COLOURS TOOL · PERCEIVE LEGACY

StyleShade3D

Enhancing 3D mesh reconstruction with deep learning segmentation.

3D Semantic Segmentation | Region-Based Shading & Stylization | WebGL 3D Visualization Tool

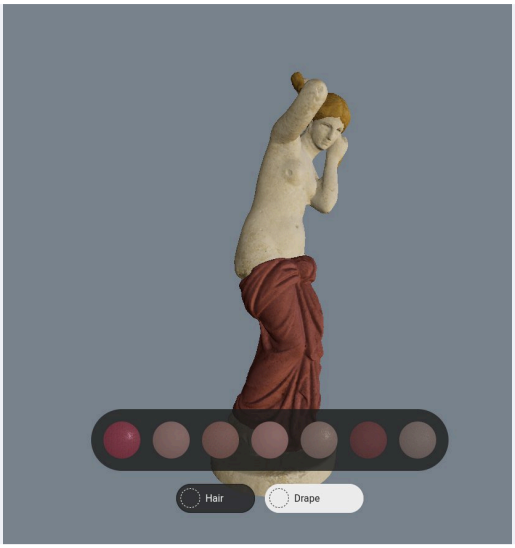


Fig. 1: Virtual reconstruction of the Anadyomene Venus (MANN – PERCEIVE project). StyleShade3D was used to stylise (marble) and shade (hair and drapery) different regions of the statue. Different hypotheses can be tested in real time.

OVERVIEW

StyleShade3D is an existing WebGL-based tool originally developed within the PERCEIVE project. It enhances 3D mesh reconstruction by integrating deep learning segmentation into a conventional geometry and material pipeline. The system incorporates models such as Segment Anything Model to generate a semantic segmentation atlas – a 2D parameterized map aligned with the 3D surface - enabling region-aware shading and stylisation. Different materials, rendering models, and artistic effects can therefore be assigned to specific parts of a mesh. The workflow begins in BlenderProc, where a full-orbit camera animation captures optimized multi-view images to ensure complete surface coverage. Inspired by path-planning strategies, the pipeline minimizes the number of views while preserving geometric completeness. Using SAM's tracking features, consistent multi-view segmentation maps are generated and consolidated into a unified atlas. Since CAD models often lack UV coordinates, a texture atlas is created using Blender's Smart UV Project algorithm. The segmented projections are merged into a 2D semantic atlas, which drives region-specific shading and deep stylisation models.

Within the COLOURS project, StyleShade3D will be further extended and technically enhanced, expanding its capabilities for advanced semantic control, material modeling, and artistic rendering of 3D assets.

KEY FEATURES

- Deep learning–driven semantic segmentation integrated into a 3D reconstruction pipeline
- Automatic creation of a 2D semantic atlas aligned with the 3D surface
- Region-specific shading and material assignment for fine-grained visual control
- Optimized multi-view acquisition and consistent segmentation tracking
- WebGL-based interactive tool designed for extensibility and advanced stylisation

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IN PRACTICE: A USER STORY

Tom is a digital heritage researcher. His team has recently completed a high-resolution 3D scan of the Venere Anadyomene, one of the museum's iconic sculptures and a key case study in the PERCEIVE project. While the geometry is accurate, Tom wants to explore hypotheses about its original appearance, experimenting with different materials and surface treatments, without manually segmenting the mesh.

Tom uploads the 3D model with UVs coordinates into StyleShade3D. The system automatically processes it through a multi-view rendering pipeline, generating segmentation maps from multiple viewpoints and consolidating them into a semantic atlas. Instead of spending hours defining regions by hand, Tom immediately sees the statue divided into meaningful parts (hair, drapery, skin, pedestal) ready for semantic editing.

Using the WebGL interface, he selects the drapery and applies a marble shader, then experiments with a subtle polychrome stylisation on the hair using a deep style transfer model. The shading remains physically plausible, preserving the sculpture's volume and fine details. Inspired by conservation studies on ancient polychromy, he tests different material assets and compares results in real time.

Meanwhile, Anna, a museum curator, joins him remotely. Together, they create multiple visual scenarios: a neutral conservation rendering, hypothesized coloured reconstructions, and several interpretations for an interactive exhibition. Each version can be exported for web visualization or immersive storytelling applications.

Within hours, what once required complex manual workflows becomes an intuitive, semantically guided process, bridging research, conservation, and creative dissemination of cultural heritage.

WHY ON THE CULTURAL HERITAGE CLOUD?

Building StyleShade3D on top of the ECCCH is technically coherent with both the COLOURS vision and the Cloud's objectives. From a technical perspective, ECCCH provides a shared infrastructure for storing primary data, digital twins, and associated documentation, ensuring long-term preservation, versioning, and secure access. StyleShade3D benefits from this by consuming high-quality 3D scans, semantic metadata, and conservation records directly from the Cloud, while writing back segmentation atlases, material hypotheses, and stylized variants as traceable research outputs.

Cloud deployment also enables distributed processing, browser-based WebGL access, and real-time collaboration between conservator-restorers, curators, and scientists across institutions, fully aligned with ECCCH's goal of supporting interdisciplinary, data-driven heritage workflows at European scale.

WHO CAN USE IT

StyleShade3D can benefit multiple communities within the cultural heritage ecosystem. Conservator-restorers and conservation scientists can use it to test colour hypotheses and simulate restoration outcomes on digital twins. Curators and museum professionals may employ it for exhibition design and interpretation, while art historians and archaeologists can explore material and stylistic reconstructions. Creative industries, including digital artists, game developers, and XR designers, can leverage the tool for high-quality, semantically controlled 3D assets.

EXPECTED TIMELINE

Alpha 2026
Stable core functions

Beta 2027
Pilots with heritage institutions

Release 2028
Production-ready on the ECCCH

COLOURS project runs from 1 October 2025 to 30 September 2028. Within this timeframe, StyleShade3D will transition from its existing PERCEIVE prototype to a fully cloud-integrated service aligned with the ECCCH.

An alpha version is expected in 2026, focusing on stabilizing the core functionalities. A beta version is planned for 2027, enabling pilot deployments with selected heritage institutions. By the end of the project in 2028, the tool is expected to reach a production-ready release fully interoperable with Cloud.

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All COLOURS tools:
colours-eccch.eu/tools

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