LISTENING - Ron Eglash is talking about his project

http://www.ted.com/talks/

1) **Do you understand these words?**

iteration mission scale altar mound recursion crinkle

2) **Listen and answer the questions.**

1. What did Georg Cantor discover? What were the consequences for him?
2. What did von Koch do?
3. What did Benoit Mandelbrot realize?
4. Why should we look at our hand?
5. What did Ron get a scholarship for?
6. In what situation did Ron use the phrase "I am a mathematician and I would like to stand on your roof." ?
7. What is special about the royal palace?
8. What do the rings in a village in southern Zambia represent?

3)Listen for the second time and decide whether the statements are true or false.

1. Cantor realized that he had a set whose number of elements was equal to infinity.
2. When he was released from a hospital, he lost his faith in God.
3. We can use whatever seed shape we like to start with.
4. Mathematicians of the 19th century did not understand the concept of iteration and infinity.
5. Ron mentions lungs, kidney, ferns, and acacia trees to demonstrate fractals in nature.
6. The chief was very surprised when Ron wanted to see his village.
7. Termites do not create conscious fractals when building their mounds.
8. The tiny village inside the larger village is for very old people.

I want to start my story in Germany, in 1877, with a mathematician named Georg Cantor. And Cantor decided he was going to take a line and erase the middle third of the line, and take those two resulting lines and bring them back into the same process, a recursive process. So he starts out with one line, and then two, and then four, and then 16, and so on. And if he does this an infinite number of times, which you can do in mathematics, he ends up with an infinite number of lines, each of which has an infinite number of points in it. So he realized he had a set whose number of elements was larger than infinity. And this blew his mind. Literally. He checked into a sanitarium. (Laughter) And when he came out of the sanitarium, he was convinced that he had been put on earth to found transfinite set theory, because the largest set of infinity would be God Himself. He was a very religious man. He was a mathematician on a mission.

And other mathematicians did the same sort of thing. A Swedish mathematician, von Koch, decided that instead of subtracting lines, he would add them. And so he came up with this beautiful curve. And there's no particular reason why we have to start with this seed shape; we can use any seed shape we like. And I'll rearrange this and stick this somewhere -- down there, OK -- and now upon iteration, that seed shape sort of unfolds into a very different looking structure. So these all have the property of self-similarity: the part looks like the whole. It's the same pattern at many different scales.

Now, mathematicians thought this was very strange, because as you shrink a ruler down, you measure a longer and longer length. And since they went through the iterations an infinite number of times, as the ruler shrinks down to infinity, the length goes to infinity. This made no sense at all, so they consigned these curves to the back of the math books. They said these are pathological curves, and we don't have to discuss them. (Laughter) And that worked for a hundred years.

And then in 1977, Benoit Mandelbrot, a French mathematician, realized that if you do computer graphics and used these shapes he called fractals you get the shapes of nature. You get the human lungs, you get acacia trees, you get ferns, you get these beautiful natural forms. If you take your thumb and your index finger and look right where they meet -- go ahead and do that now -- -- and relax your hand, you'll see a crinkle, and then a wrinkle within the crinkle, and a crinkle within the wrinkle. Right? Your body is covered with fractals. The mathematicians who were saying these were pathologically useless shapes? They were breathing those words with fractal lungs. It's very ironic. And I'll show you a little natural recursion here. Again, we just take these lines and recursively replace them with the whole shape. So here's the second iteration, and the third, fourth and so on.

So nature has this self-similar structure. Nature uses self-organizing systems. Now in the 1980s, I happened to notice that if you look at an aerial photograph of an African village, you see fractals. And I thought, "This is fabulous! I wonder why?" And of course I had to go to Africa and ask folks why. So I got a Fulbright scholarship to just travel around Africa for a year asking people why they were building fractals, which is a great job if you can get it. (Laughter)

And so I finally got to this city, and I'd done a little fractal model for the city just to see how it would sort of unfold -- but when I got there, I got to the palace of the chief, and my French is not very good; I said something like, "I am a mathematician and I would like to stand on your roof." But he was really cool about it, and he took me up there, and we talked about fractals. And he said, "Oh yeah, yeah! We knew about a rectangle within a rectangle, we know all about that." And it turns out the royal insignia has a rectangle within a rectangle within a rectangle, and the path through that palace is actually this spiral here. And as you go through the path, you have to get more and more polite. So they're mapping the social scaling onto the geometric scaling; it's a conscious pattern. It is not unconscious like a termite mound fractal.

This is a village in southern Zambia. The Ba-Ila built this village about 400 meters in diameter. You have a huge ring. The rings that represent the family enclosures get larger and larger as you go towards the back, and then you have the chief's ring here towards the back and the chief's immediate family in that ring. So here's a little fractal model for it. Here's one house with the sacred altar, here's the house of houses, the family enclosure, with the humans here where the sacred altar would be, and then here's the village as a whole -- a ring of ring of rings with the chief's extended family here, the chief's immediate family here, and here there's a tiny village only this big. Now you might wonder, how can people fit in a tiny village only this big? That's because they're spirit people. It's the ancestors. And of course the spirit people have a little miniature village in their village, right? So it's just like Georg Cantor said, the recursion continues forever.