**FRACTALS VIDEO SCRIPT DRAFT 2**

Pitch: Repeating patterns called fractals are present in every facet of our existence, and are indispensable in nature research, medicine, and technology. In that way, mathematics helps us explore and understand the world around us.

(Camera zooms into host standing by the Charles River, talking on a cell phone; when camera is close, the host acknowledges it)

What do a cellphone, a river, and a cancer cell have in common?

The answer is… (black screen with the word animated on it, framed with images) fractals.

(back to Charles River, host drawing repeating pattern with chalk while talking)

Fractals in mathematics are never-ending patterns.

(change setting: now in a room with a blank wall and computer; show animation of Sierpinski triangle while talking on screen)

Scientists can program these infinite patterns by repeating a simple mathematical process over and over. So, if you zoom in, you’ll see the same shape again and again and again… (show making sierpinski).

Similarly, a tree grows by repetitive branching. Just like our fractal, a tree extends its branches, one smaller than the other, but similar.

Of course, a tree can’t grow as far and precisely as a “truly mathematical” fractal, but parts of it show enough like properties that we can study nature in terms of fractals.

In fact, so many things in nature have these pattern properties  (show snowflake and seashell, fill screen with others – fern, water spinning out of tap; somehow zoom in or show similar parts), it sometimes feels like the world itself is one giant fractal! (fill the screen with patterned shapes until it’s too much)

SO MANY FRACTALS!!! (head spin)

A bit overwhelming, right? Well, one way to explain this abundance of patterns is the fact that nature is just great at reusing efficient mechanisms.

Rivers of the planet flow like the “rivers of blood” in our bodies. Lightning bolts become electrifying rivers of the sky. And just look at this honey!

Here’s something even wackier: a brain fractal shaped forest!

Whew, that’s enough fractals to make my fractal brain hurt.

Luckily, mathematicians have found a way to describe the wacky structures. They’ve accepted that clouds are not spheres and bark is not smooth… But, with fractal geometry, we can mathematically explore them!

In the 1970’s, a mathematician named Benoit Mandelbrot was hired to investigate noise in telephone lines. Now, Mandelbrot loved connecting images with numbers, so he immediately looked at the noise in terms of the shapes it created. And he came up with this: (show Mandelbrot  set and talk over it)

At first, the image didn’t look too special. In fact, it kinda resembled a turtle with a giant head (show turtle).

It wasn’t until nighttime that Mandelbrot looked closer. He zoomed in once, and found a smaller turtle latched on to the original one. And an even smaller turtle on that one. Mandelbrot kept zooming and zooming and the turtles kept shrinking and shrinking, but they were still all the same shape!

Mandelbrot was convinced he’d seen a nightmare! But when the shape remained on the screen the next day, Mandelbrot knew he was onto something huge. A simple equation, applied repeatedly, carried incredible properties.

What if, thought he, you could create such expressions for other natural phenomena?

And that’s exactly what mathematicians do today. Fractal geometry allows them to model, say, mountain ranges (animate from fractal triangles), and then use the models to study earthquakes or create realistic special effects for our favorite movies (Star Wars battle/death scene; pause, then show me looking disturbed).

In healthier news, fractals may also help doctors diagnose cancer faster and more accurately. They can study the edges of various cells in our bodies using fractal geometry. Here, the cell on the right is more jagged and repeating than that on the left, which means it’s the more aggressive, faster-growing cancer cell. This way of discovering cancer can be about 10 times more effective than the current methods!

So that’s how cancer cells and rivers relate. But what about cell phones? They aren’t really a part of nature.

Well, in the 90’s, a radio astronomer by the name of Nathan Cohen was having troubles with his landlord. The man wouldn’t let him put a radio antenna on the roof! So, Cohen decided to make a more compact, fractal radio antenna instead (Koch)

The landlord didn’t notice it, **and** it worked better than the ones before!

Working further, Cohen designed a new version, this time using a shape called “[the Menger Sponge](http://blog.zacharyabel.com/wp-content/uploads/2012/02/Menger-stages-big.png)” (voiceover over animation of traveling through the Menger Sponge). The fractal’s infinite “sponginess” allowed the antennae to receive multiple different signals.

(soapy sponge used as prop; maybe host is in shower?)

The Menger Sponge is not really the sponge you’d be scrubbing your back with, but you can still think of it like that. Imagine both water and soap getting through your sponge’s holes, except the water is Wi Fi and the soap is, say, Bluetooth. Without Cohen’s “sponge,” your cell phone would have to look something like a giraffe to receive both those signals (illustrate: phone with antennas glued on for those two signals). Not quite as handy, is it?

(closing statement delivered at original Charles River location)

Fractals are already very common, yet we are still searching for more applications, asking questions, building new patterns and exploring nature’s best. Here at MIT (move camera from host and Charles river to MIT dome right across) and everywhere in the world.

Look around you. What beautiful patterns do you see?

THE END

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