What Can Nature Teach Us About Patterns?

An interview with **Stephen Morris**, Physicist
University of Toronto

What I work on is called pattern formation: situations where nature produces some regular-looking structure, which we call a pattern, apparently for free, for nothing. So the classic example is that wind blows across some sand and the sand makes these beautiful little ripples. Where did the ripples come from?

The reason icicles are interesting is because you see them all the time, or at least in Canada you see them all the time, and many natural icicles aren't just sort of cone-shaped. They're actually kind of bumpy in this rather regular-looking way. And so the mystery is why are the bumps so regular and where do they come from?

We can actually reconstruct the full three-dimensional shape of the icicle as it grows. And I can take that data and send it to a 3D printer, and I can make a plastic version of the icicle that we've grown.

So we know everything about the shape of the icicle. We know everything about its growth: the flow rate, the temperature, the water, the concentration of the water, the humidity, the state of motion of the air.

All these systems have that property that they, from internal rules, they organize themselves into a complex thing. And they do this using pattern formation and other non-linear phenomena — self-organization, it's called — that's the kind of thing that we study.

What is the future promise of your research?

Physics is a strange science, because its mandate is everything. Everything! If there's something left unexplained then it's our job to go in there and figure out what the physics of that thing is.

The big picture is to learn how to engineer self-organization rather than just discover it in nature. And the place where you see self-organization most clearly is in biology: you see an animal go from an egg to a fish, and each little part seems to know what to do to organize itself. There's no blueprint of the fish that the fish is following.

And so you can sort of imagine that if we really understood this kind of self-organized process, we could do this, too. We could build machines that built themselves, or processes or materials without us having to go in there and template every little bit.

If you think about how a microcircuit or a microprocessor is made, there's a map that says where every transistor goes, and it's carefully reduced down and painted onto the thing. Now imagine making a processor where you just dump all the components into a pot and heat it up or whatever, and like a fish it just builds itself. That would be an amazing piece of technology. And that would be a self-organized complex system.