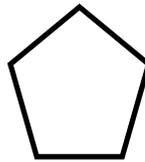
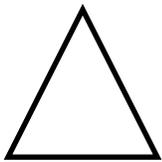


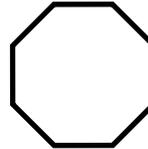
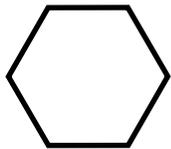
Contemplating Infinity - A Fusion of Mathematics, Physics, and Art
Jim Weiss

Sometimes I try to comprehend infinity. But wrapping my mind around something that has no limits has its difficulties. Yet, through the circle, sometimes I can get an inkling of what infinity is like.

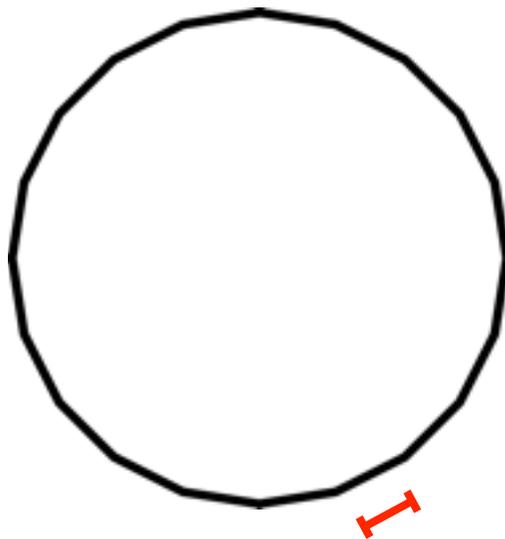
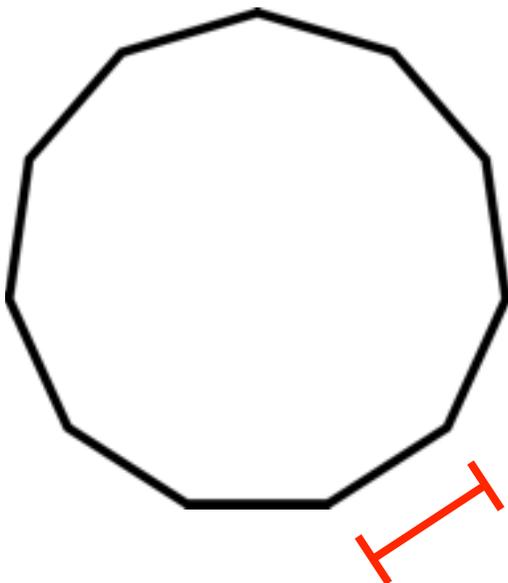
Start with a triangle, with its three sides. It's the smallest possible polygon, we learned in geometry. With one more side we create a rectangle, (or its cousin, the parallelogram), and then on to the pentagon (now the icon of military might).



Next comes the hexagon (I always think of honey comb), the heptagon (no known use to me), and the octagon, where we all come to a STOP.

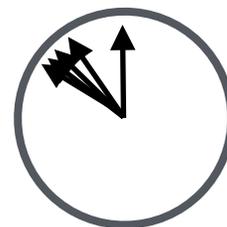


Here are two polygons : 11 sides and 20 sides. Notice how as the number of sides increases their lengths get shorter.

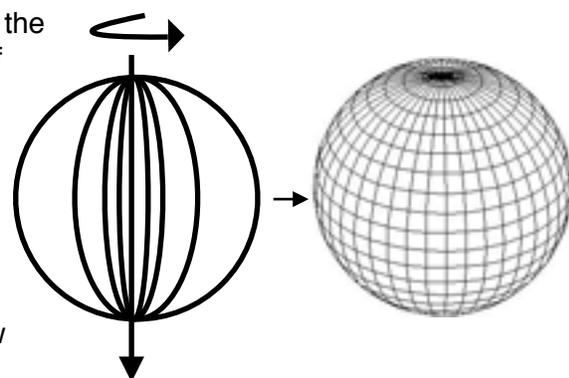


With 20 sides our polygon is hard to distinguish from a circle. How many sides can we add to our polygon - 10, 100, 1000, a million? Can one even see the individual sides of a 100 or 1000 sided polygon? Gradually, as their lengths shrink they blend into and become the arc of a circle. In a sense then, a circle is a polygon with an infinite number of sides. Wow, a glimpse of infinity.

Draw a line from the center of the circle to its edge, like the spinner on a numbered card in a child's game - the line we call a radius. Rotate it ever so slightly, to a new position. Rotate it again and again and soon the entire space enclosed by the circle has been filled in. How many ever-so-slightly advances can we make to return to our starting point? As the degree of spin gets smaller, the number of possible positions gets larger, approaching infinity. There are an infinite number of radii within one full rotation of the circle. Another view through the circle into infinity.



Imagine a diameter of our two-dimensional circle stuck through the center like an arrow vertically into the ground. Flick the edge of the circle so it starts to spin. As it rotates it fills space to form a sphere, as if a two dimensional map of the Earth from a page in an atlas has now become a three dimensional globe, our Planet Earth, rotating in space around its North Pole to South Pole axis. This axis is but one diameter of the sphere. How many diameters, like knitting needles through a ball of yarn, can we imagine? Clearly there must be more than through the flat circle. But there were already infinitely many of those. How can there be more than that?



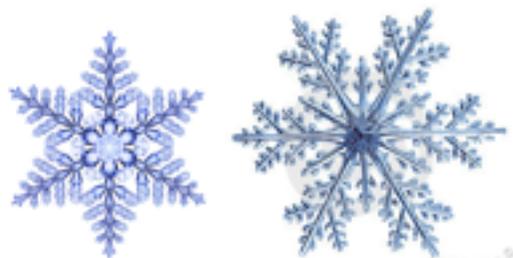
Uh oh. My glimpse into infinity just got more complicated

Imagine you are standing at the North Pole. Your feet are planted as close as possible to the center. As the Earth turns, your body rotates like a top. Imagine you could shrink your body so you get closer and closer to that center, that line we call the axis. Is there a point at which you would finally become stationary, or would you have to keep shrinking, getting closer and closer to that point, for ever? The poet TS Eliot wrote:

“the still point of the turning world....Except for the point, the still point, there would be no dance...”.

That still point is infinitely small, yet without it there would be no rotation, or, as Eliot wrote, “no dance.” The still point has no dimension. No matter how small we imagine it, it is made up of smaller points. To reach the still point of the turning world we also would have to become infinitely small.

A diameter divides a circle into halves. Fold it on that line; the two halves are identical. The circle has symmetry. Each of its infinite number of diameters, therefore, is also an axis of symmetry. No matter how you fold it, the halves line up perfectly. The circle has perfect radial symmetry. Radial symmetry has a powerful effect on us - innately appealing and calming. Who doesn't marvel at the delicate and intricate radial symmetry of the snowflake, with its innumerable (but not infinite) number of patterns. Or the exuberant radial symmetry of a daisy bursting from bud, or so many other flowers whose petals



radiate outward from the center of the circle.

Perhaps the deepest power of the circle on our minds is in the mandala used in religions as a focus of mediation. While it draws us into the still point, it also radiates outward - two opposing yet simultaneous sensations - one to the infinitely small, the other radiating outward into space.

In some branches of Islam images of persons or animals are not permitted. The art is all geometric. Below are the inner surfaces of two massive domes in mosques - each color a small mosaic tile. Looking up into the dome one feels as if one is looking into the limitless night sky. On the right is a mandala woven into a Persian carpet.



The circle is nature's default setting. Drop a pebble into a pond. The ripples travel away in perfect circles.

Imagine a rocket exploding in a fireworks display. It sends brilliant fragments out in an ever expanding sphere - (yet only for a moment, as gravity will tug those fragments in graceful arcs back to Earth). But, if the sound waves from that explosion could somehow become visible, we would see them spreading further and further outward, ripples in an ever expanding sphere. The circle and the sphere are nature's way of sending out energy.



But circles and spheres also pull in. Notice the drop of water suspended momentarily in air, rebounding from the pebble. It is a perfect sphere, formed as if something inside were pulling all the water molecules toward the center. Similarly, rain on the leaf pulls inward to form small circular drops.

Isaac Newton's legendary apple, when it fell to the ground, revealed to him the force of gravity. We perceive the apple falling vertically down. But an apple in Japan, or anywhere else on Earth, also falling vertically down, would meet Newton's apple at the center of the Earth. The lines of gravity all converge at the still point of the turning world. Newton realized that those same lines of force that pull the apple downward also reach outward into space pulling our moon in near circular orbit, just as the Sun's gravity keeps our entire planetary system in motion. And the shimmering circles that are Saturn's rings are a visualization of that planet's pull of gravity .

Just as the lines of gravity point into the center of the sphere, light rays from our sun radiate outward into space along lines that emanate, like radii, from the center. In fact, "radiate", "radiant," and "radius" all come from a common Latin root. How far will that sphere of sunlight travel? At present, with powerful telescopes, we can see starlight from galaxies over 13 billion light years away. This light must have left those stars 13 billion years ago. Those galaxies are rushing away from us, and from each other, at greater and greater speeds. Where are they going? Where is the end? Is there an end, or is space infinite? Physicists tell us that those galaxies formed during the Big Bang, a little over 13 billion years ago, and that is when time began. What does that mean? What was before then? And will it stop some day? These are the questions about infinity where I stop asking. My mind loses its grasp.

Perhaps the best time to reflect on the vastness of it all is on a clear, moonless summer night, sitting in a circle with friends around the campfire. Whether in a drum circle, or singing and playing music, we feel drawn toward the center, yet at the same time the light or music escapes and radiates out into space. As the fire turns to coals, the circle gets smaller, as we move closer to the emanating warmth. We are all equal, as if each of us is one of those little sides in a polygon, blended by music and friendship into a smooth circle. As the coals die down we lay back on our sleeping bags and feel the comforting firmness of our spherical planet against our body, as we gaze into the infinite vastness of the diamond dusted night sky.

