cells as pictured below

Simple Cubic



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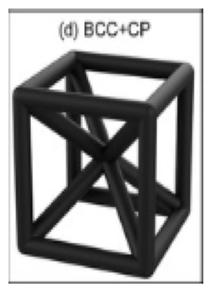

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- Other potential unit cells are triangular or octahedral unit cells and combine them

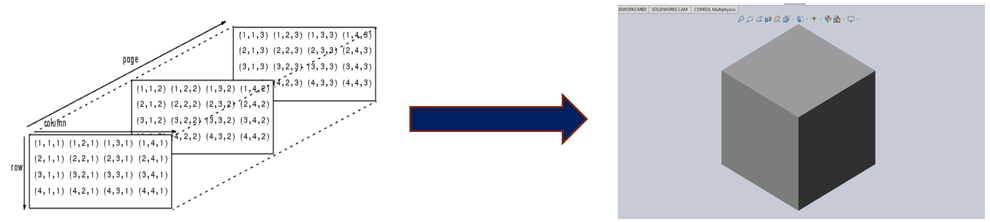
Materials & Methods

Materials:

- The primary materials for this project are MATLAB and Solidworks

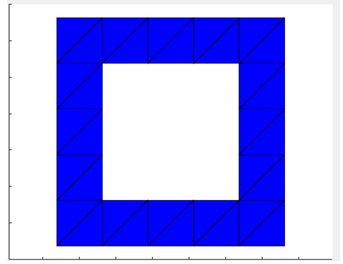
Methods:

- The backbone of the code changes 3-D voxelized (binary with 1's which represent part of the object and 0's are not part of the object) matrices into a .STL file



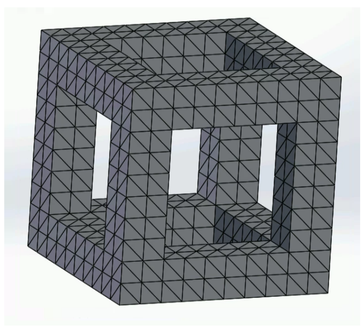
- Main task of summer research was coding automating creation of different types of 3-D matrices

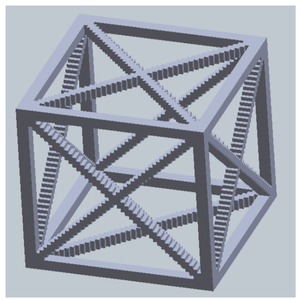
```
val(:,:,1) =

     1     1     1     1     1
     1     0     0     0     1
     1     0     0     0     1
     1     0     0     0     1
     1     1     1     1     1
```

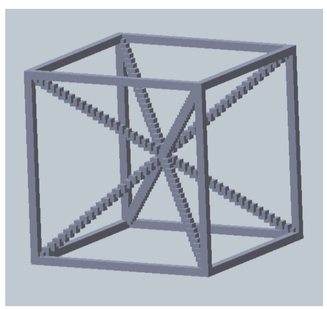


Results

- Code Header: `function [outputM] = makeCubicUnit(size,thickness,type)`







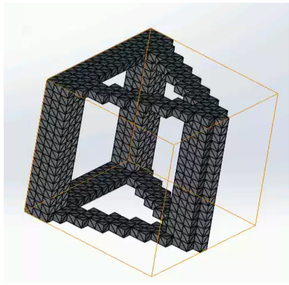
Conclusions

Reaching Objectives:

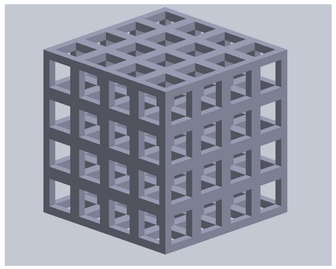
- The code successfully produced the cubic unit cells at various sizes and thickness

Shortcomings:

- The failures of the code is that it cannot produce struts at angles so other unit cells look askew



- Combining the unit cells together worked for smaller sizes, but once the tessellations got large, the files would be too large for MATLAB



Further Studies

Things to work on:

- Making other unit cells with Ansys APDL using a mesh to lattice script
- Successfully combine multiple unit cells, regardless of size

References

- Framework script: Adam A (2020). Converting a 3D logical array into an STL surface mesh
- Unit cell pictures: Chen, W., Zheng, X. & Liu, S. Finite-Element-Mesh Based Method for Modeling and Optimization of Lattice Structures for Additive Manufacturing. *Materials* **11,** 2073–20 (2018).