We would like to now introduce a new methodological tool for analyzing problems that involve momentum transfers.

And we call that tool momentum diagrams.

Now, what we'd like to do is look at our fundamental idea, which was, for discrete objects, we have that-- involved in a collision-- we have that the external force integrated with respect to time-- in poles-- is equal to the change in momentum between two different states.

So this is the momentum of the final state, and this is the momentum of the initial state.

So when we want to analyze problems, how can we methodologically introduce a picture representation of our problems?

So let's look at what we need to do first.

We always need to choose a system that we're referring to.

And with respect to the choice of that system, we need to also choose a reference frame.

Now, once we've done that, we can now represent a collision with respect to this system.

For instance, let's consider two objects-- as our system Object 1 and Object 2.

They're moving on a frictionless, horizontal surface.

And we're choosing as a reference frame, the ground frame.

Now, what we'd like to do is identify two states.

So for our initial state, we'll have-- if we're given some initial conditions-- what we'd like to do is represent each object with a velocity vector.

So here, we'll write the 1 initial, and let's suppose this object is coming at it with the 2 initial as an example.

And once we've represented the velocities of the objects, we can write down their momentum in the initial state.

Similarly, if these two objects collide and they're moving, we actually don't know which way those objects will end up moving.

And so what we'd again like to do in our final state, after this collision, is to represent the velocities by, again, vectors.

So this is V1 final and this is V2 final.

And then, we can represent the change in momentum.

So our momentum principle now becomes-- in this case, let's just assume that the external force here sums to zero-- we're assuming no friction.

And then our momentum principle says that 0 equals P final minus P initial.

And now, we can read off those momentums as vectors on the diagram, and so what we have is that the final momentum will be equal to the initial momentum.

So we can write down M1 final plus M2 V2 final is equal to M1 V1 initial plus M2 V2 initial.

And that's how we can represent a collision where there is no external forces and use our momentum principle to get an vector equation.

Now, in many problems, you're given information.

You might be given information about the speeds and magnitudes of the objects.

And in order to then take this equation and represent it in speeds and directions or even components, we need to choose some coordinate system.

So if we choose a coordinate system-- and that's the third step-- so suppose we choose a coordinate system, then we can start to look at two different representations for our problem.

For instance, let's just choose this to be the i hat direction.

Now, given that choice, we could describe the velocities in terms of components.

Now this gets awkward-- V1i x component i hat.

And similarly, we can write down all the velocities-- V2i-- as V2ix i hat, et cetera, for all the velocities.

And our momentum equation in components then becomes, in the i hat direction, M1 V1ix plus-- well, here we have the final state, so let's make this consistent-- the final plus M2 V2 final x equals M1 V1 initial x plus M2 V2 initial x.

And that's the same equation that we have as vectors, now expressed in terms of components.

And recall that components can be positive or negative.