There's another vector operation, which we call the vector product and sometimes this operation is called the cross product.

And this is taking two vectors $A$, the operation $\times$, $B$. And this will give a new vector $C$.

And now we want to define that new vector $C$.

So let's draw a three dimensional picture where we have a plane.

And on this plane, we have two vectors $A$ and $B$.

And those vectors are forming an angle $\theta$ between them.

Now a plane defines two unit normals.

I'll draw one up, which I'm going to call $\hat{n}$ right-hand rule.

And the reason for that right-hand rule is if we take $A \times B$, then our right hand thumb is pointing in the perpendicular direction to the plane.

Now I could have chosen a unit vector down, $\hat{n}$ left-hand rule.

And this would correspond to taking my left hand and having $A \times B$ pointing down.

So the way we're going to define our cross-product is with the right-hand rule.

And so we define it like this.

That the vector $C$ has magnitude, the magnitude of $A$ times sine of theta, the magnitude of $B$, and its direction is given by the right-hand rule.

Now one of the reasons for this definition is let's draw a vector $A$ and a vector $B$.

When you have two vectors, they define a magnitude in the following way.

That we can think about any two vectors define an area of a parallelogram.

And we can define that area as follows.

Let's drop a perpendicular.

And let's call this $B_{\text{perp}}$. 
Then the area, which is a positive quantity, is given by-- and by the way, our angle theta here will be always positive-- so we're going to make it 0 \theta \pi.

And that way sine of theta is always a positive quantity.

The area is the height, so that B perp times the base, which is the magnitude of A, and so we can write that as A, and the magnitude of B perp is B sine theta.

So this quantity, B sine theta, is precisely what's occurring there.

So the magnitude of C is equal to the area formed by the vectors A and B. And we have a choice of which way we want to pick C to point.

And that's where, as a convention, we're choosing the right-hand rule.

Now again, there is a symmetry here in that I can also define the area of that triangle in the following way.

Let's write this, theta.

Instead of taking how much of B is perpendicular to the direction of A, let's drop the perpendicular this way, and write that as a perp.

And then the same area can be expressed as the magnitude of-- well, we'll express it as A perp times B. And A perp is the magnitude of A sine theta times the magnitude of B.

And that's our same definition as before.

And so you see, a sine theta is appearing over here.

So in either choice, our vector operation says take any two vectors.

Any two vectors forms a parallelogram.

The area of that parallelogram is the magnitude of the vector product.

And the direction of this new vector C is given by the right-hand rule with respect to that parallelogram in that sense.