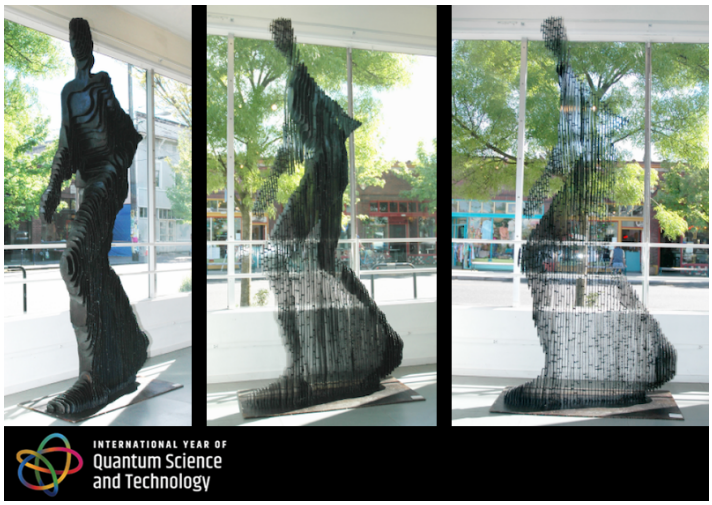
Through the Double-Slit Experiment

While seeking a visual metaphor to depict the wave-like behavior of matter, Julian Voss-Andreae forged a unique path merging quantum physics, art, and business.

By **Rachel Berkowitz**

Julian Voss-Andreae has long been fascinated by the double-slit experiment. During his PhD studies, he recalls breakfast meetings in Anton Zeilinger's lab at the University of Vienna, where the topic of wave–particle duality would come up. The year was 1999, and Voss-Andreae and his lab mates had just observed interference patterns in a beam of carbon-60 molecules sent through a multislit grating—implying that a large (almost macroscopic) object could exhibit telltale wave signatures [**1**]. The researchers playfully considered studying the quantum wave behavior in fully macroscopic objects. "We thought it would be really cool to send a person through the double-slit experiment," Voss-Andreae says. Of course, he never achieved that in the lab. But now, as a freelance sculptor based in Portland, Oregon, the concept forms the foundation of his artwork.



Quantum Man is a 2.5-m-tall sculpture of a walking man, made up of more than 100 vertically oriented steel sheets. When viewed from the front it appears solid; from the side, it appears more like a wave (Moses Lake, WA, 2006).
Credit: J. Voss-Andreae

Voss-Andreae uses parallel sheets of steel to create "quantum" representations of humans, where the nature of the object depends on the observer's vantage point. One of his most famous works is the 2006 *Quantum Man*. This 2.5-m-tall representation of a walking human looks like a solid structure when viewed from the front but vanishes when viewed from the side. Voss-Andreae says that it's a visual metaphor for the wave–particle duality, as well as the archetype of himself—as a human—being a quantum object.

Early in his career, Voss-Andreae took inspiration from Roger Penrose's 1989 book *The Emperor's New Mind*. In that book, Penrose argued that the brain is not a classical computer but rather a quantum one. Therefore, consciousness must be a quantum process. "I was just mystified by quantum physics: How can this even be?" says Voss-Andreae. "I really wanted to understand it, and that's been my North Star."

Born in Hamburg, Germany, Voss-Andreae studied quantum physics and philosophy at the Free University of Berlin and the University of Edinburgh, UK. After graduating, he happened to be "in the right place at the right time" to do his thesis in Zeilinger's group, studying the interference of large molecules. "I loved the challenge" of lab work, he says.

Alongside his studies, Voss-Andreae continued to pursue his

Stainless steel folds capture the structure of a hemoglobin protein in one of Voss-Andreae's early works. (Lake Oswego, OR, 2005).
Credit: J. Voss-Andreae

Voss-Andreae's recent sculptures have featured a vanishing point that makes them disappear when viewed from a carefully designed angle. *Isabelle* is an example of this approach (Palm Springs, CA, 2018).
Credit: J. Voss-Andreae

childhood love of art. At age 29, he made his first sculpture—of a protein. The idea of capturing the intricacies of protein molecules in folded steel structures became an early theme for him as he began his sculpture career in the US. To give scientific ground truth to his creations, he wrote software that translated protein data into a set of cutting instructions. "The side chains fold proteins into their 3D conformations, which gives them their function," he explains. Similarly, doing mitred cuts in all directions on the steel took his models into 3D space.

But he was still thinking about the double-slit experiments from his grad-school days and seeking visual metaphors for the physics closest to his heart. But how to insert wave properties in a solid sculpture? He began using steel plates, separated with gaps and aligned parallel to one another. This periodicity offered a clear embodiment of a wave—a wave that resides inside the solid object. In practice, the resulting structure looked very different from the front and from the side, as in the *Quantum Man*.

In subsequent work, Voss-Andreae further developed this viewing-angle effect. He found that he could carefully tailor the placement of steel plates such that the structure would look not only different but would actually appear invisible from one side. "That's now the basis of most of my sculptures: They disappear from sight when viewed at just the right angle," he explains.

To make this disappearing act a reality, Voss-Andreae has built a studio that resembles an electronics or computer engineering lab. He captures 3D scans of his human subjects—holding a pose or a gesture—using a homemade photogrammetry setup consisting of dozens of connected computers and cameras that together make hundreds of 360° maps of each person. Then, he shapes the raw data into its artistic form, like "modeling clay on steroids," and virtually slices it into 2D panels. Finally, he transforms the design into a pattern of smooth curves well suited to be fed into a laser-cutting machine, complete with labels for connecting pins, welds, and orientation—so that his eight-person-strong team can assemble it like a Lego kit.

The approach has allowed him to scale up and produce 40 sculptures per year. "In the early days, I only had scientists as clients." They were intrigued by the idea of a "quantum" art piece that alluded to their research. Now, his clients are more diverse, contacting him for private projects through commercial art galleries. One current favorite is a sculpture of a Mexican father's three children, which Voss-Andreae made using scans taken with a portable photogrammetry setup. Another project was commissioned by a Mongolian family who asked Voss-Andreae to create a sculpture of their deceased mother using only photos.

The demand for quantum sculptures keeps him busy. But Voss-Andreae still follows his quantum North Star. He argues that we've become imprisoned in our modern world's materialist paradigm, and a quantum philosophy might help us escape. In the double-slit experiment, the object can behave as

a wave or as a particle—depending on how the scientist chooses to measure it. Similarly, the reality of material things depends on how we choose to value them. Recognizing this inseparability between observer and observed can give us a fresh perspective. "That's the quantum way of finding new things," he says.

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REFERENCES

1. M. Arndt *et al.*, "Wave–particle duality of C_{60} molecules," **Nature 401, 680 (1999).**