From Human Hands

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Should visualization look natural and not sterile? Should it source material from human hands, or only from software? Just ask Dan Keefe, whose research with Artifact-Based Rendering demonstrates that the fine arts can augment scientific visualization.

Keefe currently teaches in the Department of Computer Science and Engineering, University of Minnesota, where he directs the Interactive Visualization Lab. Having grown up with visual art, Keefe studied both computer engineering and oil painting in college. A summer internship at NASA Langley's data animation and visualization lab blew his mind, setting him on a path to combine the technical with the artistic. He even went to grad school at Brown University so he could collaborate with artists and illustrators at the nearby Rhode Island School of Design.

All of which surfaces in Artifact-Based Rendering, a framework that leverages the visual languages of traditional fine arts, or even nature, as input for the digital visualization pipeline. With artists helping design the visual language used to represent data, a more natural result emerges.

ELEVATE THE ARTIST

In previous generations, an artist's role might be simply showing up to the lab and giving advice on which color palette is better for plotting, say, temperature. Then, in later days, maybe the artist provided some additional design knowhow to supplement the way the visual language could be presented.

"There was always a hang up, in terms of the artists might come up with these amazing visual ideas, but how do they actually express it, given the computer tools that are available for data visualization," Keefe says.

With Artifact-Based Rendering, supported in part by a National Science Foundation grant, (IIS-1704604 & IIS-1704904), artists create 2-D drawings or 3-D sculptures, inspired by their own muses and/or the organic forms of nature, all of which is then 2-D or 3-D scanned to serve as building blocks for real data-driven visualizations. The artist then picks which visual elements—lines, textures, colors, topographies, or even whole glyphs—are best suited to represent specific variables in the data. The artists do not have to spend months learning software that only limits their expertise or barely even replicates the creative process. As a result, artists can contribute more effectively to visualization teams.

In previous cases, what usually happened was the artist's vision got dumbed down throughout the whole process. Their creative input often got lost, so that it rarely felt like a true collaboration.

With the framework of Artifact-Based Rendering, Keefe elevates the artists' input by asking them to go into their studio and use whatever tools they normally use, whether it be wood cutting devices, pigments, etching knives, or clay. Rather than scientists using found objects and pulling color maps from nature, the team collaborates with artists to design an entire visual language using tools from their own practice. Keefe just tells them to use all the expressive power they already wield in their own studios and make that the starting point. After the drawings and sculptures are digitized, algorithms then capture and extract properties of the physical forms and the computer morphs them onto the data, with the artists helping to drive the decisions.

"It's very simple in a way, but I think it actually is really powerful in terms of being able to include artists in this process," Keefe says.

In the cover image, as well as Figure 1, climate scientists are trying to identify optimal locations for the cultivation of sargassum, a macroalgae not only well suited for bio-fuel production but one that could also help restore the biogeochemistry of the Gulf of Mexico to a more natural state.

The visualizations are the result of the team's custom, hand-crafted visual language. The green curvilinear elements were chosen to represent chlorophyll due to its organic nature.

The neutral brown elements indicate dissolved carbon and are shaped in more angular forms since they represent a mineral. Visually speaking, the neutral hue allows them to recede into the background since they are less important than the other elements.

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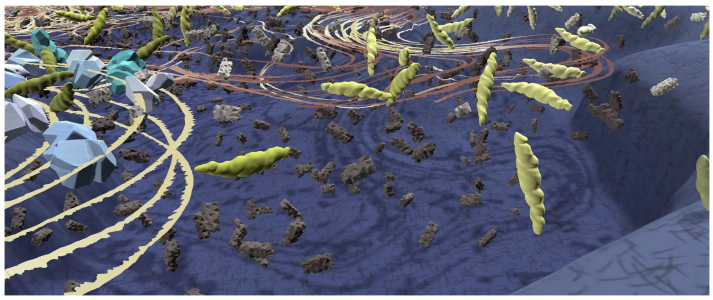

FIGURE 1. Visualizing the cultivation of macroalgae in the Gulf of Mexico.

In other cases, the swirling beige streamlines represent currents, eddy locations, and strengths. The one-sided angular pattern indicates direction. The hue shifts show the curvature.

The light-blue and teal glyphs (see Figure 1) represent nitrates, the primary variable of interest, specifically their location and density. The hue and texture concentration of the glyphs indicate the salinity level of the surrounding waters. Figure 2 shows examples of premade glyphs used for the research.

All of which originated with artists designing the elements by hand with materials and/or influence from the real world.

NATURE'S CALLING

With artists helping to orchestrate the visual representation, Keefe discovered more data gets packed into the picture, which is what scientists really want anyway. As a result, they see previously unrevealed relationships between multiple data variables, correlations that were not yet visible.

Keefe does admit such a method can seem controversial in the scientific community, many of whom are accustomed to the opposite approach, one that begins with cognition, that is, figuring out how we react to color and shape, and then having the computer design the visuals from scratch.

The artist's approach is different. If a project requires visualization of, say, fluid flow, one of the first things an artist might do is look to nature for metaphors and patterns that evoke flow. If the artist sees ripples in the sand left behind from the water, or the tail of a sea creature with streamlined surfaces, that is where the inspiration will come from, and the resulting visual language will be more expressive.

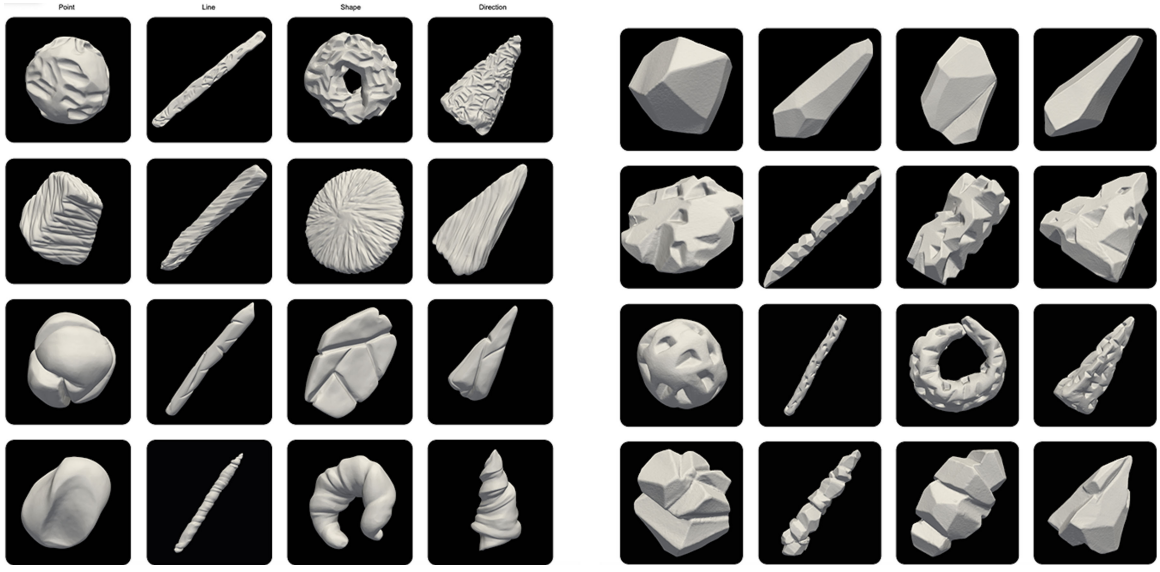

FIGURE 2. Examples of premade glyphs used in the research.

"It's not that one approach is necessarily better than the other," Keefe says. "It's just that maybe we have to try the artistic method for a little bit."

Another benefit of this approach, says Keefe, is that with artists orchestrating the visual language of data representation, the results are simply more natural-looking. This is not normally what scientists aim for. Usually a more sterile, unbiased, unemotional look is desired in the visualization.

Keefe says he pushes back against such an attitude. Especially these days when science seems under attack in many respects, if scientists want their work to resonate better in the public sphere, then perhaps they should be open to engaging people in more natural ways.

"There's this disconnect between scientific results on climate and what people believe, and what people feel they can even engage with," Keefe says. "You show me this sterile visualization of some scientist's life work, and if I'm just some regular dude, it's just going to seem completely unapproachable, right? You show me something where it looks natural, then I'll take a closer look at it."

Keefe continues, speaking of the artifact-based renderings: "Some of these things, you can see a thumb print in them. There literally is evidence of the human hand involved in making this visualization."

TAKING IT TO THE STREETS

So what comes next? If artists can take to their own studios, working in ways they normally work, all to help improve the communicative possibilities of data visualization, then it only makes sense for the scientists to expand on this by taking to the streets and bringing the science to the people. Keefe says that is exactly what he wants to do. He is now partnering with climate researchers who focus on communication, in order to connect with the broader population in rural Minnesota where agriculture is very important, for example. Now that Keefe has shown how professional artists can design a visual language, why not have the community—farmers, children, everyday people—design visual languages that reflect their own values and convey those values back to the scientists, thus facilitating a two-way dialog, all to foster better communication? That is, he wants to treat the everyday people in the community as additional users, rather than limit the discussion to just the scientists.

All of which is quite different than how Keefe's peers normally operate. But maybe that is a good thing.

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