Photo of Alchemy, painting by Jackson Pollock
Photo Credit: Lluis Ribes Mateu, flickr

Fractal City: How Is a City Like a Jackson Pollock Painting? An interview with University of Oregon Physics Professor, Richard Taylor

By Tim Beatley

Fractals are self-repeating patterns in nature and we have evolved to love and prefer them. A classic example is a tree: look from a distance and the tree has a trunk and major branches; zoom in more closely and smaller branches form smaller versions of the tree. Natural fractals are everywhere in nature: in meandering rivers, in mountains and topography, and in clouds.

Professor Richard Taylor, who heads the Physics Department at the University of Oregon, has spent much of his life studying fractals. He is convinced that they are one of the main reasons we respond so favorably to nature: it is because our bodies, and specifically our visual systems, have evolved to process fractals. Taylor calls this "fractal fluency." We have developed this visual system because we have evolved in a natural world full of fractals. Taylor's research suggests that, because we have evolved over millennia looking at and viewing fractals, our modern eyes are better able to recognize and process these patterns.

Much of the credit for raising awareness about fractals and their power must be given to Benoit Mandelbroit, a Polish mathematician, who wrote the book *The Fractal Geometry of Nature* more than three decades ago. He coined the term fractal (from the latin fractis) an unfortunate, off-putting word choice, Taylor believes.

For Taylor, much of his fractal research started out as a way to analyze and understand what it is that we react to and prefer in art. Aesthetics and fractals go hand-in-hand, it turns out. Taylor famously analyzed the fractal composition and complexity of Jackson Pollock paintings, concluding that it is the paintings fractal composition that viewers favorably respond to. Taylor found himself working alongside those in the art world trying to monitor and detect forgeries, and in the case of a Pollock painting it is almost impossible to fake this unique fractal composition (something that Taylor's computer models show). According to Taylor's findings, Pollock's drip method became more fractally complex later in his career (during the late 1940's and early 1950's), as seen in paintings like Alchemy (painted in 1947).

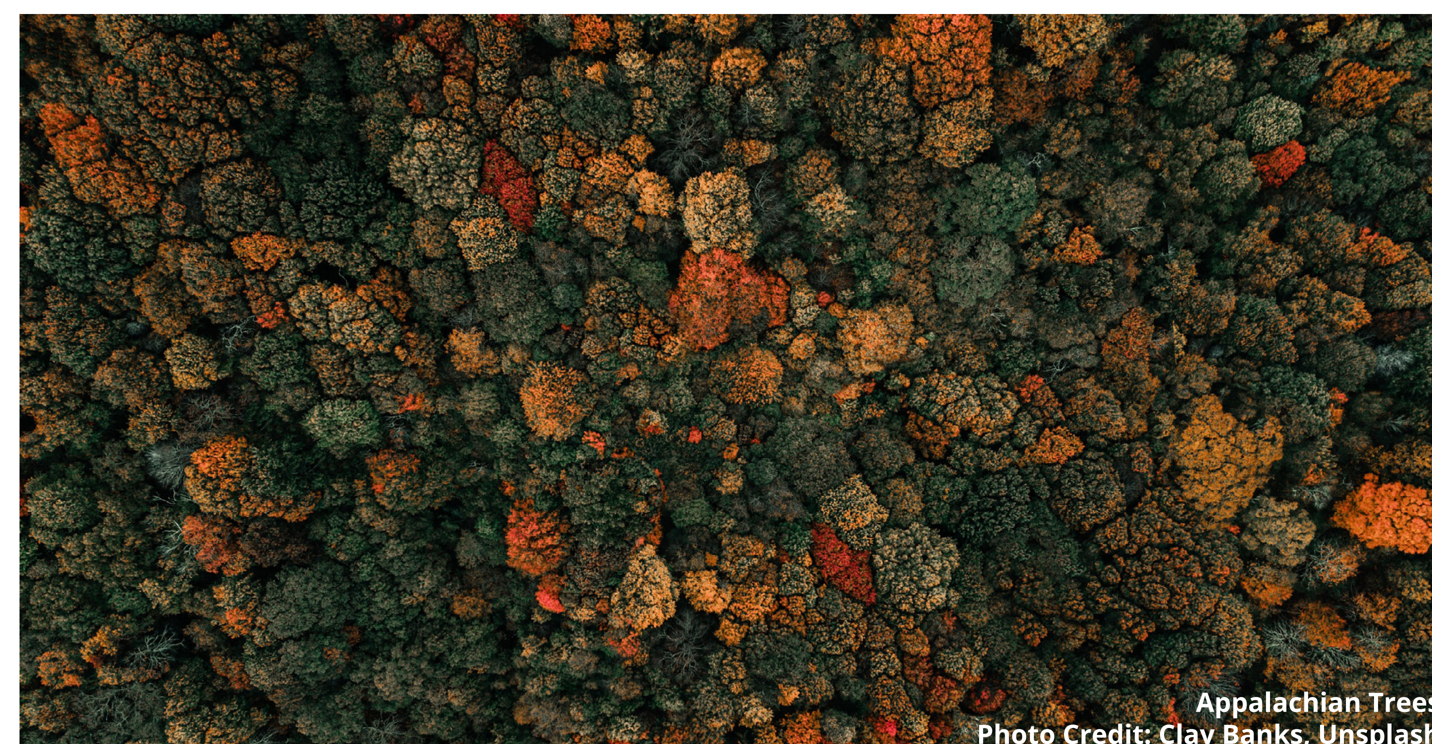
The key insight behind fractal fluency, Taylor tells me, is "that your visual system is set up to process this complex imagery." Taylor's research analyzing the alpha and beta brainwaves recorded through EEGs found something unusual: both alpha and beta waves peaked when subjects were exposed to fractals. "It was both grabbing your attention and relaxing you at the same time.... It grabs your attention but it doesn't wear your concentration down." Fractals at once arouse and relax, captured in the way that we engage in "effortless looking" when it comes to such things as clouds. Our proficiency at recognizing patterns in nature helps explain why we sometimes see forms and shapes in clouds that do not exist (what Taylor refers to as being fractally "trigger happy"!).

Planning for Fractal Fluency

We want and need fractal-rich cities and living environments. Taylor's work points to a sweet spot of fractal complexity, or what he and his colleagues refer to as the "D" value, a measure of relative ratio of coarse and fine structure. The more complex the fractals are the better, but only up to a point. The mid-range D value is where our human (evolved) preferences lie and images or views (or paintings) with this level of complexity are especially pleasing to the eye.

The implications of fractal theory for design and planning are almost limitless. Nature-rich cities are by definition fractal-rich settings: we need and want more trees and nature. We have known that nature reduces anxiety and stress, makes us feel better, and happier, but Taylor's work suggests that much of that owes to their fractal composition. It provides a powerful theory for understanding why it is that we so enjoy and benefit from watching trees and clouds.

And it turns out that fractal fluency can find expression in other ways. We can also design our buildings and neighborhoods in ways that incorporate fractals and fractal geometry. Taylor and his team have just collaborated with designers at Mohawk carpet company to design a new fractal-based carpet line called Relaxing Floors. These fractal designs have already been winning awards and will soon go into production. As Taylor explains, "this is for commercial spaces like airports, hospitals, hotels;" places where stress-reducing qualities of fractals would be most needed. For Taylor, this is a logical extension of his work more than a decade ago for NASA, thinking about what kinds of interior



Appalachian Trees
Photo Credit: Clay Banks, Unsplash

Autumn Walk
Photo Credit: Andreas Dress, Unsplash

spaces astronauts would need to sustain them during long space missions.

One of Taylor's studies demonstrates that it is easier for humans to navigate through a fractal environment, suggesting ways to improve wayfinding in buildings or in public spaces. Fractal urban design and architecture has the potential to enhance not only the visual pleasure and enjoyment of cities but the practical ease of getting around. According to Taylor, "just as when you walk through a forest you're not designed to walk in straight lines, you're designed to take this fractal trajectory."

There are also other ways that fractals can provide bio-inspiration. For instance, fractal building design may help us better design structures that will withstand the forces of earthquakes. As in a tree, simple repetition of fractal shapes can deliver "immense flexibility" to a building's structure. There is evidence that shoreline protection structures that are fractalized are more effective, and that high fractal buildings and surfaces may do a better job dissipating wind, a result of their high surface area to volume ratios. Taylor also thinks these properties could maximize solar gain and solar production from photovoltaics.

We teach little in planning and architecture programs about the science of fractals and that is a shame. We could begin to evaluate the cities and landscapes we plan and design according to their fractal complexity. I asked Taylor about how we might go about doing this - he says: "you could take the very same computer programs that we have for the Pollocks and apply it to any object really." In this way, it would be possible to analyze a visual frame aimed at a downtown or a city's skyline, through which we might discover that (hopefully) our city resembled (fractally) a Jackson Pollock painting; a similarity that might surprise most residents.

Resources:

Taylor, Richard et al. (1999). Fractal analysis of Pollock's drip paintings. *Nature*. 399, 422. https://doi.org/10.1038/20833.

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