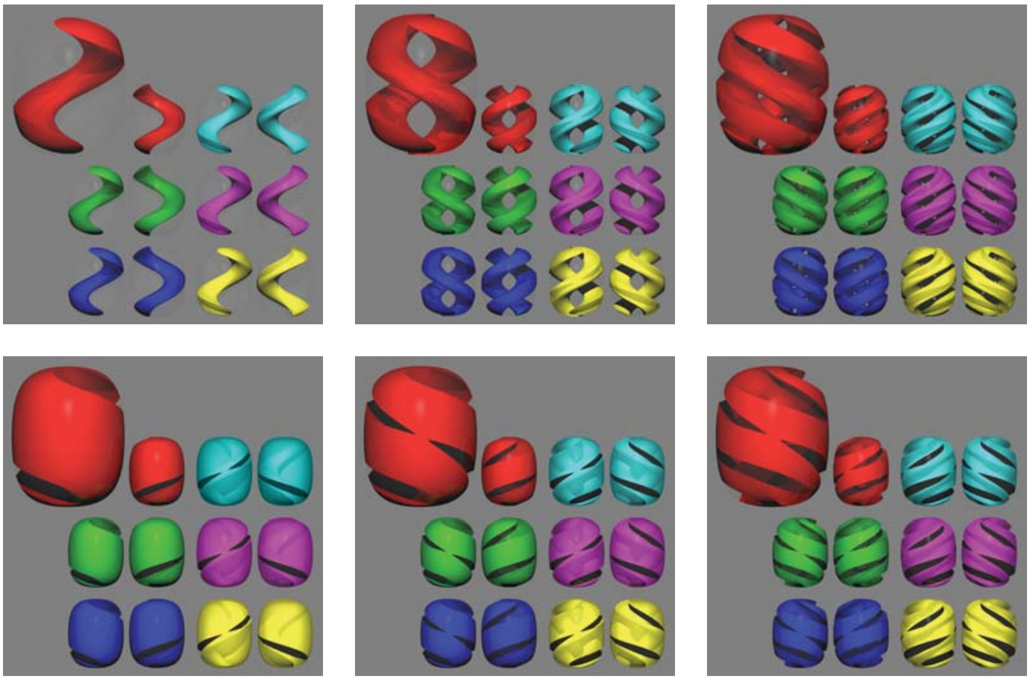
gallery: jan-henrik andersen

Designer Jan-Henrik Andersen, in conjunction with particle physicists, developed a visual language that describes the interrelationships between the elementary particles, both known and hypothesized.



***The Quarks Series*, digital ink on paper, panels are 44x44". Top row, left to right: up, charm, and top quark; bottom row, left to right: down, strange, and bottom quark. Each quark is shown with left and right spin, and in 3 colors and 3 anti-colors. The full key is available at www-personal.umich.edu/~janhande/sizedmatter/standard_model.htm**

Text: Elizabeth Wade

Few facets of nature are more mysterious than the quantum world. Particles that appear and disappear from nothing, interactions governed by probability, and intrinsic uncertainties are enough to baffle even the most experienced scientist. Making these ideas even more difficult to grasp is the fact that no one can ever hope to see a particle—in fact, particles may not even have "looks" at all. Undeterred by these challenges, industrial designer Jan-Henrik Andersen set out to create a visual guide that anyone, from particle physicists to high school students, could use to navigate the quantum universe.

"The idea was to transform physical properties into visual properties," Andersen explains. After working extensively with University of Michigan physicists Gordon Kane and David Gerdes, Andersen decided on four rules that would govern his representation of particles:

1. All the forms should be generated by one simple visual element.
2. The particles must have the same basic form, yet reflect differences in mass, parities, functions, and behavior.
3. There must be logical coherence between the particles according to the categorization and decay patterns of the Standard Model. Yet, the model must be open for possible extensions due to supersymmetry, string theory, gravitational forces, and the Higgs field/particle.
4. The particles' spins and directional velocities require a multidirectional visual quality.

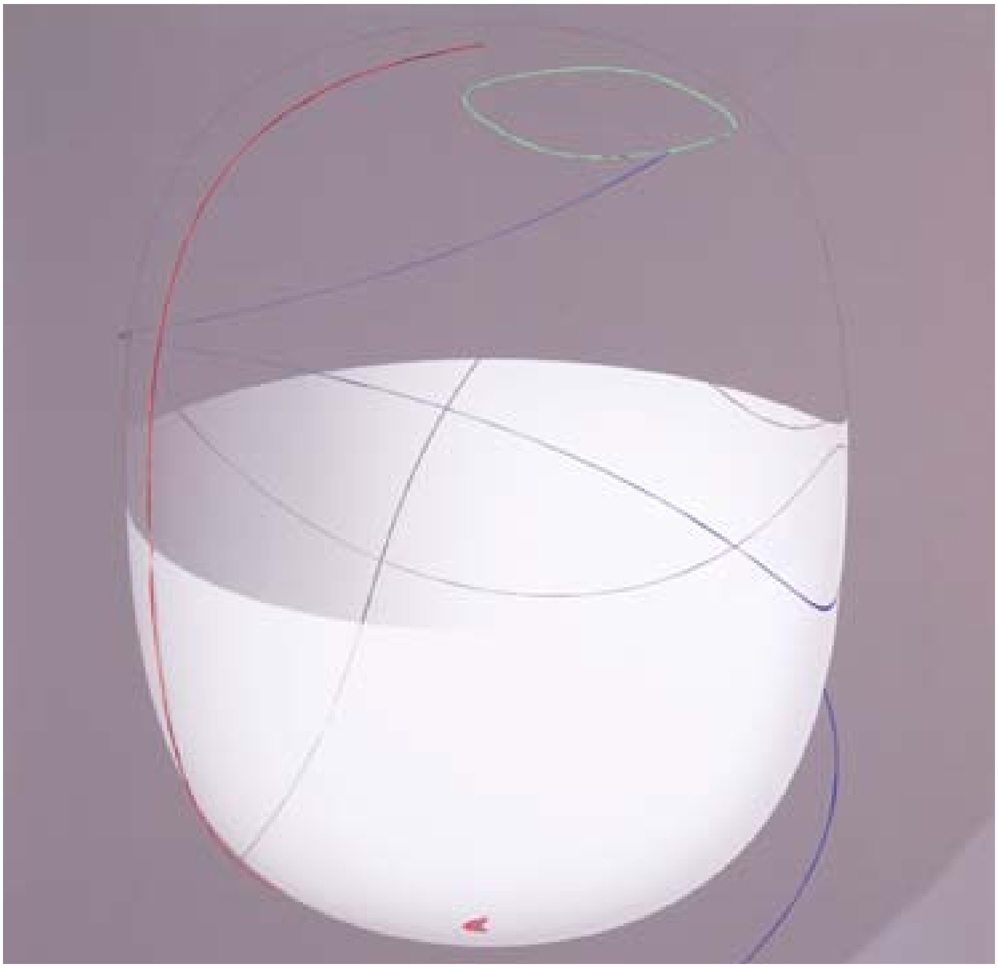
After extensive experimentation, Andersen decided on a shape called a superquadric ellipsoid, created by manipulating the equation of the Lamé curve (see image below), for the basic shape of all of his Standard Model particles.

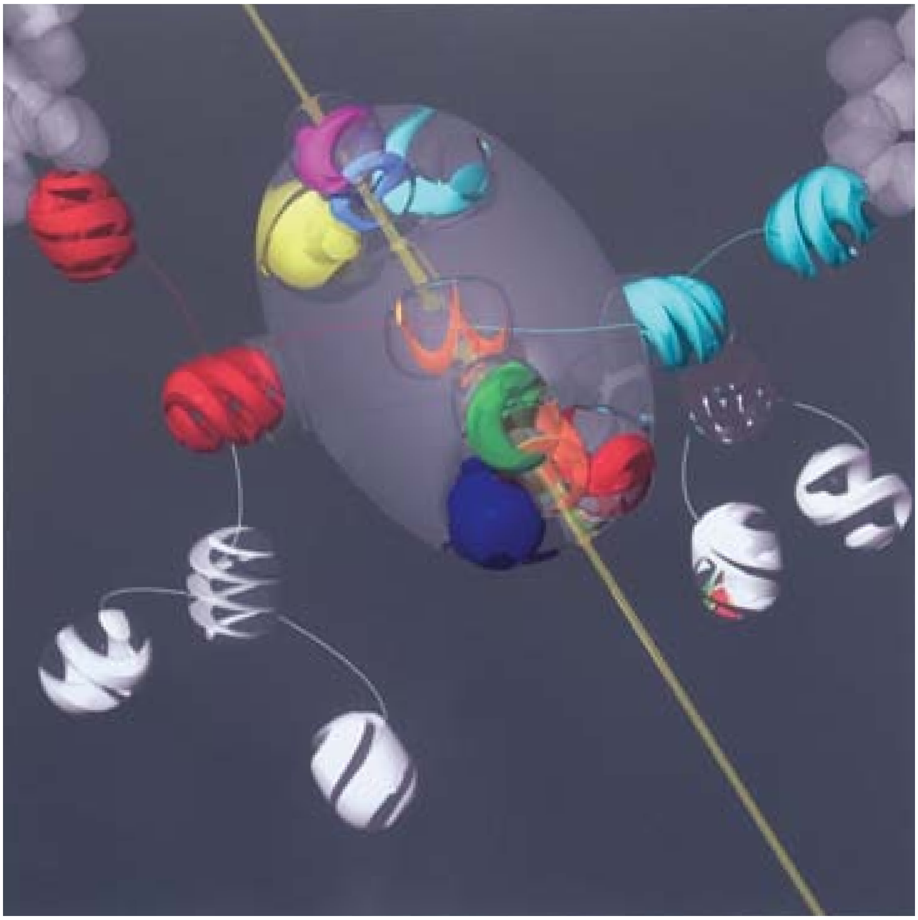
While the modified Lamé curve represents the geometric boundary for all of the particles, each particle's shape varies within the basic structure. Andersen's visual legend explains that "the number of core geometries in the Fermions [matter particles] is based on the generations of quarks (first, second, and third). The difference in mass is indicated by the number of geometric elements and visual 'activity.'" For example, the first-generation up quark (see image left) is represented by a single curve in space, while the charm quark is created by fitting two of those curves together—indicating the charm's identity as a second generation particle. The increased number of components and "visual activity" also indicate that the quarks become heavier as their generation number increases. Quarks that are in the same generation, such as the charm and strange quark, are positive and negative versions of the same space, and particles with opposite spins are represented as mirror images of each other. The colors are based on naming conventions in quantum chromodynamics (the theory of the strong force)—quarks are red, green, and blue, and their anti-colors are represented by cyan, magenta, and yellow, respectively. Leptons, such as electrons and neutrinos, are colorless, both in physics and in Andersen's designs.

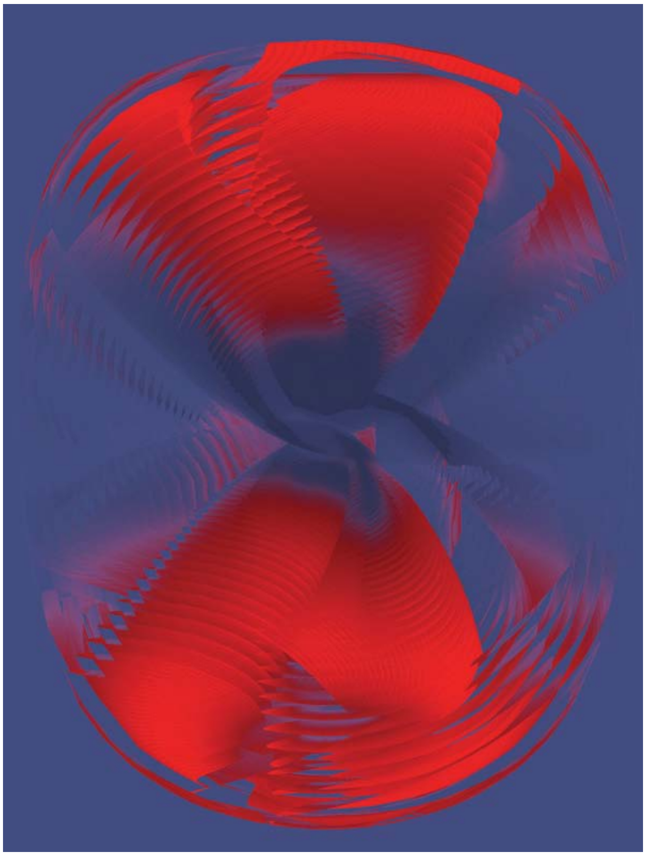
Once Andersen finalized the design of the Standard Model particles, he was able to move on to representing decay patterns

Above: *Supersymmetric Up Quark* (Red with no spin), ink on canvas, 42x42".

Bottom: *The Lamé curve*, which is defined by (x/a)m + (y/b)m = 1, 42x54", is used as the foundation for Andersen's representation of particles, modified according to specific and consistent patterns for each.







Above: ***Top Quark Event***, additive color scheme, ink on paper, 20x20". The image is based on a proton-antiproton collision at the Tevatron collider at Fermilab and the resulting particle decay pattern.

Right: ***Higgs Field 3*** (Interaction with third generation fermions), ink on canvas, 42x56".

and interactions between particles. His *Top Quark Event* (image top left) is based on actual experimental data from Fermilab. When applied to data in this way, Andersen's work becomes particularly educational: even people without a physics background can look at the event and distinguish the various particles produced by a collision. "It's a far stretch for people to imagine these distances and speeds," Andersen says. "But this highly abstract world is real, and my work makes it visually tangible." Andersen has also used his designs to create a series of three-dimensional sculptures.

Ultimately, Andersen hopes to have his visualization of particle physics used for educational purposes. "The distance between Fermilab and the dinner table is getting larger," he says. "I want to aid communication between a larger audience and physicists, and make this fantastic and beautiful part of our world conceptually available to a broader audience."

Below: *Photon* (Colorless light carrier), ink on canvas, 42x56".