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## **STEAM: Make Balloon Propelled Vehicles** with Jamie Hudson

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### **Chapter 1 - STEAM: Make Balloon Propelled Vehicles**

#### Overview

(upbeat music) - Hi, I'm Jamie Hudson, I'm a scientist who started the craft company with his wife a few years ago. That gave me a passion for bringing science into art, and kind of bringing creativity from art back into science. We're gonna play with basic concepts of kinetic energy and potential energy by using balloon powered vehicles. It's a classic experiment, which you blow up a balloon, let it go, and it flips around. We're gonna use the Cricut cutter to make some simple parts, and try and make some different kinds of vehicles using those balloons. (upbeat music)

#### Materials

- For this project, you're gonna need a Cricut cutter, a mobile device to access Design Space, and you'll wanna make sure you have the tangential knife blade, a piece of basswood, and a StrongGrip mat. You'll need some art tape or masking tape, as well as balloons, straws. Here, I'm using paper straws. Plastic straws will also work just as well. Electrical tape, glue dots, Velcro dots, the kind you can find in any craft store, a pair of scissors, and an X-ACTO knife to help clean up the cuts. You'll also need a marble or a ball-bearing for one of the projects, as well as string. And remember to download your SVG files, which contain all the cut paths that you'll need for this project.

#### Assemble the vehicle

- First let's open a Design Space. We'll get a new canvas by clicking the new button. And then on that toolbar on the left, you'll see an upload button on the bottom, click that. Click next to it and we'll say upload image to import our image. We'll now browse to the SVG file that you downloaded. Here it's called balloon cars Basswood. You'll see all the lines. Go ahead and say, save on the bottom right. And then that'll import that image. Select the image but make sure it's got a green outline around it and then in the bottom right, click insert images. That'll pull all that into Design Space. The way this project is laid out is that we're actually taking advantage of some of the negative space. Spots that would normally get thrown away, we're actually using as parts. So we wanna make very sure that all the cuts go exactly where they want to. When you're in Design Space, the way you do that is you grab everything and you say attach on the bottom. What that does is all the cuts as you see 'em on the screen is how they'll actually get cut on the mat. So we'll then say, make it and you can see that entire design got moved over. We're gonna grab that design and we're gonna line it up between the two inch and eight inch lines on our mat. That's where we're gonna put the Basswood when we align it onto the mat. We'll then say continue. It'll then connect to the maker using Bluetooth or USB, however you have it set up. We'll now say browse all materials. And we're just gonna search for Basswood. Select Basswood 16th inch. Say done. And now the cricket cutter's telling us to load the knife blade and the clamp B. We already have it but the knife blade is this tangential cutter with a gear at the top. It's always used for Basswood. So we'll put that in, that gear we'll line up and we'll simply clamp it down. We are now ready to prepare our mat. We're gonna align the Basswood again between the two inch and eight inch lines on our mat, just like we laid it out and we're gonna push that down, try and get it to stick. We'll use either the masking tape or art tape. Here, I've got this nice green art tape and we're gonna put a tape line around the very edge of this to help hold it onto the mat. There's a fair bit of pressure of this happening as this gets cut and

what you wanna do is make sure that Basswood stays firmly clamped to the mat as you can. So adding this extra layer of tape just makes sure that happens. If you don't, it can move the wood around a little bit and you'll start noticing some errors in your cuts. So we're just gonna wrap that with tape. And let's go ahead and just put tape the top and the bottom as well. The other thing you always wanna remember when you're doing Basswood is to look at the position of the star wheels. The star wheels are these little plastic rings that sit on the front bar, the feeding bar, on the Cricut machine. You wanna move those to the sides to make sure that when they roll over the mat that they go on either side, but not over the Basswood. They go over the top of the Basswood, it'll leave a nasty impression on the wood itself. The load light is blinking. We're gonna click that so it loads the mat in properly. And once the Cricut light is flashing on your machine, press that and begin. So it's flashing, let's go ahead and start cutting. The first thing it's gonna do is drive over to calibration station, figure out the orientation of that knife blade, because when this cuts it's gonna do what's called a tangential cut. It's gonna follow right along the edge of the cut and always keep that knife positioned really well. This is a really nice feature of the Cricut machine. We'll leave that to run for a while and it'll do multiple passes to make sure everything cuts through. When the job is complete, the unload button will flash. Select it and they'll unload your mat. Now on this, we'll wanna be real careful when we weed out the different parts that is to remove the stuff we don't want and make sure we're keeping the parts that we do want. I'm gonna go around the edge here and just carefully take that tape back off. I'm just gonna try and keep everything nice and flat on the table while I do this. Now, when I weed anything like this it looks like this is coming out really nicely but I like to carefully pull the mat backwards by kind of curling the mat. And I wanna keep the wood from getting bent itself. 'Cause it would, at some point will break. And so we're just gonna carefully bring this off and it looks like that cut through really nicely. So this is gonna be really easy but one of the tricks you can use as if things aren't quite cutting out, you can come through with an X-Acto knife and kind of break up the tabs and just be real careful with it. The other thing I do sometimes is I'll actually intentionally break the parts of the wood I don't want. So I might be able to do this and make a crack there to remove the wood. So things like that, just kind of help get these parts out when you're doing Basswood on a Cricut cutter. In this case, though, what we're gonna end up with is four of these little mushroom looking things that are gonna be used as hubs for our wheels, four of these keys that are gonna be used for axles or bearings for our wheels, and we have a large circle that we're gonna use to make a spinning UFO kind of disc using our balloons and then we have the four wheels themselves, which have a tiny little tab in the middle, that'll probably need to be sort of poked out very carefully with an X-Acto knife or a different tool Here I'm just gonna just kinda help that break out. Basswood does break pretty easily. So you just wanna be careful with it. It will break along the grain fairly easily and it'll be fairly strong against the grain. Let's just go ahead and clear all those out. And in total, this little kit makes 13 parts. All right, we're ready to build the car. Let's start by putting together the body of the car and for that we're gonna use these kind of key shaped pieces. We'll put them into each end of the straw, making it just flatten that straw a little bit and it should slide right in there and make a nice snug fit. Put the one on the other side and try and keep it as close as you can get to being parallel to the other one so that each one is in about the same orientation. We'll do the same thing on the other straw, just flatten that end a little bit. Put a key into one end, rotate it around. We'll hold it nice and flat on the table so that we can kind of get it oriented into the other end and just try and get it nice and flat. This is gonna form the body of our car. It'll go back and forth and then we'll just need axles with wheels on them. To do that, each one of these wheels attaches to a straw using these little hub keys. So this slides into the center of the

wheel and then we'll attach to a straw. So let's just go ahead and put those four together now. And it doesn't have to be a very snug fit. When the straw gets put on the end, it'll help it hold it all together. All right so we're getting close. Now, what we need to do is build a couple of axles. Let's just pick our favorite color of straw here. Let's do green and let's make an axle that's, oh I don't know this long. So I'm just gonna use a pair of scissors and I'm just gonna cut off a piece that's maybe three inches long that's gonna make the axle of my car. The way that'll work is it that'll go onto the end of this and ultimately this will roll over that and you'll have an axle. To help kind of keep these things oriented side to side. What I like to do is just to cut off a couple of little pieces here. Let's say about an inch on each one or maybe about three quarters then it's a little under an inch. So let's go ahead and make four of those. I'm just using the first one I cut as a reference for the other three that I cut. So just holding these up, I'm just gonna use that and just cut it here. Again, I'm using paper straws. They work really well. Plastic straws should work just as well and you might have to fiddle around with them to get it all kind of rolling well but that's part of the fun. Science almost never works quite like you expected the first time. In fact, scientific discovery is almost exactly that, it's things not doing what you expect and then trying to figure out why and in that process, a lot of discovery is made. For these little pieces, I wanna slide it over the straws just to kind of help keep these round bits from getting too close to the ends and to do that, I'm gonna insert the scissors into the straw itself and I'm gonna cut down lengthwise. So they form these little sleeves. The sleeves in turn are gonna fit over the straw. Just kind of open that up a little bit, fit over the straw and we'll just put it out at the end. What that does is it'll form kind of a shoulder that that'll sit onto it. Let's just go ahead and do that. We'll put our two axles on there. Put that hub on the other end. I'll just cut the next one lengthwise. I'm just gonna slide that over the straw and go there. Now to help kind of keep it oriented side to side, I'm gonna cut a different piece of straw that's about the same long enough just to keep that right. So I'm just gonna do that by hand by holding it up and saying it's about that long. If I'm wrong, then I've got scissors and I've got time. So we'll just fix it and get it right. So that looks good. We're gonna do the same trick, just run down through the middle, kind of help open that up. What you're doing is you're building a little thing that'll just pop over the top over the top of the straw and build a shoulder. So now this'll roll back and forth really easily. And you wanna get this car as frictionless as you can because when the balloon is deflating, we're gonna use the displacement of the air out the back to propel the car forward. So I'm gonna do the same thing on the other end. I'm gonna take my axle, run it through there and attach my wheels on either side. Then using the same trick, I'm gonna come through and cut down the middle of these guys and make those shoulders again on the straw. So I'm just gonna cut a couple another little pieces that I already made, just kind of open them up and then they'll pop on over the top of the straw. What's fun here is you can try using making this part shorter. You can try making the axles longer. It's kind of whatever you can do with the straw here so that it looks like it's a little long. Let's trim that a bit shorter. Oh, I bet that works great. I'm just gonna cut down the length of the straw again. Eh, just kind of open that up a bit and snap it on to my vehicle. Okay and now I've got a car that rolls back and forth pretty well. I'm already having a lot of fun. (laughs) So probably you wanna see the rest of the craft video and not me playing with that car for the rest of the day. Let's go ahead and just make a simple little carriage in the middle and this'll make sense in a second but I'm a use a piece of tape. Here's just a piece of art tape and I'm just gonna put that up between the two straws kind of in the middle. Ooh, let me get that a little more square first and that'll be good enough to kinda help hold the orientation of these straws. So I'm gonna just kinda make that flat. And all that's really doing is just kinda, trim the end here, just making it so that that'll

have about the right orientation. How I actually made that a little wonky. I'm gonna try that again. So no problem. Science. (laughs) We're gonna cut that off. (laughs) We're gonna do that one more time, except this time we're gonna do it correctly. Let me just pull that piece of tape back off. And we leave that piece of tape on there as a record that we made a mistake and we learned from it. Let's get that all nice and square and I'll set that across the top. Okay. So that just helped kind of keep this in the right orientation. They're pretty flexible and pretty versatile. I keep this all very loose so that this will roll back and forth. That's not exactly frictionless, but it's pretty close. It's pretty good for straws and a couple of pieces of wood and some tape. Now we have the basis of our car. We need an engine. To do that, we're gonna grab a balloon. I like to cut the end off, that little rolled over part at the end. And you can even go back in a little ways. So let's just cut off about a half inch of that. I'm gonna get my electrical tape, which is just kind of a nice plastic tape. You might be able to use masking tape for this but electrical tape will work a little bit better. Just cut off maybe a two or three inch piece of it, set it aside for a second. Now we'll get a straw and insert it into the balloon. And then we're just gonna kind of pull that tight and make sure that looks nice and good. And we're gonna form an airtight seal between the balloon and the straw by just folding that over and rolling it up and it doesn't need to be great but as soon as it looks like it's airtight, we can bring in our piece of electrical tape that we set aside and we'll cover the straw and we'll cover the balloon and we'll just wrap that around a few times. What we've got is a nice tight seal. We have our balloon. Let's blow that up for a second. I'd like to be able to use this balloon for all of our balloon powered vehicles. To do that, we're gonna use these Velcro dots. If you use the Velcro dot directly on a balloon because when you blow it up, the surface is stretching out, when it deflates it'll actually peel itself right back off that dot. A trick here is to use glue dots. Glue dots, as anybody who does balloon art can tell you are really great for balloons. Holding the balloon, I'm gonna put the glue dots just up on the very top of the balloon, kind of center it on the top. Just get a couple of dots there and then I'm gonna use those glue dots, oh no, I'm stuck. Okay I'm to use those glue dots to attach the Velcro. Then I'm gonna take one side of our Velcro dots here. Here, I'll take the fuzzy, not the pokey side and I'm gonna attach that directly onto the glue dots and that will just help that Velcro dots stay on there even as the balloon deflates. Normally that would pop off right now if we didn't use the glue dots. So that's just a nice trick. The next trick we're gonna do here is that we're gonna play around with trying to direct the air that comes out of the back of that balloon a little bit. And to do that, we're going to cut the straw at an angle. So setting the balloon flat on the ground with the dot at the top again, we're gonna cut a 45 degree angle along the straws just near where the electrical tape is. So we're gonna cut it like that. When we let the air out of the balloon, most of the air in this orientation will wanna go back. If we take this same guy and we fold it over, that'll help redirect the air and send it out sideways. So if we wanna make our balloon spin, which of course we do, because that sounds amazing, then we'll bend it over and we'll have it spin. But for now for the car, we'll just let it go straight. Just to finish this up, I'm gonna take the other side of my Velcro dot, here, the pokey side and I'm just gonna attach it to my balloon car carriage, that little tape piece I did in the middle. I'm just gonna attach it up there. And again, because this is pretty versatile, you can try different spots and different orientations and you'll find that you get pretty different results. So let's blow up the balloon and see how our little car works here. All right, so now we've got it blown up. I should be able to take that one Velcro dot, attach it to the bottom and watch out everybody because here it comes. There goes our car. Ah! (laughs) Probably got enough to keep it going by a couple of times. And there is a great balloon racer. This is another classic of science fair projects. How does it work? When you blow up a balloon (air hissing) I would call this potential

energy, that means there's energy in here that could be used for something. So when you see a rock sitting on the top of the hill, that rock has a lot of potential energy. When that rock starts to roll down the hill and the energy starts being used, here we put it on our car and it starts going. That's kinetic energy. That's the energy that's actually being used and going out. The balloon works by displacing mass out the back. If you're floating freely in space, and this is a good tip, if you ever happen to find yourself floating freely in space and you'd see your spaceship and it say a hundred yards away and you have no way of getting there, you can try swimming, you can try jogging, you can jump up and down all you want but you're just gonna stay there perfectly still. If you have anything on your body, like a wrench that you can throw, you would throw it away from the spaceship because that displacement when that energy leaves, you're gonna go proportional to the weight, the other direction. Pro tip, that might save your life someday. So now we have our basic engine. We have a balloon car. We've proven what we can do. Let's see what else we can do for balloon powered vehicles. One of the things we made on the cricket is this disc combined with a marble or in this case a ball-bearing. What you can do is make something that'll look like a UFO, something that spins. I'm gonna take a piece of electrical tape again. Just cut off a couple inches of it without pushing the marble up through the center, I'm just gonna carefully put a piece of tape on there to keep that marble in place. I'm gonna use the pokey part of a different Velcro dot. I'm just gonna set that on top of the marble as well, just carefully, just enough to get our balloon on there. What we're gonna try and do is get the balloon to provide energy that spins it around and around. Let's see if we can get it going very fast. To do that, I like to take the straw, just kind of bend it over and get a little bit of a jet action. What's happening now is the air is gonna kind of come out and blow this direction. So that means that all the energy is pushing the balloon in this orientation with everything here. It should cause it to spin. Let's find out if we did a good job. (air hissing) Gonna put that on there. (laughs) We can do a little better than that. Let's try it one more time. This is just sort of fun, just keep playing with it. See what you can do. See what you can make work with this. (air hissing) All right so we'll get that on there. (laughs) So depending on how well you can get that balanced, you can get that spinning pretty good. Definitely can play around with this and get it working a little better. Let's try a different orientation though. Let's try making a balloon string shuttle. So we're gonna have a little piece of straw that fits over the string and we'll use the balloon to power that piece of straw down the length of the string. So be a nice way to send a message across the room. For this part, we'll need string and a straw. Let's start by just cutting off about oh, I don't know, two or three inch piece of straw. We'll just feed that onto the string. And now we just need to find something to hang this string back onto so that when the balloon is there it'll push that straw one way and the down there. We're gonna tie this directly onto the lighting stands, just make a loop over here, run over to the other lighting stand on the other side of our table here. And we'll just go ahead and tie that on. And now we have our shuttle. Now we're gonna go back to our Velcro dots. We're gonna grab the pokey side again. We're just gonna attach a couple of those to the straw and I'm just gonna add, oh, I don't know, two of them. Oh you know what, let's do three of them to the bottom of that straw. What that'll let us do is play around with the balloon position and see how that looks. There is a little bit of sticky there. You can kind of roll that over onto the straw. And now you've got kind of a bristly little straw that's Velcroed, and it should be willing to take our balloon. Let's just blow up our balloon again. (air hissing) We'll attach it back to the straw. Let's move it down to this end. And now, (laughs) there goes our balloon. So you can send a message from this side of the lighting stand to that side of the lighting stand. Whoever's over there could take it off. Reverse the balloon and send it back. With all these parts, we made ourselves a balloon

car, and balloon UFO, a balloon shuttle and it'll be interesting to see what else you can do. When you start playing with this, you'll notice that it really matters how you have that straw aimed, how it bent on the end, where the glue dot is positioned, the weight matters, all these things matter. This is actually a really interesting introduction to the basics of things like rocketry and for how you orient a jet to get it to go the right direction. This is a lot of fun to play with. I encourage you to do that and see what you can come up with.