IT’S A STUNNING ABSTRACT WORK, in the collection of the Museum of Modern Art. As it rises from its narrow black base, it both twists and expands into a fan shape at the same time undulating slightly into a lean S-curve. Dance aspires to this kind of smooth shapeliness. The shapes are subtle, but there’s nothing weak or timid about them. This strength of form is reinforced by the shiny black color of most of the surface and the contrasting broad silver edge. There is an uncanny coherence about the work; no element, no line or portion of its surface is irrelevant. It has the arresting authority of an African fetish. In its clean abstraction it could have been inspired by Brancusi, but its industrial aura suggests a direct descent from the Russian Constructivists.

The work is a fan blade manufactured by General Electric for the GE-90 jet engine and is in the museum’s design collection (Fig. 1). GE engineers designed the blade, using complex computer programs, so the list of “creators” might include computer programmers and aeronautical engineers, as well as material scientists who created the composite material (carbon fiber in a toughened epoxy matrix) from which the object is made. No artist would appear on the list of contributors. From its inception, the only objectives and specifications used in the fan blade’s design and construction were practical: to move air as efficiently as possible (and thus, to move an aircraft forward). The designers needed to balance multiple, sometimes conflicting, criteria, such as cost, durability, weight, noise and reliability, but aesthetics never entered in.

Then why is this object so beautiful?

The GE fan blade is not the only industrial object designed for purely practical purposes that still has aesthetic merit. It’s not an odd chance event. For decades, a related object, the marine propeller, has been a favorite subject of photographers and painters. A robust and curvy marine propeller was part of the sign that announced the Museum of Modern Art’s historic 1934 exhibition, Machine Art, and a bronze outboard propeller was one of the most popular objects in the show (Fig. 2) [1]. The three symmetric elements of the propeller relate to a characteristic of man’s earliest aesthetic markings: a repeating pattern. Nicholas Roerich had that heritage, dating back to the Stone Age, in mind when he chose three dots

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**Fig. 1.** General Electric, GE-90 fan blade, composite fiber resin, polyurethane coating and titanium, 48 × 23 × 17 in. Gift of the manufacturer. (The Museum of Modern Art, New York, NY, U.S.A. Digital image © The Museum of Modern Art/Licensed by SCALA / Art Resource, NY)

**Fig. 2.** Aluminum Company of America, outboard propeller, aluminum, 8 in. diameter, before 1934. Gift of the manufacturer. (The Museum of Modern Art, New York, NY, U.S.A. Digital image © The Museum of Modern Art/Licensed by SCALA / Art Resource, NY)
as the basis for the banner for his Pax Cultura pact to protect cultural artifacts (Fig. 3) [2]. Roerich added the circle, that most redolent of symbols, around the three dots.

The circle was ubiquitous in the Machine Art exhibition. At its entrance was another example of an alluring non-sculpture, a circular work by Sven Wingquist in gleaming chrome-plated steel (Fig. 4). No symbol is richer than the circle. It has been used for millennia in various cultures to represent the universe, continuity and the cycles of birth and rebirth, or as a perfectly enclosed, aesthetically satisfying shape. In Wingquist’s work there are two concentric circles, actually rings or annuluses, circles with heft, that partake of the perfection of circles, but that also exist in the real world. Two circular arrays of 15 small spheres each fit in tracks between the two rings, aligning them to share a common axis. A sphere is a three-dimensional geometrical shape created by rotating a (two-dimensional) circle through 180 degrees. The work is a beautifully crafted exploration of circular form. Wingquist designed this object, a self-aligning ball bearing, for a purely practical function: to allow a shaft to rotate at varying angles within a cylinder. It was manufactured by the Swedish company SKF Industries.

There are many other industrial objects in the MoMA design collection that have distinctive aesthetic merit: furniture, kitchenware, automobiles and a helicopter among them, but most have been designed with form, as well as function, in mind. Much of the aesthetic appeal of a suspension bridge is due to the laws of physics that determine the sway of the cables, but engineer/designers also played a role. The objects that are the most revealing are those that are innocent of artistic intent, like the GE fan blade, the propeller and the self-aligning ball bearing, for their unquestionable beauty suggests something about the roots of our aesthetic judgment, our concept of the beautiful.

One approach to dealing with these issues, or abstraction in general, is to invoke the passage in the Philebus where Plato identifies beauty of form with "the straight line and the circle and the plane and solid figures formed from these by turning-lathes and rulers and patterns of angles." Plato asserted "that the beauty of these is not relative, like that of other things, but they are always absolutely beautiful by nature" [3]. That passage was used as the epigraph for MoMA’s Machine Art show. One can dispute, given Plato’s denigration of art in general, and the overall thrust of the Philebus, whether this passage can be used in support of any form of art [4], but physicists and mathematicians continue to use the word beauty—more so than art critics these days—to describe their work. Bertrand Russell wrote, "Mathematics, rightly viewed, possesses not only truth, but supreme beauty" [5], and the mathematical physicist Paul Dirac once described a mathematical description of atomic events as too beautiful to be false, stating that “it is more important to have beauty in one’s equations than to have them fit experiment” [6]. Philosophers and mathematicians have related mathematical forms, and mathematics itself, to the universal and the timeless, and their use of the word “beautiful” in this context provides a strong clue as to why we see the fan blade and the ball bearing as beautiful and reveals how deeply the concept of beauty is rooted within our consciousness.

Our non-sculptures differ in their composition. Although the fan blade has complete compositional integrity in the relationship between its elements, the ball bearing is a more complex composition of multiple parts. With a multicomponent work by Bernini or Anthony Caro, we can’t conceive of one element being moved without reducing its appeal [7]. So it is with the ball bearing, with its perfect symmetry and balance and the harmony between its parts. The ball bearing shares this characteristic of the coherence of its parts with all well-designed machines. Think of a watch before watches were little computers with faces. Clocks and watches, with
their perfectly meshed gears turning at different speeds, have long been objects of aesthetic admiration. We admire their integrity and compositional coherence. The ball bearing also embodies a further characteristic that is common to art and music across centuries and cultures: the steady repetition of its spherical elements. It has a clear beat or pattern.

There are several aspects of the visual appeal of the fan blade, the ball bearing and the propeller, objects where purely practical considerations determined their shape. Particularly important are balance, rhythm, pattern, symmetry, correspondence to physical laws and a coherence of parts. So the original question of why these objects are so beautiful comes down to why we value those particular characteristics. The answer is in our genes. Strong common human inclinations and emotional responses are the product of evolution. They exist because during human evolution those emotional responses and pleasures gave their possessors a comparative advantage in survival and/or reproductive success. Our aesthetic inclinations and responses can be explained in the same way.

Once a random genetic change occurs, there are two phenomena through which that change will be carried along into future generations. The first operates if the change gives an advantage in the physical survival of the individual or the group to which the individual belongs. This survival value due to "natural selection" was first fully developed in Charles Darwin's *On the Origin of the Species*. But this theory implies an austere world, a world characterized by Herbert Spencer as "survival of the fittest." Darwin was troubled by the sheer gaudiness of much of nature that seemed to be inconsistent with the dog-eat-dog world of competition for survival. The classic example is the peacock's tail, which certainly doesn't help the bird move fast or escape predators. In a letter that he wrote in 1860, the year after *The Origin* was published, Darwin complained that "The sight of a feather in a peacock's tail, whenever I gaze at it, makes me sick!" Eleven years later he published *The Descent of Man, and Selection in Relation to Sex* in which he described the second phenomenon that can cause a mutation to persevere: sexual selection through mate choice [8]. Feathers have evolved to be choosy and prefer gaudy peacocks, perhaps because that outrageous tail is an indicator of fitness. It is reasonable to believe that our own formal aesthetic tastes have evolved through the mechanisms of both natural and sexual selection.

In recent years an evolutionary approach has been applied to the universal human instinct to make and appreciate art. There are countless examples in nature of what we would call beauty playing a role in evolution. The peacock's tail is one. Among the most striking cases are the decorated structures built of branches and twigs by Australian bowerbirds. Each of the several species of bowerbird has its individual style; one decorates its structures with moss and lichen; another favors the color blue and searches around for blue blossoms or parrot feathers or bits of blue plastic. The point is to attract the female bowerbird with the most elaborate, best-decorated structure [9]. Various proposals have been made on how art-making contributed to human evolutionary success. In her book *Homo Aestheticus*, Ellen Dissanayake focuses on art-making as a fundamental human trait that evolved to indicate the special nature of important activities [10].

The argument here has a different focus: the formal qualities that we find aesthetically pleasing. Those preferences are mostly revealed by objects that have no representational content—and no aesthetic intent, like our non-sculptures. Our feeling for these formal qualities starts with our own bodies, with an awareness of our own symmetry, of the coordination between parts, and a self-conscious balance. There are two roots of our taste for symmetry and balance. First of all, we, our physical selves, are in many ways bilaterally symmetric. We favor what we are. As infants we seek balance as we learn to stand and walk. Balance—symmetry in action—is a directly felt, inherent value that readily translated into aesthetic preference. Just as symmetry is a reliable sign of health in others, so asymmetry, say in the gait or tracks of an animal, was an indicator of being infirm or wounded. It is not surprising that we evolved to be sensitive to and to value symmetry and balance.

A consciousness—or appreciation—of the natural forces that act on our bodies helped a Stone Age man to decide when to jump and when not to. The right decision could determine whether he made it back to the cave that night to make a child with his mate. His mate would be there if she had made similar survival decisions. Darwinian value could also be ascribed to man's appreciation of formal aspects of the outside world. The hunter-gatherer who looked at nature carefully and appreciated the intricacies of her forms had a better chance of success than his insensitive, uninquisitive brothers. The qualities of nature—plants and animals—that are important are determined by the physical laws that determined the shape of the jet engine blade. In the words of D'Arcy Wentworth Thompson in his justly famous 1917 book *On Growth and Form*, "The harmony of the world is made manifest in Form and Number. . . . The living and the dead, things animate and inanimate, we dwellers in the world and this world in which we dwell, are bound alike by physical and mathematical law" [11].

The early man who had an intuitive appreciation of those natural laws, of the forces that acted on his spear or arrow as it followed its parabolic path to its target, had a better chance of having dinner that night. An innate appreciation of mathematical form had survival value. The cavedweller who scratched the three marks on a stone that inspired the symbol of Nicholas Roerich's Pax Cultura likely also saw patterns in the universe, patterns of animal behavior as well as the seasons. In this way, what we now view as aesthetic preferences, for balance, smooth curves, repetition, symmetry and the like, are part of our genetic heritage. In addition to the aesthetic instincts that contribute to natural selection, some formal aesthetic qualities can also contribute to sexual selection. The most obvious is symmetry. Both sexes appropriately take the bilateral symmetry of anatomical features as indicators of fitness [12].

There is tangible evidence that early man, going back to the Neanderthals, valued symmetry. Stone handaxes were produced more than 1.3 million years ago, and over time attention to two-directional symmetry grew well beyond practical
requirements [13]. Beautifully symmetrical stone handaxes and projectile points are eloquent evidence of man’s deep-seated aesthetic sensibility, even in his earliest production of the tools of survival (Fig. 5). It has been argued that sexual selection played a role in developing the formal beauty of these objects; to a discriminating female, an axe’s fine, polished symmetry was an indicator of valuable cognitive and physiological traits in the maker [14].

As artistic sophistication evolved, variations from perfect symmetry gave life to classic Greek statues and Roman sarcophagi, but the intuitive reference point was pure symmetry. Herman Weyl expressed it well: “Symmetry, as wide or narrow as you may define its meaning, is one idea by which man through the ages has tried to comprehend and create order, beauty and perfection” [15].

This analysis of the genetic basis of aesthetic preferences started with practical non-sculptures in order to isolate formal aesthetic qualities such as balance, smoothness and the relationship between parts. These qualities do not completely determine the art objects, which are also shaped by the cultures in which they emerge. They are, however, qualities that are common across cultures. As Dennis Dutton states it, “Art may seem largely cultural, but the art instinct that conditions it is not” [16]. Ironically, these somewhat dry, formal qualities are the most fundamentally human elements of art-making, because of their universality. What gives us aesthetic pleasure is embedded in our genes, and we share our fundamental aesthetic preferences, of smooth curves, balance and mathematically defined shapes, with all of humanity. Art is often viewed as a frivolous, incidental or elitist part of our lives. The evolutionary argument for the genetic basis of our aesthetic tastes makes a counterclaim: that art is a fundamental part of what makes us human, the “natural and sometimes the supreme expression of the common principles of our nature” [17].

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References and Notes
2 The Roerich Pact was signed by the United States and 20 Latin American nations in 1935, agreeing that “historic monuments, museums, scientific, artistic, educational and cultural institutions” should be protected both in times of peace and war, and identified by their flying the Banner of Peace, bearing the Pax Cultura emblem.
7 Leon Battista Alberti (in De re aedificatoria) used this concept to define beauty: “The beautiful is that from which nothing can be taken away and to which nothing can be added but for the worse.”
9 The first chapter in David Rothenberg’s Survival of the Beautiful: Art, Science, and Evolution (New York: Bloomsbury, 2011) is titled “Come Up and See My Bower.”

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