Unbox 3D

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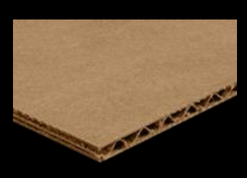
Background

ARL is the Army's central R&D organization, advancing science and technology to ensure future battlefield dominance. Its work supports innovation in AI, robotics, materials, and more.

Objectives

Our mission is to simplify the transformation of 3D objects, stored in .stl or .obj formats, into precise 2D net representations. These 2D nets will be exported in a format compatible with laser cutters, enabling accurate cuts and folds on corrugated cardboard. Our goal is to ensure that these 2D shapes can be seamlessly reassembled into their original 3D forms, combining efficiency and accuracy to meet the needs of military training and beyond.





Testing & Reliability

xUnit - Unit Testing Framework
We used xUnit to write and run automated tests to verify that our application logic behaves correctly. This improves:

Code quality
Stability
Confidence in new features or refactors

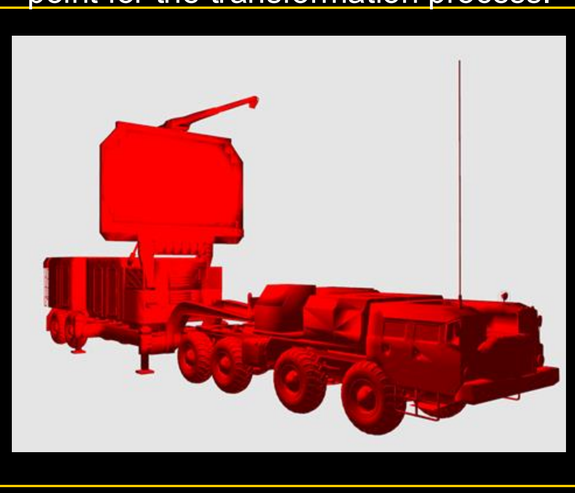
Moq - Mocking Dependencies for Isolation
We used Moq to allow us to simulate dependencies so we can test our logic in isolation without needing the real systems. By using Moq, we can

Focus on specific parts of our code without worrying about external factors
Verify interactions
Speed up tests and avoid complex tests setup

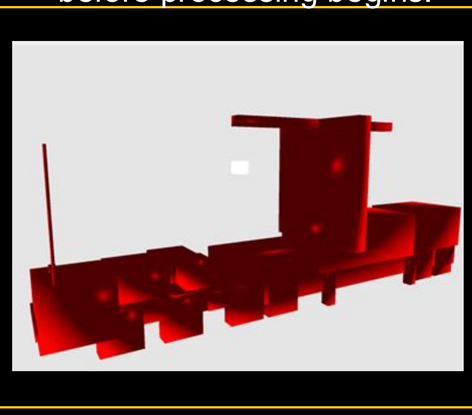
Process



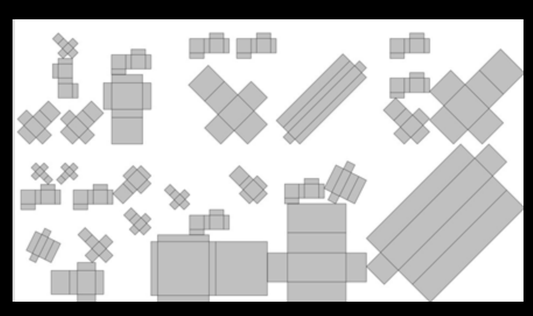
A high-detail 3D model used in simulation and training scenarios. This serves as the starting point for the transformation process.



The original model is loaded into our pipeline. Geometry is preserved at this stage for fidelity before processing begins.



The model is reduced to basic shapes and components. This step enables cleaner unfolding and prepares the layout for 2D transformation.



A flattened version of the simplified model, structured for compatibility with vector-based fabrication tools such as laser cutters.

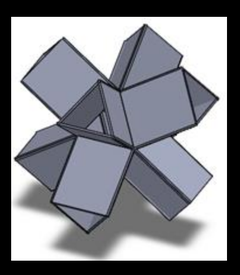
Challenges

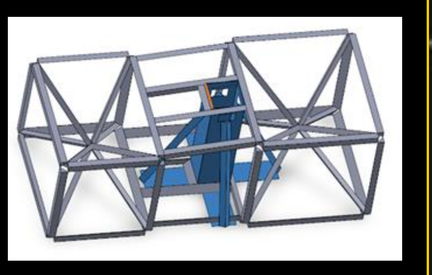
- Finding the best simplification techniques like decimation, photogrammetry, and replacement.
- Modifying Export Paper Model to accommodate for nonpaper dimensions
- Proper implementation of lighting and visualization

Future Scope

In the future, labeling for laser cutting could be added once a model is exported and unfolded.

Additionally, we could include adding structural supports to our models.





Conclusion

This project demonstrates user-friendly design, modern .NET development, and 3D geometry processing. By combining OpenTK for real-time 3D rendering, Blender scripting for mesh unfolding, and tools like xUnit and Moq for automated testing, we created a powerful yet accessible application for visualizing and simplifying complex 3D models.

