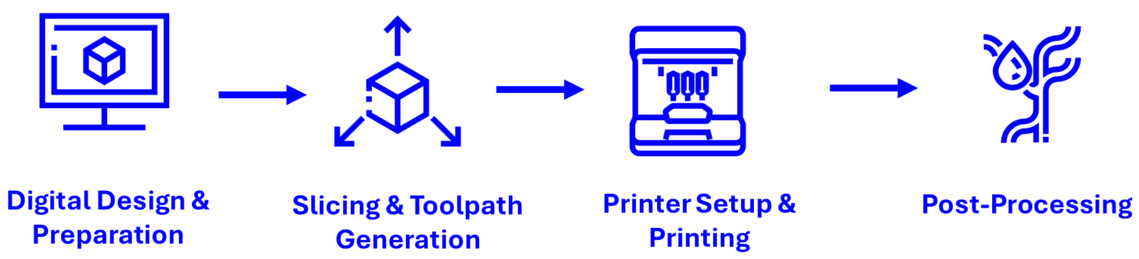
Advancing tissue engineering through non-planar bioprinting of complex anatomical structures

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INTRODUCTION

This poster addresses a key limitation of conventional planar bioprinting: the inability to reproduce the smooth curvature and topographical continuity of native tissues. Here, we present two complementary non-planar BIO X series approaches: conformal GelMA-C deposition onto a curved Pluronics nose scaffold, and embedded coaxial printing of branched GelMA-C vascular constructs within a CELLINK START support bath using sacrificial Pluronics 40% lumens.



Non-planar process for BIO X series path preparation and printing.

Over-surface non-planar printing

An anatomical nose STL model was split into planar base layers and a curvature-following top surface. Pluronics 40% formed the scaffold, and GelMA-C was deposited conformally over the surface using a TCPH and 405 nm photocrosslinking.

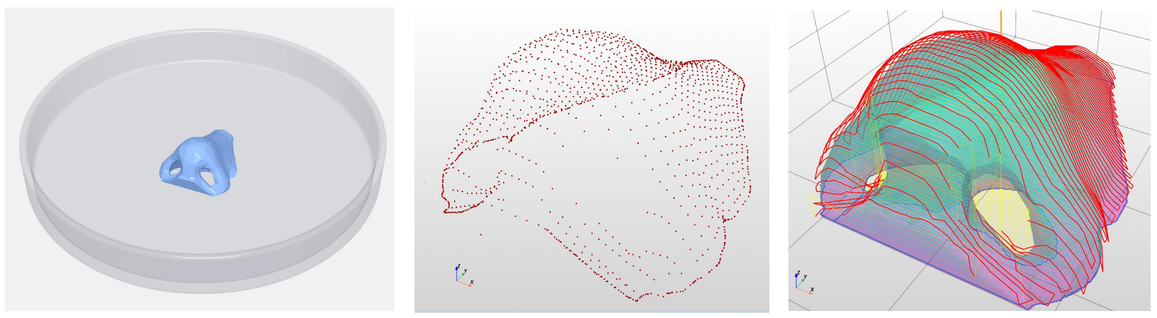


Figure 1. Nose construct approach showing the anatomical STL scaffold, curvature-following toolpath generation using a custom software interface, and the corresponding non-planar generated G-code path.

Embedded coaxial non-planar printing

A branched vascular STL was converted into a non-planar coaxial path for embedded printing inside CELLINK START. GelMA-C formed the shell while sacrificial Pluronics 40% defined the lumen and preserved branching fidelity during printing.

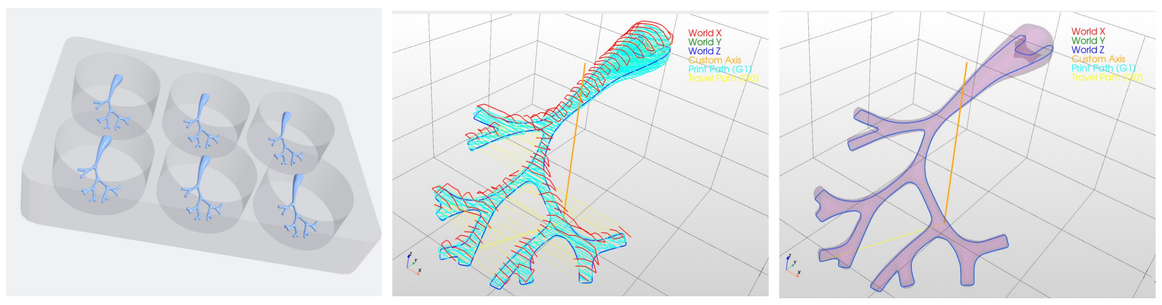


Figure 2. Embedded vessel approach showing the branched well-plate model, generated non-planar infill / perimeter travel paths, and the mesh-aligned perimeter representation to compare generated perimeter and reference model.

Toolpath generation & validation

This approach combines ImagoBot, a custom software interface for curvature-aware slicing, with a custom G-code Tool utility application. Together, these tools convert STL surfaces or coordinate clouds into BIO X-compatible paths, separate extrusion (G1) and travel (G0) moves, insert Z-hops, and enable 3D G-code simulation and validation before printing in DNA Studio.

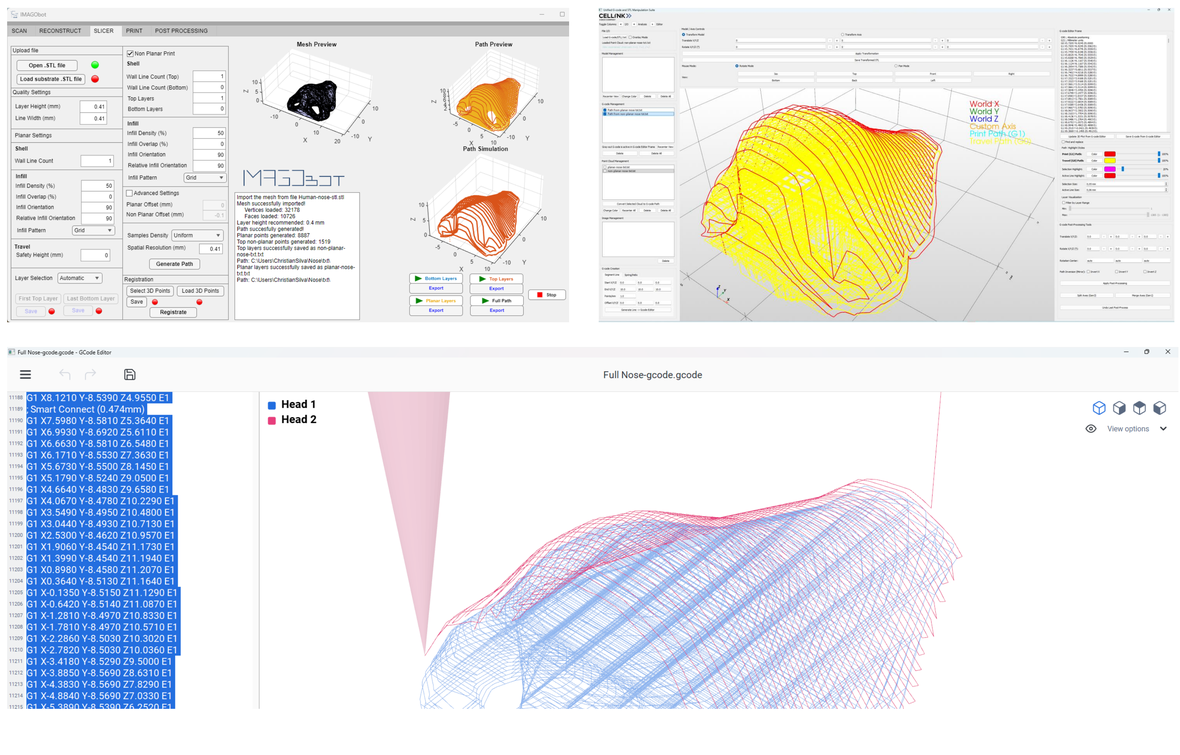


Figure 3. Software-assisted preparation and validation: ImagoBot setup, perimeter extraction, and fused nose toolpath review before export to BIO X using DNA Studio.

Results & interpretation

These two non-planar approaches extend BIO X series bioprinting beyond conventional flat-slice fabrication. In the nose model, conformal over-surface deposition achieved approximately 95% geometric agreement with the reference STL geometry. In the vascular model, embedded coaxial printing enabled stable fabrication of branched lumen-like structures with preserved channel architecture after sacrificial ink removal. Together, these approaches expand BIO X series bioprinting toward regenerative constructs with greater anatomical fidelity.

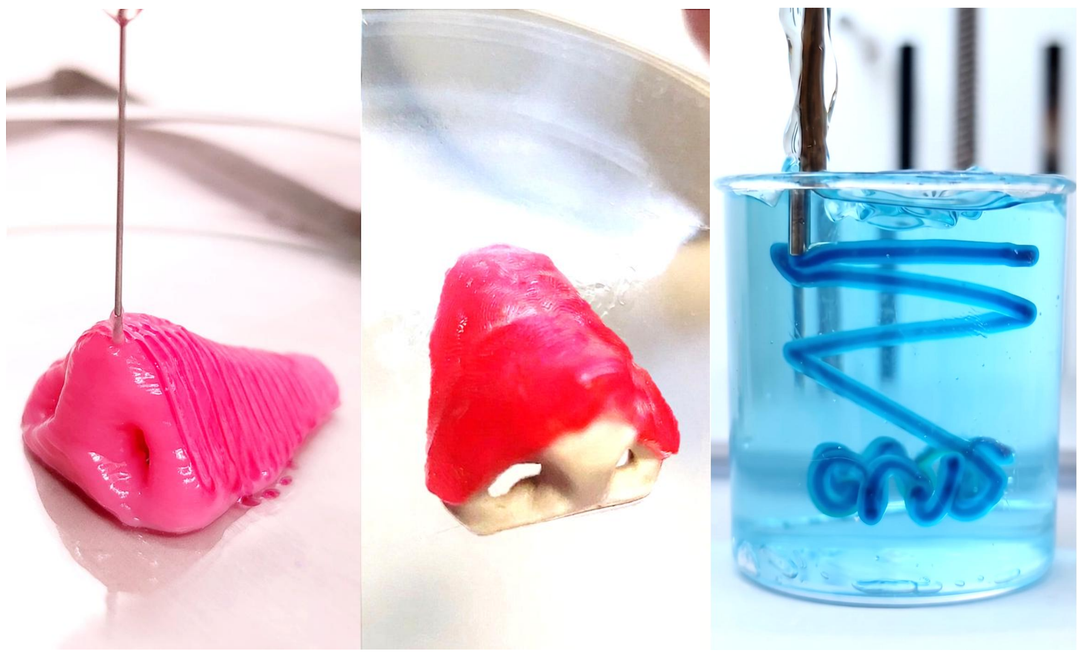


Figure 4. Representative output views: curved anatomical model printing, non-planar construct transferred after crosslinking to a rigid anatomical surface, and a printed branched construct after embedded fabrication.

SUMMARY

- Conformal deposition and embedded coaxial printing extend BIO X series bioprinting beyond conventional flat-slice fabrication.
- Curvature-aware slicing and G-code correction improve continuity and reduce travel artefacts.
- GelMA-C, Pluronics 40%, and CELLINK START support reproducible skin-like and vascular-like demonstration constructs.