Ok. Why does this matter?

Well, this is one reason.

If you don't plan your cold work carefully, you might make the material too brittle.

You wanted it to be so hard because this was such an important ship and it was going to be a big deal and the launch was really exciting.

And then it cracks in half, the entire ship.

Why?

Because you didn't look up what dislocations mean.

You didn't take 3.091, that's why.

That's a pretty big crack.

The main why this matters-- oh, I couldn't help it.

I am a big fan of wind.

Wind energy is growing and growing and it's such a great national resource.

Here's the global capacity.

This is install capacity for wind turbines.

But see, this is a mechanical materials problem that you are now equipped to think about more deeply.

Because, you see, you can do a lot of different experiments on those turbines.

So the blades here are critical.

You can imagine that you want them to be light, but if they're too light, they may not be strong enough.

And then how do they need to be strong?

Because you've got huge amounts of wind coming at them.

And it turns out, you need to hit just the right balance of elastic deformation before it goes into some plastic regime.

You need to hit just the right balance of ductility.

So here's, for example-- these are some simulations.

Here are some experiments on a new material for a wind turbine blade.

And then you put it out there and look at what happens-- ice.

By the way, this ice comes off at hundreds of miles an hour in chunks.

These farmers are not happy about that.

Seriously.

And those are bugs.

Actually, bugs in wind turbine blades is a serious problem.

How do you clean bugs off of it?

Because it dramatically changes the aerodynamics and the efficiency.

It also can damage the blade itself.

So there's all sorts of work going on.

How do you make bug-proof wind turbine blades?

OK.

Well, now just spray it with something.

Ah, but then does it have the right plastic deform-- does it have the right yield point or is it just going to crack?

And by the way, it's got to have 5 times 10 to the 9 cycles before it can fail.

That's the metric.

So that's a pretty big ask of a material.

It all comes down to understanding this curve.

And in the broader sense of materials, this to me is a very exciting ask.

Why?

Because if you look at a plot of the density of materials-- heavy, light.

Good.

Kilograms per meter cubed.

And the Young's modulus-- now, this is a measure of the strength of the material.

It's a measure of how much strain you could put on the material before it breaks or goes through deformation.

But look at this.

Different materials are here-- rubbers, foams.

OK, foams have relatively low Young's modulus, but they're really light.

That could be good.

Up here you've got metals and alloys, ceramics, you've got polymers in here.

But notice, I've got so many different applications and needs in the applications and I've got this plot where I've got nothing here and nothing here, even though, if I could fill this out and dial up any stress/strain curve for any density or Young's modulus, you can make a big difference in a lot of different applications.

So I think this is a great challenge.