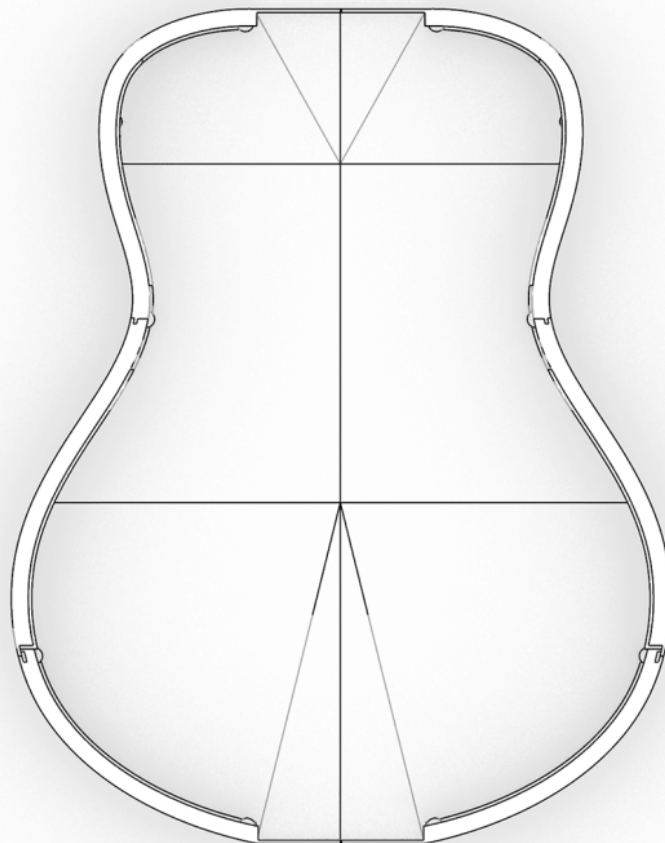


Rethinking Acoustic Guitar Construction Through Digital Fabrication

This project began with a fundamental question: how can acoustic guitars be built efficiently without relying on traditional, labor-intensive luthiery or large-scale manufacturing? The objective was to develop a digitally native instrument, designed entirely in CAD and optimized for distributed fabrication using accessible tools such as 3D printers and basic woodworking equipment.

From the outset, the design strategy focused on simplifying construction. Processes such as wood bending were eliminated, glue-intensive steps were minimized, and off-the-shelf components like a bolt-on neck and metal bridge were integrated. The challenge was not only to reduce complexity, but to do so while maintaining structural integrity and acoustic performance.

Top



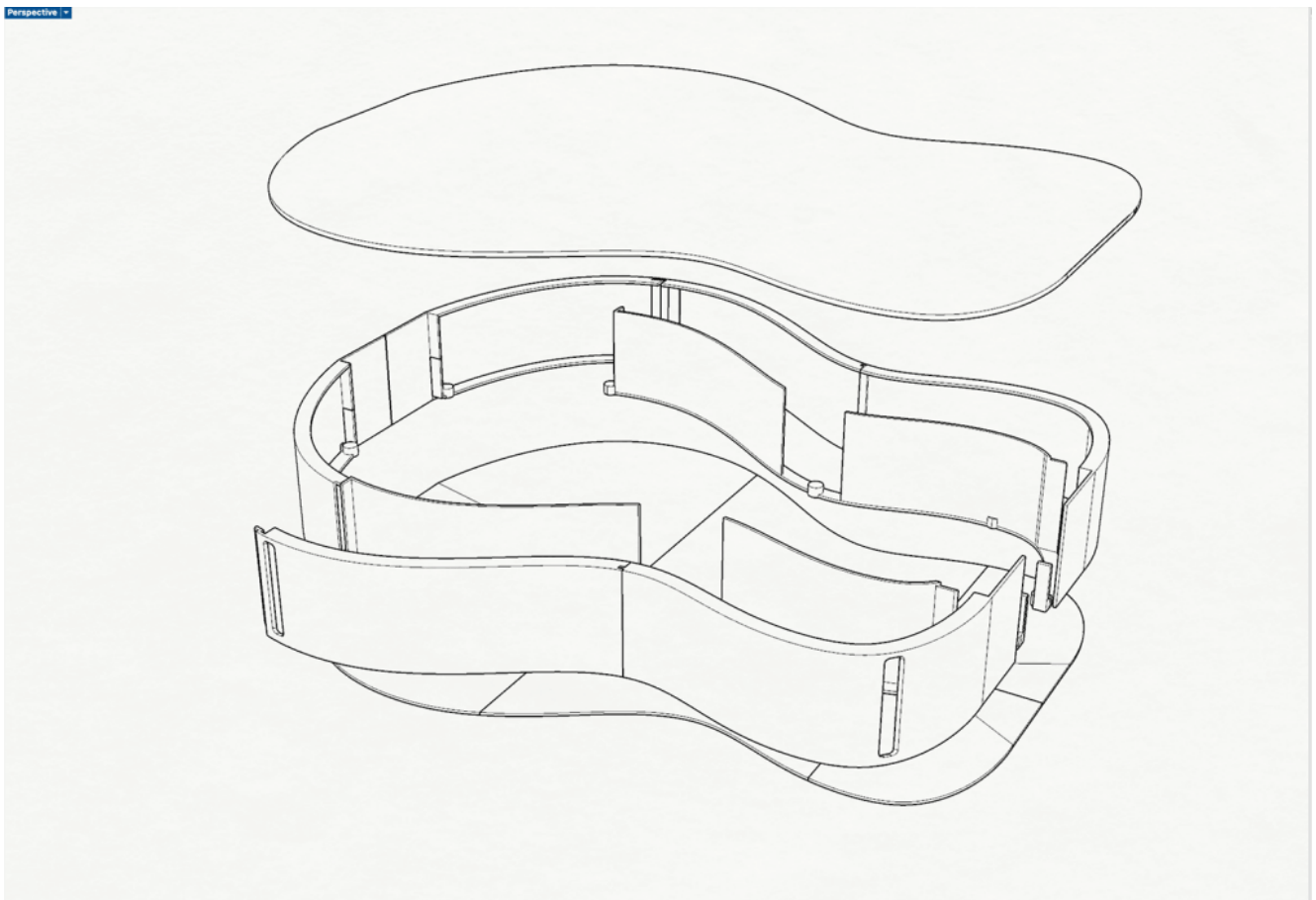
Top view in Rhino showing the double-walled side structure and

internal channel layout.

MODELING WORKFLOW IN RHINO

The entire project was developed in [Rhino 8](#) using a [NURBS](#)-based workflow, starting from a single curve defining the guitar body outline. This curve remained the backbone of the model, driving surface generation and solid construction throughout the process.

Core commands such as **OffsetSrf** were used to establish wall thickness, **BooleanUnion** to create watertight bodies, and **Split** to divide the model into manufacturable sections. The model was organized within a single file using layers to separate components, including the top, back, sides, and internal structures, enabling efficient visibility control and export workflows.

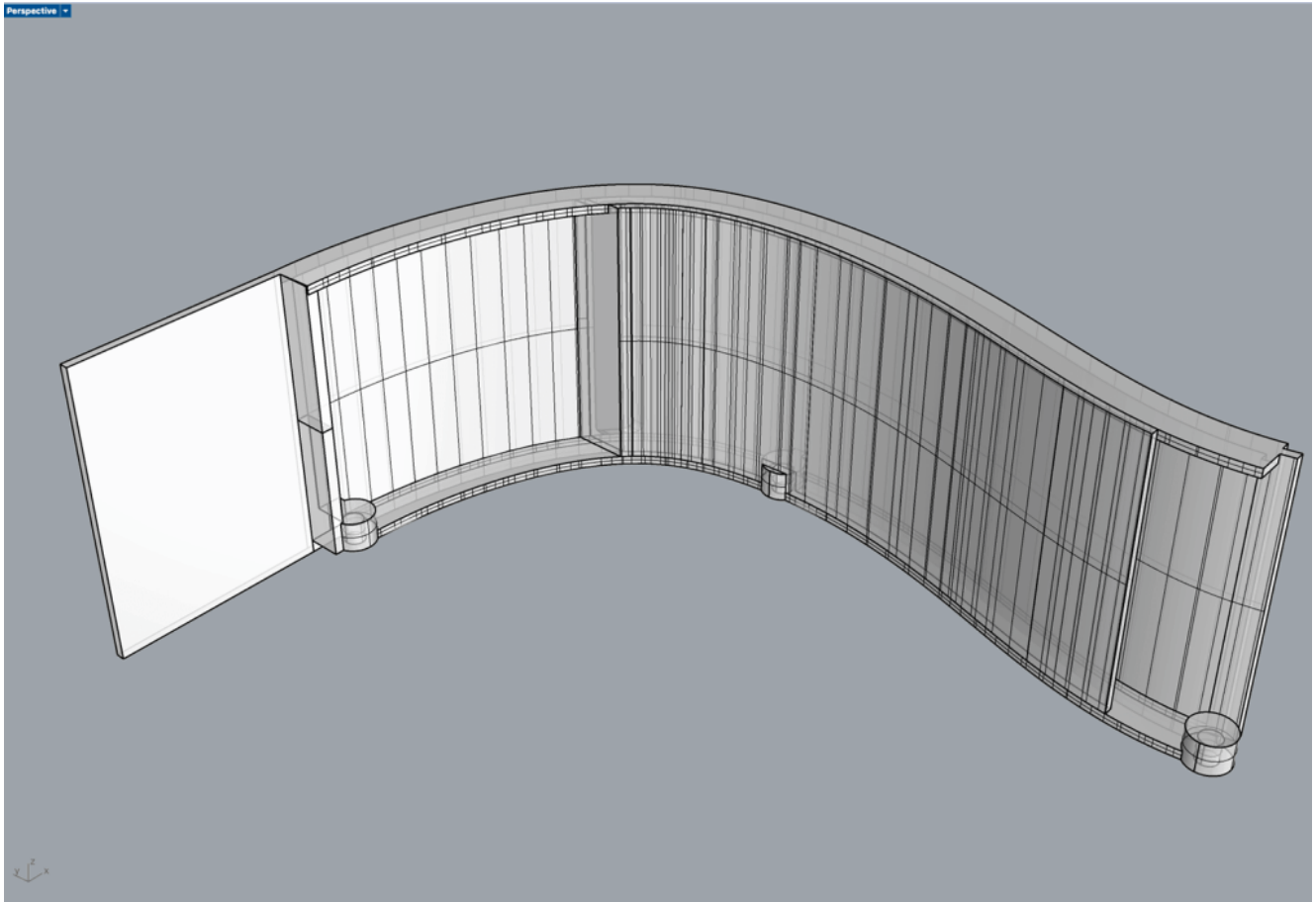


Exploded view of the guitar components, illustrating segmentation strategy for fabrication and assembly.

One of the key technical challenges was ensuring watertight geometry suitable for 3D printing. Rhino's analysis tools, particularly the **What** command, were used extensively to validate geometry and

understand object structure. Additionally, Rhino played a central role in calculating internal volumes, which directly informed acoustic decisions.

For fabrication, STL files were exported with controlled mesh settings, balancing resolution and file size to preserve curvature quality while maintaining dimensional accuracy for assembly.



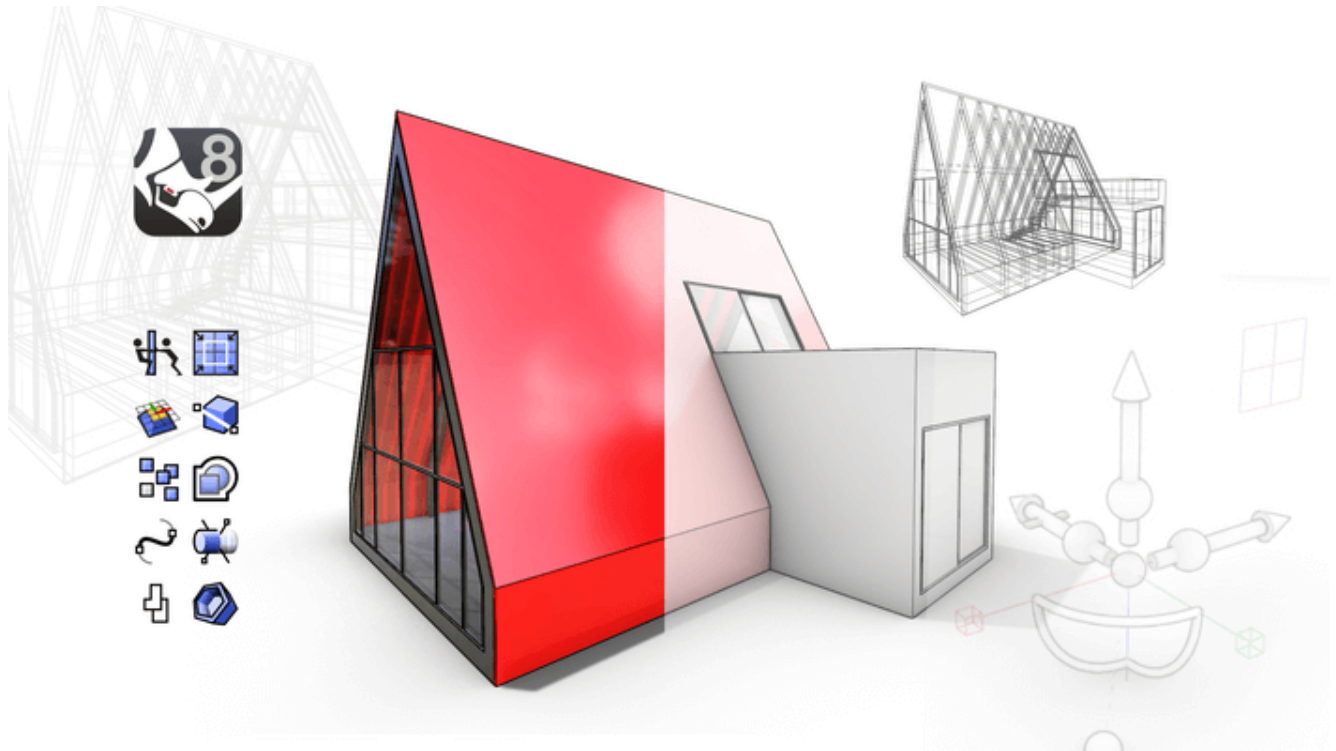
Section view highlighting the double-walled construction and internal air channels used for acoustic tuning.

AI-ASSISTED LEARNING

A distinctive aspect of the project was the use of large language models as both learning tools and collaborators. Starting with no prior CAD experience, the designer followed structured learning paths generated through AI and refined them iteratively.

When encountering technical issues, detailed prompts, including Rhino geometry reports, were used to diagnose problems and generate solutions. Because responses varied in reliability, outputs were

cross-checked across platforms and refined through repeated prompting. This iterative dialogue enabled rapid skill acquisition and allowed the focus to remain on design challenges rather than tool limitations.



[See Also](#)

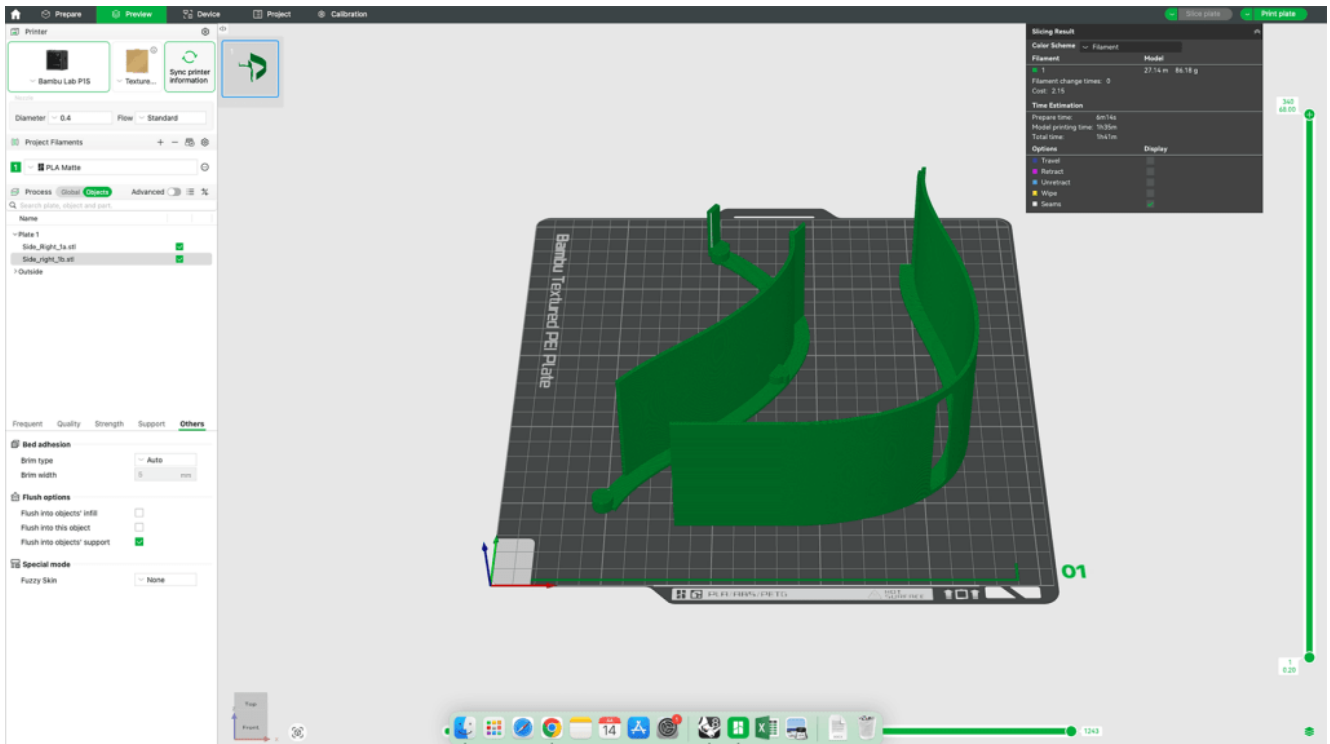
[INTRODUCTION TO RHINO 8](#)

ACOUSTIC STRATEGY: HELMHOLTZ RESONANCE WITHOUT A SOUNDHOLE

The main innovation lies in the acoustic system. Instead of relying on a traditional soundhole, the design employs Helmholtz resonance via a network of internal air channels.

In conventional guitars, the body cavity and soundhole form a Helmholtz resonator, in which the air volume and the opening geometry determine the low-frequency response. In this project, that role is replaced by four internal tunnels integrated within the double-walled side structure.

These tunnels were dimensioned using Rhino-based volume calculations to tune resonance behavior. The result is a system that enhances low-frequency response while removing the need for a soundhole, simplifying fabrication and introducing a new acoustic logic. The approach draws parallels with bass-reflex speaker enclosures, where internal channels are used to amplify lower frequencies.



Preparation of a side segment in the Bambu Lab slicer, showing orientation for 3D printing.

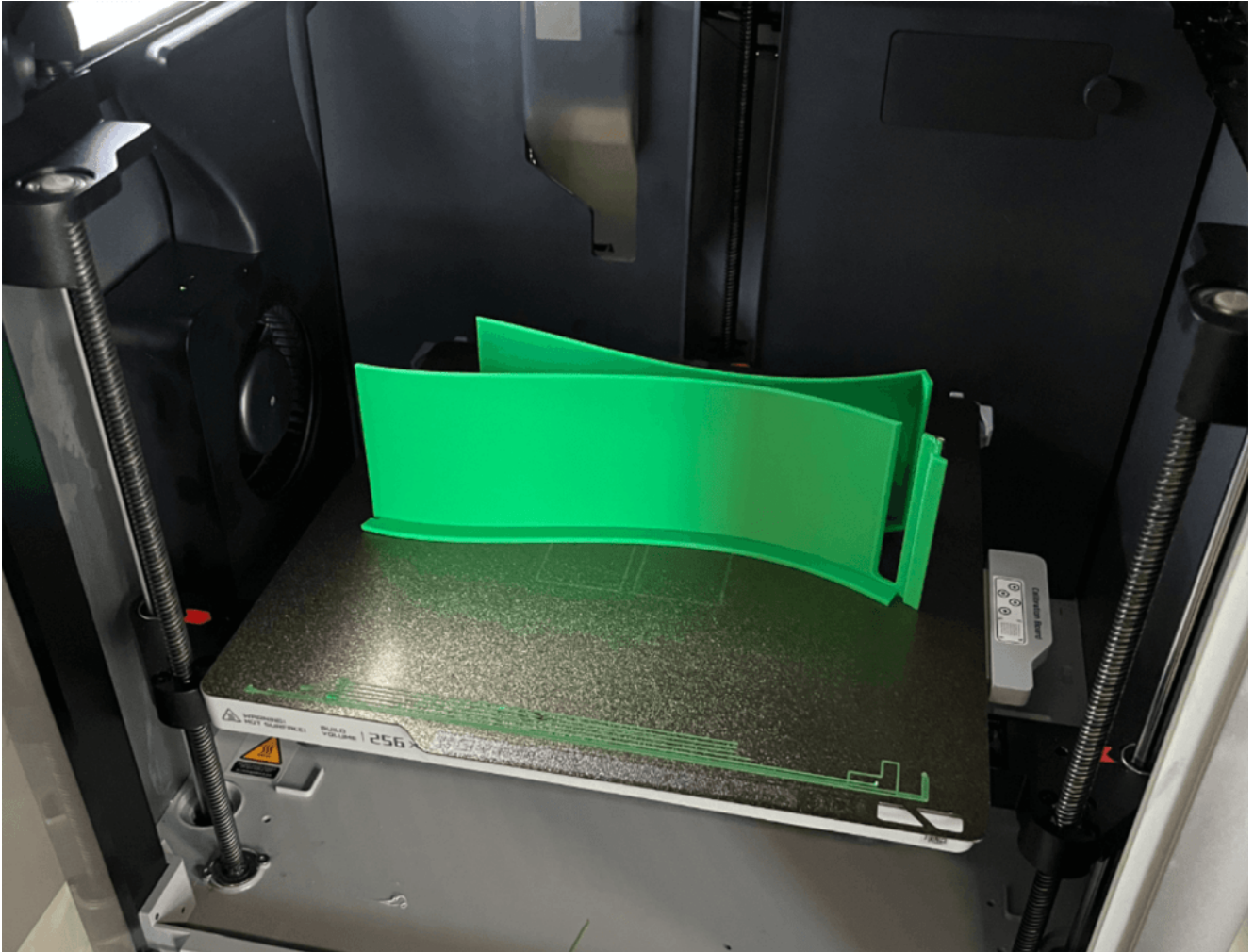
FABRICATION & ASSEMBLY

The guitar was fabricated using a hybrid approach combining 3D printing and traditional woodworking. The sides were printed as double-walled structures and divided into 12 segments to accommodate printer size constraints and avoid support-heavy geometries. The back was printed in six panels, while the top was cut from a single sheet of plywood.

All printed components were assembled using epoxy, with final assembly relying on clamps, screws, and minimal specialized tools. Internal wooden blocks and carbon fiber rods were added to reinforce the structure.

This segmented strategy allowed the design to remain compatible with

standard desktop 3D printers while maintaining alignment precision and structural continuity.



3D-printed side section.

OUTCOME

The final prototype performs comparably to an entry-level acoustic guitar. While there is room for improvement in projection and efficiency, the instrument is lightweight, structurally stable, and maintains reliable tuning. Adjustable intonation and action provide additional flexibility not always present in traditional builds.



Body assembly with internal wooden reinforcements and carbon fiber rods.

Overall, the project demonstrates the viability of combining Rhino, AI-assisted workflows, and digital fabrication to rethink instrument

design from both a production and acoustic perspective. This approach points toward more accessible, decentralized instrument production, where digital design replaces traditional, time-consuming and expensive methods. Learn more about [Q³ Factor™](#) and how they use engineered tridimensional structures to shape these innovative instruments.



Final assembled prototype demonstrating the hybrid construction of 3D-printed sides and wooden top.

CREDITS

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Moonlighter FabLab – Maker Space