

LORNA GIBSON: My name's Lorna Gibson. I'm the professor for 3.054, it's a course on cellular solids. And I've been working on cellular solids since I was a graduate student, since I did my Ph.D. And cellular solids are materials that are made up of an interconnected network of struts or plates.

And there's examples like engineering honeycombs and foams, and there's lots of examples in nature. Things like wood and cork and there's a type of porous bone. And there's lots of examples in medicine too. Tissue engineering scaffolds, for example.

So my background is in civil engineering, and in civil engineering we study structures. And typically people think of large structures like bridges or buildings. But in fact when we analyze the cellular solids, we use the same kind of mechanics. It's just the scale is very much smaller. So we're looking at structures where the scale might be hundreds of microns or millimeters, things like that, but the same sort of mechanical principles apply to that.

OK, so I grew up in Niagara Falls, in Ontario. And people always think of Niagara Falls as being the waterfall and all the tourist stuff, there's a casino there now. But in fact, there's loads and loads of big civil engineering works in Niagara Falls, mostly associated with the hydroelectric power station. So when they make hydroelectric power in Niagara Falls, the power station is actually about a mile downstream from the Falls. And what they do is they have a big hydraulic gate that goes into the river and it diverts water from the river above the Falls into a whole series of canals and tunnels and there's a big reservoir where they store water.

And then the water from this reservoir goes into the penstocks, the tubes that go down to the turbines and then make the electricity. Niagara Falls is not a big town, but if you drive around Niagara Falls, you see these canals, you see the reservoir, you see the big power station. And so there's these really huge, impressive civil engineering works. And my father worked for an engineering company in Niagara

Falls and they specialized in the design of hydroelectric power stations, and I think that's how I got interested in engineering.

So I've been interested in bird watching for some time. Mostly just because birds are beautiful and there's all sorts of interesting behaviors you can see with birds. But since I started doing research on cellular solids and, in particular, teaching this course, I realize there's lots of examples of things about birds that have to do with cellular materials.

So for instance, some people had once told me that woodpeckers avoid head injury and brain injury by having a special cellular material in between their brain and their skull. And that this acted kind of like a foam in a bicycle helmet. That it would absorb the energy of the impact. And I thought oh, well, I like bird watching and I study cellular materials, I should find out about this. So I started looking into it and people had looked at the anatomy of the woodpecker skull and brain. And, in fact, there is no special cellular material.

But by that point, I was kind of hooked. And I actually did a project at one point looking at why it was that woodpeckers don't get brain injury. And it's largely a scaling law. It has to do with the fact that their brains are very small.

Another aspect of birds that has to do with cellular solids is how birds make themselves very light. And here we have an owl skull. This owl, unfortunately, had an accident with a car. But somebody picked up its body and took it to Mass Audubon, and I got this from somebody at the Massachusetts Audubon Society.

And if you look at the skull-- I don't know if you can do a close-up here-- if you look at the skull, you can see there's a dense layer of bone on the outside and there's another dense layer bone on the inside, and there's a sort of foamy layer bone in between. And that's called a sandwich structure. And this foamy type of bone is called trabecular bone.

And that's one of the things that I study. And it turns out that particular structure gives you a very stiff, strong, lightweight structure. So you can see an example of

how cellular materials are used in engineering but here sort of manifested in the owl's skull in making the skull very light.