Now that we've introduced mechanical energy in our potential energy functions, we're describing our systems differently.

We talk about states.

We talk about the potential energy of that state.

We talk about the mechanical energy of that state.

Remember we're always referring to a reference state for a reference potential.

But in one dimension, what we have is that the potential energy say, in some final state, minus the change of potential energies from some initial state was that integral x final of the x component of-- I'm going to put c up there for conservative force, dx.

And now, so the potential energy difference is the integral of the force with the minus sign.

Now let's look at a fundamental theorem of calculus, which tells us that any time you take the difference of a function between two end points, then by definition that's the derivative integrated with respect to dx.

So when we compare these two pictures, this is a map here.

This is our physics, how we define them.

That when we compare these two pictures, we see that we can recover the conservative force by taking the derivative minus the derivative of the potential function.

Here, force does not depend on any reference point.

And when we differentiate a constant, that's 0.

So this is independent of the reference point.

And this enables us to, when we think about the potential function and its first derivative, then this tells us about forces.

Let's look at an example.

Suppose again we look at our spring potential where we're talking about the potential energy function of a spring where at our zero point where it was unstretched was our reference point.

And if we plotted this function-- so let's plot that function.

So here is U of x versus x.

Now we can talk about at any given point-- so suppose we're at a point here.

Maybe our energy has some fixed value.

Then the slope at this point is equal to du dx, and the force is minus that slope.

So here you can see that the slope is positive.

So the force is negative.

So I can write Fx like that.

So here Fx is negative, so our actual force is pointing inward.

When we're on this side of the potential function, my slope is negative.

So the x component of the force is positive.

So my force is pointing everywhere on this side back to the unstretched length.

So knowledge of the potential function, also by knowledge of its first derivative, gives us information about the force at any point, any state that the system is in.

So when we talk about potential implicitly, we also know what the force is.

And the potential function is enough to tell us what the force is at any point.

And let's just check for this simple case.

This is minus du dx.

When you differentiate that, you get minus kx, and we know that's the spring force.

So this is why we're suddenly shifting our focus to our state, our function u of x, and it's first derivative.