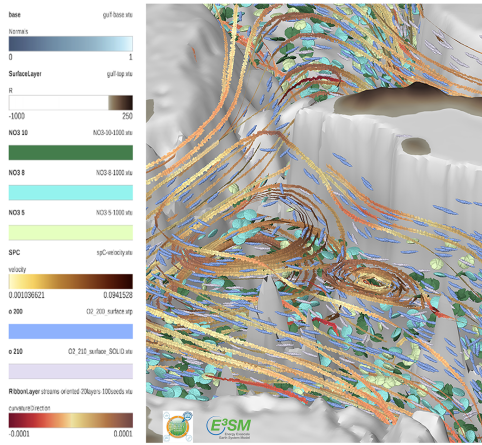
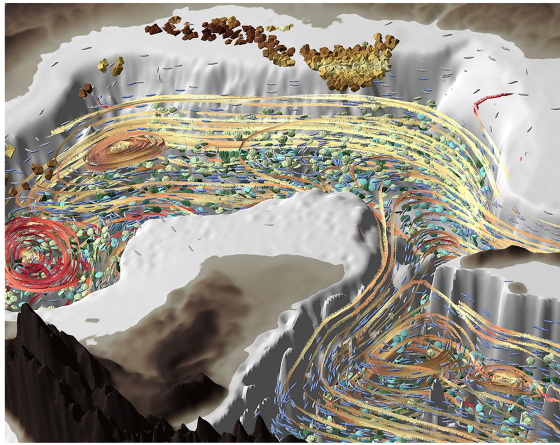




# Sculpting Visualizations

Expanding the Vocabulary of Scientific Visualization,  
Facilitating the Construction of Engaging Communication of Complex Science  
Francesca Samsel, Seth Johnson, Gregory Abram, Bridger Herman, Phillip Wolfram, Daniel Keefe

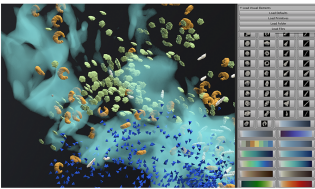
As scientific data grow larger and more complex, an equally rich visual vocabulary is needed to fully articulate its insights. We present a series of images that are made possible by a recent technical development "Artifact-Based Rendering," a component of our broader effort to create a methodology for sculpting scientific visualization that draws on principles of art and design.



The theory is, in part, to leverage the richness and control over visual expression that is possible when artists work with traditional media. The ease of iteration and experimentation simply cannot (yet) be matched in the digital world. By starting in the physical world and moving to the digital, our approach seeks to effectively convey data while increasing sustained engagement and connect with our humanity.



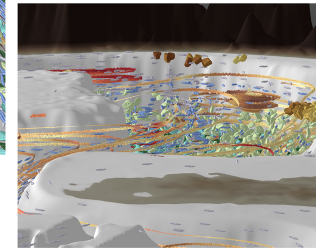
Art, at its core, stems from our human desire for connection to others and to our world. Scientists, particularly those in the environmental community, often struggle to connect and to communicate with their peers and with the public. Widely used 3D visualization software packages, such as Paraview, include small sets of 3D glyphs, typically based on standard geometric primitives. Our work enriches the visual language available for multivariate 3D visualization and provides a means of connecting the science with our humanity.



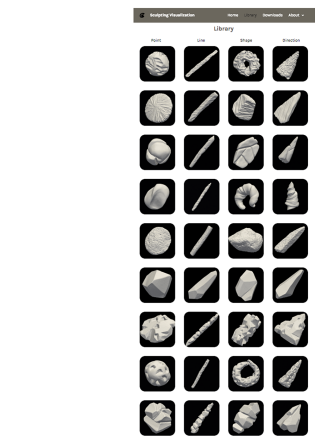
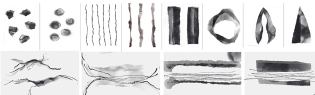
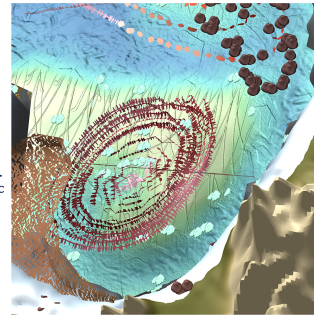
The Artifact-Based Rendering interface

Artifact based rendering is a tool that enables visualizations to include physical media. Whether natural, machine-made, or handcrafted, objects can be scanned and applied to visualizations as glyphs, ribbons, or surface textures. ABR introduces new technical tools and algorithms for front-end applets to create artifact-based colormaps, to optimize 3D scanned meshes, and to synthesize textures from artifacts, as well as a back-end VR-enabled rendering system. Ultimately, ABR allows for more effective and informative visualizations by expanding the visual vocabulary for scientific visualization, enabling artists and other non-programmers to participate in the design process, and bringing a more natural, handmade aesthetic to digital visualization.

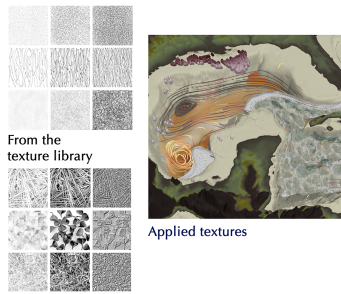
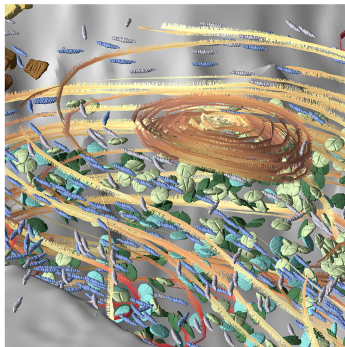
These visualizations, depicting Los Alamos National Laboratory's MPAS-Ocean biogeochemistry simulation of the Gulf of Mexico, encode multiple variables within one image thus enabling scientists to identify how the ocean conditions impact the plankton. There are over 30 variables, encompassing both physical conditions such as temperature and velocity as well as physical elements such as plankton, carbon and nitrates. Understanding the impacts and dependencies is critical to answering their science questions.



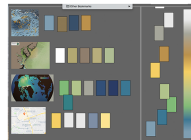
The Metropolis-Hasting algorithm enables the conversion of volumetric data into sampled point data. Thus scientists are able to view multiple 3D volumetric variables in one visualization.



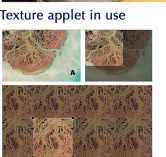
The glyph Library



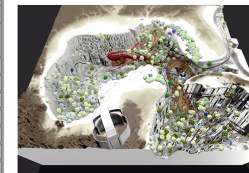
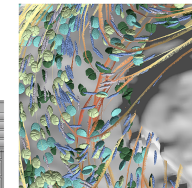
Applied textures



Color Loom applet for creating custom colormaps



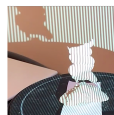
Selecting glyphs and colormaps



Viewing 3D results in virtual reality

By bringing the human hand and the natural world to data visualization, our work helps scientists to visualize their data in a richer visual vocabulary that is more expressive and informative. This work is part of a larger project including a suite of interfaces, algorithms, tools, and guidance to capture, extract, and apply physical forms.

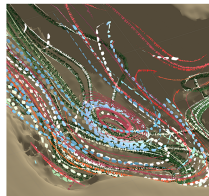
Artists and design-minded practitioners are experts in conveying complex ideas visually, using rich visual vocabularies able to articulate associations between visual elements. Our methodology builds on the perceptual sciences research on encoding data for visualization by identifying solutions applicable to 3D time varying multivariate data and drawing upon design principles to create more complex sets of encodings with inherent intuitive associate properties and hierarchies.



Capturing the glyphs



Glyph construction



Using a variety of the line options

www.sculpting-vis.org

