JOSH: OK, so let's turn the page to storyboarding, which, for us, no matter what sort of video you're doing-- live action, animation, or some sort of combination-- is vital to the process. And here's why.

It allows you, basically, a lot of freedom to not have to make any really high stakes creative decisions and just be creative at a very early stage. You don't have to commit to any sort of production at that point. That's why we do it.

And it's why we share with clients before we commit to doing any animation, because it's very time consuming for us to animate. And we want the client to know what we're doing before we commit to doing any of that really labor-intensive work.

It serves as a blueprint for timing and visual flow. So you can get a sense of the pacing of the video, whether or not, as Elizabeth was saying, things are going to get stale at a certain point. It can help you make those sorts of creative decisions without having to commit a lot of resources.

The storyboard can reveal where you're going to need to shoot, what props you're going to need, the types of shots you're going to employ. All that decision making gets made in the storyboarding process. And another, really crucial thing is, so often when we're doing a storyboard, we realize that the script needs to be different.

You write something-- maybe you have some visual sense when you're writing a script. And that's good, because-- and I've done it a lot. So a lot of times I am thinking visually. But I'm not always thinking visually. And I'm not-- it's not my strong suit all the time when I'm script writing.

So a lot of times, we'll be in a storyboard meeting. And we'll say, well, this line is just sort of dumb. Why don't we say this so that we can show this? So that integration of visual and oral-- the voice-- is a really crucial part of storyboarding. So that's why we storyboard.

And let me just show you an example of one of our storyboards. There are many different

ways to storyboard. But I'll just show you one example.

The first is-- well, I'll show you the storyboard for this video we did for NASA, actually. And it was produced by WNET in New York. And they asked us to create a series of videos about different physics topics. And this one is on centripetal force.

So I'll just switch over to-- let's see, episode-- So this is essentially-- this is our storyboard method. We do an Excel spreadsheet with three columns-- shot, narrator, and notes. Very simple-- email me, and I'll send you this storyboard. And you can use it in your own work if you want.

Imagine you've got a tennis ball. So we start the shot on the tennis ball. We either pull back-- we'll watch the video. I can't remember if the camera pulls back or we jump cut or something-- attached to a piece of string. And we pull back further. And you start swinging it.

And then-- when did we have this idea for the dog? I mean, probably this came in the storyboard meeting. Like, OK, we'll have this nice dog element to the experience.

In circles-- and so gradually, the camera's getting further back. And now we can see the background. "Whoa now, watch out for your buddy."

This is not for adults, by the way. I'm sorry. I should've mentioned that. This is for, like, elementary and middle schoolers. So if you find this a little facile and dumb, just imagine you're 13 years old.

"Watch out for your buddy." So the guy on the skateboard ducks down. And then he goes past and waves.

Let's take-- so we start with-- my attitude about this, in a lot of cases, is to start with action. Like, start with something that's really compelling. Like, some-- you don't have to start, right away, explaining things. Just sort of start with imagining something or doing something.

There's that old comment, I think-- this is Hemingway said this, he talked about "in medias res." Start in the middle of things. So don't start with elaborate explanations.

Just start in the middle of the action. So something needs to be happening at the beginning of a video. So that's why we chose to start-- you got this ball spinning. There's something going on.

There's this dog. There's the kid skateboarding by. You're starting with a high level of engagement and interest.

Let's take a closer look at the fascinating physics of this simple action. And then we go into the more detailed analysis of what's really going on. We talk about f equals ma-- Newton's second law-- and how it relates to objects moving.

So I'm not going to show you the whole storyboard. But you start to get a sense of how we put this thing together visually in a very methodical way before we did any work-- I mean, this is work-- but before we did any animation or illustration. And I think John did all the artwork for this. And it's very basic.

She's basically a stick figure. John makes really nice stick figures. So he has that talent.

So let me just show you the video. And it came out of that process. Hold on a second. There we go.

Whoops, that's not the right one. Here we go. This is a minute and 46. So our challenge was to do these topics in about a minute and a half, a minute and 45 seconds.

[VIDEO PLAYBACK]

-Imagine you've got a tennis ball attached to a piece of string. And you start swinging it in circles. Whoa, now! Watch out for your buddy!

Let's take a closer look at the fascinating physics of this simple action. You've probably heard of Newton's second law of motion as it relates to objects moving in a straight line. Turns out, Newton's second law also tells us about the net force on an object as it moves in a circle.

When an object moves in a circle, its velocity changes direction. Since the velocity's changing, that means we have an acceleration. And we know from Newton's second law that if we have an acceleration, we have a net force. Now back to our spinning ball.

For objects undergoing circular motion, the net force on the object is called the "centripetal force." It's a weird sounding word, but it's Latin for the phrase "center-seeking." It's named centripetal because the centripetal force always points to the center of the circle.

The ball has a tangential velocity. So if you suddenly cut the string, it would fly off in whatever the tangential direction was at the moment you made the cut. But assuming you don't cut the

string, and you keep swinging the ball, the ball's tangential velocity is constantly changing directions.

This means the ball is accelerating. And the reason it's accelerating is due to the centripetal force. The centripetal force acting on the ball is constantly directing the ball towards the center of the circle, your hand. This, combined with the ball's velocity, keeps the ball swinging in a circle.

The same centripetal force that keeps the tennis ball swinging in a circle also keeps roller coasters on the track as they go through a loop-de-loop. So the next time you're having a blast on a roller coaster, you can thank the centripetal force.

[END PLAYBACK]

JOSH: OK, so that's a pretty short little ditty. But you can-- I just wanted to show you how we built it. And this next thing is-- I'm not going to show the whole thing. But it's interesting.

This is a video, a sort of an insider look at how Pixar does their storyboarding. And I'll just play a little bit of it. And then perhaps you can watch the whole thing on your own time.

[VIDEO PLAYBACK]

-All right, so this section is the storyboarding process. And this is where, instead of writing with words, we write with drawings. And we put them on little pieces of paper. And it's sort of seeing the movie in comic book form.

And we'll do a section of the movie at a time and we'll pin them all up on boards. And then, when we get a certain chunk done, we'll show them to the directors. Or they will show them to us. And, I don't know, it's kind of complicated thing to explain--

-Well, you know, that was a really good description of about how better to describe--

-Something better than that.

-Yeah.

-Well, we could show it.

-Yeah, let's show it.

-With storyboards.

-With storyboards. OK, this is the storyboarding process, as illustrated by Joe Ranft, our head of story.

-Yes, so there's the little, cute, Mr. Storyboard Artist working very diligently and happily in January.

-And he has a deadline. He's working hard to do his sequence. Every time he does a drawing, he pins it up on the board.

And there, he stands back when he gets done with his sequence. And he says, hmmm, did I do it the best way? And storyboarding actually balances, like, composition, cutting, staging, acting, writing, everything that goes through the storyboard artist's mind as he's doing it.

-So he'll try another pass at it a couple more times until he feels he's got it just right.

-Just right.

-It's perfect.

-So he calls in the story department--

-And the directors.

- --and, of course, the director.

-There you can see John Lasseter. Looks just like him.

-Yeah, it does, doesn't it? Thanks, Joe.

-And then Joe-- or whoever's pitching, the little storyboard artist, in this case-- will pitch the sequence. And in the middle of the pitch, John gets an idea.

-We all get ideas. And that's one of the great things about storyboarding here at Pixar is it is a free-for-all once we get in this. And everybody is out, coming up with ideas to make the sequence better, to make the film better. And when the pitch session is done, inevitably there is lots of ideas to make the sequence better. The storyboard artist kind of wakes up from it.

-Right, and we're infamous for putting all our notes on little post-its.

-Yeah.

-That's why you see all the little yellow squares there. And so we'll all leave, all excited about the great new ideas we've got. And then the storyboard artist--

-Mr. Storyboard Artist goes back and thinks about it and starts over with all his notes that he has to do. Joe Ranft often calls it-- the storyboarding process-- not storyboarding, but "story-reboarding" because we work on it, redo it, redo it, redo it, to make each sequence, to make the entire film as best as we possibly can be. In the next section, you're going to see Joe Ranft, our head of story on *A Bug's Life* pitching to Co-director Andrew Stanton.

-Me.

-And I think Bob's in there, too.

-I think Bob Peterson, one of our story guys.

-He's pitching the circus sequence from *A Bug's Life*. Enjoy.

-OK, so Slim and Francis are hit by the spotlight. They're not too excited. And Slim says, tra la la la la, spring is in the air. And I'm a flower with nothing interesting to say.

And then they go, ah, look, a bee. And then Heimlich comes running forward, I am a cute, little bumblebee. Here I come! I want to catch up with your flowers!

-Oh, oh, oh, I've got it, I've got it. What if, like, he just can't catch up? He's like-- it's just so heavy, it's just hard for him to catch up to Slim.

-Slow down, slow down! So he's like--

[PANTING]

you flowers, slow down, slow down!

-Right, right.

-Yeah, right. That would be great. You flowers are too fast! You're running too fast. Slow down, you guys!

-That's great.

-OK, that'd be good.

-OK, so then he's chasing after them and Heimlich runs by the stands. And there's a little kid eating candy corn. And he stops.

And he turns around and he goes, oh, candy corn, here! I, oh-- you have to let me eat it! Oh! And his stomach is grumbling. And he can go, let me help you, let me help you to finish it!

-Wait a minute. Is a candy corn funny?

-We were thinking of red vines.

-Would red vines be funny? That's a little bit tough for a fly to hold.

-There's those little sombrero jujubes. Those are kind of funny.

-The question is, what would a fly like as far as candy goes?

-Well, dots. But we already have a character--

-Candy corn is pretty funny, though, because it's really, like-- it's a big triangle. I think that actually--

-OK. Yeah, that's why--

-More identifiable.

-I think we should go with candy corns. Like, is it too Halloween?

-Nah.

-No, OK. So he goes, Oh, candy corn, here. Let help you to finish it.

-Great. That's great.

-Tra la la la la. Spring is in the air. And I am a flower with nothing interesting to say.

-Ah!

-A bee!

-I am a cute little bumblebee!

-Ah!

-Here I come!

-Ah!

-Slow down, you flowers! Oh! Candy corn! Here, let me help you to finish it!

[END PLAYBACK]

JOSH: So they obviously-- they went with the candy corn.

ELIZABETH: Before you move on--

JOSH: Go ahead.

ELIZABETH: --share the storyboard that came from Science Out Loud?

JOSH: Oh sure, yeah.

ELIZABETH: Sorry, I totally forgot that I had this.

JOSH: OK.

ELIZABETH: Not to--

JOSH: No problem.

ELIZABETH: Sorry, Josh.

JOSH: No problem, here.

ELIZABETH: Thanks. We've been seeing all these very gorgeous storyboards. Like, even-- you guys talk about how it's not when the real work starts. But obviously that takes a lot of time and talent.

So this was a storyboard that Ashley did for our very first episode of *Science Out Loud,* just to show you how basic it can be and still be effective. So she did an episode on exoplanets. Ashley's K-12 video-- ooh!

And what we discovered after she storyboarded this-- she's talking about a very abstract, cosmic topic. So obviously we can't go into space, which made deciding what the visuals were

going to be surprisingly difficult. Or maybe it should have been unsurprising. But we were newbs at the time. So it was hard.

But she-- literally just drawing stick figures, aligning them with her text. And when we were looking at the storyboard, we were like, wow. There's not really a whole lot going on, except for her just standing there. And basically half of the video was going to be an animation without her on screen.

And there would have been no way for us to really anticipate the extent to which she was missing from screen until she storyboarded this out for us. And so she tweaked not only her visuals, but she ended up tweaking her script a lot after she did this to make room for scenes in which she could be more present, where it could be more than a fully animated video.

But in case you wanted to see, we actually kept the first six frames pretty similar to her original plan. And we just tried to alter the animations to make it a little more engaging. So I'll show you the first part of her video.

[AUDIO PLAYBACK]

-This rock can absorb--

[END AUDIO PLAYBACK]

So this was-- this animation was actually done by our first editor.

[VIDEO PLAYBACK]

-25 years ago, most people would have told you that there are only nine planets in the universe. Since then, we've lost one. Sorry, Pluto. But we've discovered thousands of others.

So what happened? Did astronomers suddenly get a new pair of glasses and now we're meeting all of our new neighbors? Well, no. It turns that we could've seen these exoplanets all along. But we only recently figured out exactly where and how to look.

We call these new planets exoplanets, or--

[END PLAYBACK]

ELIZABETH: So, because we knew what she wanted to do with the animations ahead of time because of

her story board, that allowed us to direct her while we were shooting to put her hands down, to look up at the ceiling, and all that stuff.

And I'll show you one more storyboard that was done a little bit differently. And then I'll let Josh talk again. But Alex actually just did pictures for some of them.

So he did an episode on how carbon nanotubes are made. And he had this sort of "imagine a blank" opening. And so he just took pictures of the locations and types of places that he wanted to go.

And then, from there, he literally just drew stick figures. So you don't have to draw anything crazy beautiful-- no offense to Alex. But this was actually very helpful for us as well to see how the pacing of his demos were going to go.

So we altered his script again after he made this, because we realized that it was a lot of just him sitting at a table demoing things. And we decided that there needed to be something a little more visually engaging besides him just at a table. But he's talking about how a thread made out of carbon nanotubes could lift up something as heavy as an elephant. We quickly realized that we wouldn't have footage for that.

But this is again, really basic-- nothing too crazy-- but helped us a lot in the planning of the video. So I'll show you the first couple bits of his.

[VIDEO PLAYBACK]

-Imagine a material that would let you use your phone for weeks without a charge or would let you build an elevator to space. These elevators and batteries can one day exist with a material called "carbon nanotubes." Carbon nanotubes are tiny.

Take this human hair, for example. You need 10,000 carbon nanotubes to make a rope as big as this hair. Despite being small, they're really strong. This cotton string holds up this lego car fine. But if it was made from carbon nanotubes, it could hold up a real car.

[END PLAYBACK]

So originally he was going to talk about this model of carbon nanotubes at the very beginning of the video. But after we saw the storyboard, we thought that we should wait until later on to explain it and just hit them with this example first. So I just wanted to show you guys that so

you knew that your storyboards don't have to be anything super complicated.

JOSH: Cool, thanks. OK, let's see. All right, so just some-- we're almost done with this, by the way. But some quick tips for storyboarding-- and I guess this was something that Elizabeth was just saying.

It doesn't have to be a work of art. Stick figures work. Focus on details that matter. We don't draw a lot of backgrounds. We just draw the bare minimum of elements that will get across the intention of the scene or the shot, rather. It should include a composition and camera angles.

Is this a wide shot? Is it a close-up? What is the cam-- you might make a note about what the camera's doing. Is it pulling back? Is it on a dolly? Is it tracking something?

ELIZABETH: And just so you guys know, since we haven't really talked about that stuff yet, that's a lot of stuff that Chris is going to talk about tomorrow. So I would suggest that you try to keep that stuff in mind and then maybe revisit it again after Chris talks about it tomorrow, too.

JOSH: Yeah.

ELIZABETH: And you can also ask him while he's here, too.

JOSH: Right.

AUDIENCE: You know I'm not supposed to--

ELIZABETH: It's OK if you have, like, spoilers in the class--

JOSH: Yeah. And Chris-- I mean, Chris knows the grammar of this stuff better than I do. Admittedly, I didn't go to film school. So we use terms of art in our studio that probably aren't appropriate.

But the camera's close-up on this guy. The camera's far back from this guy. The camera's moving while this guy's talking. That sort of-- any of that stuff. Don't be constrained by--

AUDIENCE: Too many technical terms.

JOSH: Right.

AUDIENCE: What about aspect ratio of, like, the paper that you're using in the shot that you're gonna use. Eight and a half by 11 turned sideways, like--

JOSH: Yeah.

AUDIENCE: Or is there another shortcut that's helpful?

JOSH: Yeah, well a note card is a very-- turned sideways is perfect, is a good 16 by 9 approximation. The template that I'm going to give you guys is widescreen. But yeah, definitely have to think about those sorts of things. You don't want to be doing it in a 4 by 3 box. You want to think about the full frame.

And this is sort of stupid. I don't why I put this. Make them easy to read visually and understand.

So I think one thing I wanted to really stress is that, for us-- and I think, for most people, as you saw on the Pixar video-- storyboarding is a collaborative process. So you can't-- this is a process. This kind of art is something that comes out of a lot of different minds working together creatively.

And so the story-- one reason to make the storyboard really easy to understand is that somebody else is going to have to use it and work on it. It's not just what's inside your head. This is a part of a process that collaborators are all working on. So it has to communicate very effectively.

ELIZABETH: And I haven't mentioned this formally yet, but obviously, if you're going to be hosting your video, you can't simultaneously be shooting it as well. So the way that's going to work is we'll partner you guys up, or we'll figure something out to where basically, you'll be shooting someone else's video. And someone else will be shooting yours.

And the storyboard is going to be really important for that reason, because you have to somehow give the instructions to whoever's shooting for you exactly how you want things framed, how you want your shot to look like and things like that. So I agree completely. It's a very collaborative and necessary thing.

JOSH: Yeah. If there's time, make a few boards. Like, a lot of times people in our office will make some boards independently of each other.

And then we'll bring them all together and see what we've all got. Sometimes that's part of our workflow. If you have time, storyboard the same script in a couple of different ways. You might get different ideas with different perspectives.

And as I said before, revise the script as needed. Sometimes a great visual idea doesn't line up with the script. Focus on visual story, not adherence to your script.

So if you come up with a cool idea, and you may-- you know this is hard to-- I can say this. But you just have to experience it to really understand it. You might come up with a cool idea, but the script doesn't quite match what you're saying. So don't feel like you're locked into that script.

And finally, the storyboard is only a guide. Changes are often made in the production and editing process. So all this stuff is very plastic. You're moving it. You're changing it as you go.

All right, so how to make a storyboard. We brought some paper templates. You can use note cards, We don't use note cards.

But it's actually an interesting idea, which is that-- then, if you put one scene or one shot on each card, you can start moving the cards around on the wall, which might be interesting, an interesting way to do it. And each frame should include the script line and basic direction notes.

We don't always do that. But we, at minimum, we include the script line that's coordinated with the shot.

So let's workshop. And there's a couple different ways we can do this. Well, first let me go over what I think this basic format.

John and I will sit up here and storyboard a script. And what that script is, I want to talk to you about a minute. And then, once we've done some of it-- maybe over 30 or 45 minutes-- we'll break you into small groups and you'll continue the same script, storyboarding it. You'll do a few-- some frames on your own. We'll walk around and help you.

And then you guys will present what you have. And we'll just and share and discuss them. Yeah?

AUDIENCE: Josh, how do you feel about using PowerPoint for storyboarding?

JOSH: That works. That would work great.

AUDIENCE: In my brain, that would be a better tool--

JOSH: Yeah, sure.

ELIZABETH: That's what Ashley did. She made hers on PowerPoint.

JOSH: Yeah, that would work great-- Keynote, PowerPoint, that would be great. And you don't have to use these paper sheets. But unless you have a Wacom with you, it can be difficult to draw on your computer.

So the script that we're going to storyboard, we can either do a script that we've already done-- that we've already written and storyboarded and produced. But it would be-- it would be wonderful to storyboard it again with all of your input. Or we can take one script that you guys are currently working on and just get started on it with you.

So either someone-- is-- someone is either a victim or very lucky or some combination of the two in this. Who votes for storyboarding one of our scripts? OK, who votes-- OK, so fine. So it sounds like you want to storyboard one of your scripts.

ELIZABETH: They might not raise their hand for that, either. We've got a quiet crew.

JOSH: All right, who wants to storyboard one of their scripts? Oh, come on, guys. This is absurd.

ELIZABETH: [INAUDIBLE]

AUDIENCE: I find mine is trivial, but the one I showed you yesterday-- is that--

ELIZABETH: Oh, you mean the hotel one.

AUDIENCE: Yeah, because it's shot there.

ELIZABETH: Yeah, do you have-- should we just storyboard the latest script that you uploaded to the Tumblr?

AUDIENCE: It's the one I showed you yesterday.

ELIZABETH: So he's got an idea that he hasn't fully scripted yet.

JOSH: Oh, OK. Yeah.

ELIZABETH: It might be easier if we have actual, like, text to a line.

JOSH: Yeah, we need a script for sure.

ELIZABETH: Just for logistical purposes. Does anyone have-- it's not going to be your entire script. It's just going to be a portion, a couple scenes from it. Does anyone feel comfortable? And it's OK if you end up changing it completely, too.

AUDIENCE: Could we do enough of one that you've already done? Because if mine has to be-- I'm just thinking, from a learning perspective, that it might be really interesting also to match that with-- what you are-- actually ended up doing?

JOSH: Yeah, and I thought that, too. That was kind of what we were planning to do. But I didn't want to make it all about us. But if you think it's instructive, then--

AUDIENCE: I think that might be nice to have that framework for everyone, since everyone else is copying off of it as well.

JOSH: OK, cool. So I do have a script here.

AUDIENCE: Do you guys all have pencils? Or should I grab some--

ELIZABETH: Do you want them to do pen or pencil?

JOSH: It doesn't matter. It doesn't matter. Pencil's nice because you can erase it.

Yeah, so I think what we'll do is we'll start off with John working. And then we'll all chime in. And then you can see how John works. And then you can do it yourself. Does that make sense? Yourselves.

I have the script, actually. So you can see what I was hoping we do. This is a video, another one of those WNET episodes on mass and force. I hope I printed out enough of these. I may not have.

ELIZABETH: We can share.

JOSH: OK. Some people are going to have to share, unfortunately. OK, so John-- we use Flash a lot, just for illustration and for storyboarding and for some animation components. I won't go into all that.

But what John has here is a Wacom tablet. And it allows us to just get our ideas in the computer, basically. So I need the script.

AUDIENCE: Yeah, let me help. We can share this one.

JOSH: All right, so let's just focus on the first paragraph. And in order for this work, please chime in and participate in this process because what'll end up happening is we'll end up with exactly the same thing we already did. And I don't want to do that.

"Mass is a measure of an object's ability to resist being accelerated by force. That means the more massive an object is, the harder it is to make it move if it's at rest or to stop it if it's moving."

So thinking about the need to make the beginning of the video very interesting and to immediately engage the viewer, how do we want to start this one?

AUDIENCE: Maybe somebody being pulled by a force and they're trying really hard to resist?

JOSH: OK. "Mass is a measure of an object." So we've got an object. What kind of object do we want?

AUDIENCE: Well, a fat man--

JOSH: Huh?

AUDIENCE: A fat man.

JOSH: A fat man. Something big. Something iconic. Something that really symbolizes mass.

AUDIENCE: A building, a monument or something?

JOSH: A building, a monument. How about-- what were you gonna say, Josh?

AUDIENCE: I was thinking of just the but in some kind of like stone, like a big stone that says "mass."

JOSH: OK, that could work.

AUDIENCE: And it falls down in the dust.

JOSH: OK.

AUDIENCE: A brass weight.

JOSH: A brass weight, yeah.

AUDIENCE: An anvil?

JOSH: An anvil-- those are iconic things, yeah.

AUDIENCE: A one-ton thing that gets dropped on someone's head.

JOSH: Yeah, that would be the Looney Tunes approach for sure. It OK, so what do you think, John? Should we go with something big that falls? Is a good-- do we need the word "mass" on the screen?

AUDIENCE: Not really.

JOSH: OK.

AUDIENCE: Something big that falls.

AUDIENCE: Stick with beer.

JOHN: So beer could work.

JOSH: Why don't we do the-- let's go with-- let's try out this idea of the word "mass" being made out of stone. That's kind of interesting. It falls and, like, crumbles, like, creates this sort of cloud of dust and stuff. That sounds good.

AUDIENCE: I have a question.

JOSH: Yeah.

AUDIENCE: How many is number of storyboards do you need for every one of your ideas? Like, to what detail do we need to go?

JOSH: Yeah, that's a good question. What you think about that, John?

JOHN: I think that's up to you. I mean, I'm a very visual person. So for me, I'd like to draw maybe three or four frames of this mass dropping down. But for you, maybe you could just make one drawing. And next to the storyboard, explain the action. Explain what's going on.

JOSH: Yeah. A lot of times, we draw a red arrows to indicate movement. So you could draw the word "mass" at the bottom of the screen with the clouds and have a red arrow facing down.

ELIZABETH: I mean, there's no right answer. This is really for your benefit or the benefit of whoever's

gonna be filming it for you.

AUDIENCE: Yeah.

ELIZABETH: So we definitely go the more rudimentary route in general.

AUDIENCE: Yeah.

ELIZABETH: But whatever would make you feel most comfortable. I think a rule of thumb-- like, a bare minimum-- is that any time you're changing the scene, like you're changing the camera angle or you're changing the location, you definitely want to do another board for that.

JOSH: And John is drawing in, like, just a horizon here. So you have a sense of the scene, just at a very basic level, where the background is going to be and where the word is going to land. And I think that's enough for the first line.

JOHN: And this is just the beginning, too. A lot times with our storyboards, we'll just draw out our ideas. And then we'll come to the end of the whole story board and take a look at it.

And we'll say, well, we have this ending. But it doesn't really match with the beginning. So then we go back and maybe we change the beginning to more match the end. We're just getting all our ideas out. But you're not locked into this idea now that we've drawn it.

JOSH: Right, OK. So, next line-- "That means the more massive an object is, the harder it is to make it move if it's at rest or to stop it if it's moving." And that-- yeah, so what do you think about that one? We've got this object that's fallen onto the screen and now we're talking about moving it and stopping it.

AUDIENCE: I think of a person who's, like, kind of doing, like, the old pushing against it.

JOSH: Yeah.

AUDIENCE: And their legs are moving, but they're not going anywhere.

JOSH: I think that's a natural, very, very iconic way of doing that. So we have a character now who comes in. And, you know, like this-- "oh god!"-- is trying to push this thing.

AUDIENCE: I think that, for the second portion, when the thing slides and the mass will come sliding off the guy, he has to try stop it by [INAUDIBLE]. So he's, like, pinned to the wall by the mass.

JOSH: OK. What if this little guy tries to push it and then maybe an elephant comes on the other side of the word and pushes it-- and is effective at pushing it towards him? And then he has to, like, go this to get it to-- he's like, oh my god. And he can't stop it. And he gets pushed off the screen. Something like that, would that--

AUDIENCE: How about the screen tilts?

JOSH: Oh, that's a good idea.

AUDIENCE: I like that, yeah.

JOSH: So then it's-- gravity is working on the word, then. That could work.

AUDIENCE: I really like that idea.

JOSH: Yeah, yeah. And he tries to get out of the way. OK, great.

So that covers the first paragraph for me. Are you guys-- do you think we're-- this is a good start? So let's start with the next sentence. Are you all set? OK.

"The nifty thing about mass is that it doesn't necessarily have to do with size. Think of a big pile of rocks and a big pile of feathers. Both piles are the same size or volume.

But it would take a lot more effort or force to move the pile of rocks than it would to move the pile of feathers. The reason? Rocks have more mass than feathers because they're more dense."

All right, so how do we tackle this one?

AUDIENCE: You could, like, camera this big mass thing and just [INAUDIBLE] into a bunch of rocks.

JOSH: OK, cool. Maybe--

AUDIENCE: I don't know if you want to go away from the mass thing, but if you want to keep it, then just-- I don't know.

JOSH: That's nice-- I like the idea of making it cohesive, like it's all-- it's all working together. So maybe the mass slides down the ramp and hits something and breaks apart into a pile of rocks. So there's a pile of rocks on one side of the screen.

AUDIENCE: The birds.

JOSH: What's that?

AUDIENCE: And it hits the birds, and then you get the feathers.

JOSH: Oh, that's a good idea. That's an interesting idea.

AUDIENCE: And you have a pile of feathers and a pile of rocks.

JOHN: Oh, so this character is a bird?

AUDIENCE: Yeah.

JOHN: I like that idea.

AUDIENCE: Right? Now we've got organically our rocks and our feathers.

JOSH: Yeah, so--

ELIZABETH: Oh, I have a clarification question. So, in the script, is it that the guy is running from the mass? Or should he push back on the mass when he starts to fall? Oh, I guess he's doing it on the first frame.

JOSH: He's pushing against it. And then it starts-- then things tilt. And it starts to slide forward.

AUDIENCE: And then he gives up because--

JOSH: Yeah, but is somebody suggesting that this guy's a bird?

AUDIENCE: Yes.

JOSH: OK, so how are we going to do this in a kind of fun, nonviolent way, that this bird, like--

AUDIENCE: Tell us that he had feathers, right? If we're not gonna kill a bird, like, there's pillows, right?

JOSH: Yeah.

AUDIENCE: How else could you get a big pile of feathers?

JOSH: Well, I mean they could just sort of divinely appear, like they could just fall from the top of the screen.

AUDIENCE: Someone could walk on screen with a wheelbarrow full of rock, dump it, and then carry on a bag of feathers that's about the same volume.

JOSH: Yeah, yeah. And let me back up for a second, because let's think about this in terms of-- So this first scene-- obviously, we're talking about animation here. Like, we're not going to do this live action, right?

But let's imagine that the next scene-- the second paragraph-- is live action. So then we're talking about more of like an idea like you have, where you have some actual people moving rocks around. And you have maybe somebody dumping out feathers.

Is that what we want to do-- is kind of a combo here? I know I may be--

AUDIENCE: Well, maybe bringing it to [INAUDIBLE] the mass where it falls into his hand, crushes it. And he can see, maybe it's like he puts it ont he table and [INAUDIBLE].

JOSH: Oh, OK, so you're talking about a nice transition between-- that could be interesting.

ELIZABETH: Or you could do overlay to transition--

AUDIENCE: Yeah, with the overlay.

ELIZABETH: That person in the middle and the mass falls down next to him or her and creates a rock pile. And then--

JOSH: Yeah, so then we have a--

ELIZABETH: And then feathers pop up or something.

JOSH: Yeah, so then we have a host at the-- throughout-- we start with a host, a talking head. And then we have the mass fall down beside him. You see how this gets complicated, right? There's lots of different ways to do things.

Well, for the sake of simplicity, let's continue as if we're just going to animate this video, OK? Is that OK with you, Elizabeth?

ELIZABETH: Oh, absolutely not. No.

JOSH: OK.

ELIZABETH: Of course it should be that way.

JOSH: Just so that we-- you guys get the sense of the process. But you can already see that there are so many options. There's so many different ways to do things.

OK, so back to our feathers. "The nifty thing mass is that it doesn't necessarily have to do with size." All right, so we've got this mass that's rolled down the hill. And I like the idea of hitting something and turning into a pile of rocks. Are we going to go with that idea?

AUDIENCE: And maybe it goes off a cliff?

JOSH: OK, yeah, it goes off a cliff.

AUDIENCE: It could hit a pillow factory. You could have a--

JOSH: A pillow factory.

[LAUGHTER]

That's funny. Yeah, that's funny. All right, so here we have our cliff. And this action will cover the nifty thing about mass.

And then, down in the valley-- or the canyon-- is the Acme Pillow Company?

ELIZABETH: I've seen this video. So it's really interesting. Yeah, it's different, this one. I really like this one.

JOSH: Pillows 'R' Us? That's

AUDIENCE: Fun.

JOSH: So we've got to do-- think of a big pile of rocks and a big pile of feathers. Boom!

AUDIENCE: So then maybe we cut--

JOSH: Then we cut to a pile of rocks and a pile of feathers. So this is a jump cut to a close-up?

AUDIENCE: Just imagine these piles.

JOSH: "Both piles are the same size or volume. But it would take a lot more effort-- or force-- to move the pile of rocks than it would to move the pile of feathers." So maybe our protagonist, our little guy who was holding the mass thing, needs to come back in here. What should he do now?

AUDIENCE: When [INAUDIBLE]

JOSH: Yeah, we could do it that way. When is--

AUDIENCE: Could he try to clean it up, with a broom or something?

JOSH: Potentially, yeah. Yeah. Or maybe he-- well, any other ideas?

AUDIENCE: If you want, you could add this-- you could take away with, like, a leafblower. Something that just blows off and thunders off the screen.

ELIZABETH: Yeah--

AUDIENCE: --blow the rocks.

JOSH: That could work, yeah.

AUDIENCE: By adding onto that, maybe he tries to blow the rocks and nothing happens. And he kicks it. And he injures his own toe.

JOSH: Yeah. So what do we have? A leaf blower, we have a cleaning up scenario. You want to try the leaf blower?

AUDIENCE: Sure.

JOSH: Or anything else?

JOHN: Is there any way we can connect this with the beginning? In the beginning, he's trying to move this word, "mass." Is there anything there? Is he, maybe, the janitor? And this mass is in his way. He doesn't like it there.

And then he's trying to do the same thing here. He's trying to clean up this mess. I don't know, just spitballing here. Is there a way we can tie the two things together is the question.

AUDIENCE: Yeah.

AUDIENCE: I don't know. I was thinking that he's running-- because he's running away from the mass. So he runs along with the mass. And he crashes and booms.

And he lands in the feathers. He's like getting away from the feathers. This clears the feathers. Then he tries to get it off.

JOSH: That's interesting. So it's what does it say here? "Think of a big pile of rocks and big pile of feathers. Both files are the same size or volume. But it would take a lot more effort-- or force-- to move the pile of rocks than it would to move the pile of feathers."

So I think we're back to a scenario where we need to have some sort of-- we need to show force being exerted. So "It would take a lot more effort-- or force-- to move the pile of rocks." So what sort of-- how can we show that? We almost already showed it in a way.

AUDIENCE: Maybe a cleaning up crew trying to move them off the frame?

JOSH: Yeah, or maybe just our character trying to push this pile of rocks again. It's like, oh man, not again. I got to push something else.

AUDIENCE: I'm wondering if he should have a backpack, so he could--

JOSH: What's that?

AUDIENCE: We're heading towards having a student, right?

JOSH: Yeah, yeah.

AUDIENCE: So maybe he's our student.

JOSH: Right, right.

AUDIENCE: And that we identify with the beginning as some thing that makes him obviously a student.

JOSH: He's on his way to school or something. And this adventure happens.

AUDIENCE: A kid would obviously, like--

JOSH: Yeah, yeah. And the audience is kids. This is middle schoolers. So we could add a note to that first scene, like, kid with backpack.

So we agree that-- so this kid is going to try to move these rocks in some way? He's trying to push them or gets his back up against them and tries to get them out of the way?

AUDIENCE: I like the idea of there's a clean-up crew. So there could be two different kinds of [INAUDIBLE] on the right. Here are the feathers. Or someone sweeping-- one of them. And the rocks would be just like this construction truck-- beep, beep, beep. Then he comes in and picks it up.

JOSH: Yeah. Does that really show the notion of differing amounts of force being required?

AUDIENCE: That's a good question.

AUDIENCE: Maybe less likely.

AUDIENCE: Yeah.

JOHN: Maybe you use the heavy machinery to move the rocks. And then we just move our little character. And he can move the feathers.

JOSH: Yeah, that could work. Like, a big backhoe has to move the rocks. But the character is able to just either blow on the feathers or move them out of the way really easily.

JOHN: Can you see a little berm here?

JOSH: OK, yeah, that's nice. That work? Does that "sell it," as we say? So we need to show that the-- do we need to show the backhoe first? "It would take a lot more effort-- or force-- to move the pile of rocks." And then we have another shot-- "than it would to move the pile of feathers." We see the rocks gone in the next scene.

JOHN: Right here they're gone?

JOSH: Yeah. So he gets through-- so the feathers are gone.

And then we've got another line here. "The reason rocks have more mass than feathers because they're more dense."

AUDIENCE: Maybe you could, like, have a scale with, like, the backhoe with rocks on it. And you've got feathers on it or something. [INAUDIBLE]

JOSH: Is it-- yeah.

AUDIENCE: That's why I was, like, it's not a type of scale.

JOSH: Right, right. I'm not a scientist-- and you guys can help me with this-- but does density really equate to weight? If we just show them on a scale, does that really show that one is more dense than the other?

AUDIENCE: Yeah, I guess not.

AUDIENCE: I mean, it's indirect. So maybe a better way would be to address density more directly?

JOSH: Yeah. Could we do something, like-- just very simple, where we just-- the character extends two hands. In one hand is a rock. And in the other is a feather. And we just-- and we put the words more dense above the hand with the rock in it or something like that?

How do you visually say something is more dense? Like, how do you show that visually?

AUDIENCE: The tractor, or whatever that heavy machine was, it could be throwing the rocks off into the ocean. And you see the rocks sinking. And then the feathers are just floating in the air, maybe just landing on the surface.

JOSH: That's an interesting idea.

AUDIENCE: It definitely shows that. And I'm not sure how familiar the kids will be with the concept of density. But having the water-- sinking, floating, maybe-- makes the point a bit better.

AUDIENCE: You already introduced volume. So I feel like to introduce density wouldn't really be doing, like, what came before, which is volume. I don't think it would do it justice.

Because density is volume and mass. So if you're able to have volume and then go to mass after that, I think that's where they'd connect, that the mass could be different even though the volume is the same. And you would still have different densities.

ELIZABETH: I mean, the other thing is that the video isn't really about density. The video is about mass and acceleration.

JOSH: Yeah.

ELIZABETH: So it may not even be-- and, like, this is sacrilege-- but it may not even be that important to really define what density is in this particular video, which is why maybe it's OK to say one's more dense than the other. It's like, a couple minute video?

JOSH: Yeah.

ELIZABETH: The point is really about how things that have more mass require more force. If you start going into density, I'm afraid that people would also want to talk about what the difference between weight and mass are, too.

JOSH: Yeah, true.

ELIZABETH: So again, it's like, at what point are you branching off too much from the point of the video and the main point of the story?

JOSH: That's a good point, yeah. Well, "The reason rocks have more mass than feathers because they're more dense." Yeah, so maybe-- I don't remember what we did in the video we actually ended up producing.

I think I would go with the hand displaying the two things and think about how they're essentially the same size. But one is very light and one is this rock. It's dense.

ELIZABETH: Can you-- is it possible to zoom in on the rock? Because density is really that there's more stuff per space, right? So somehow have the rock bulge a little bit to show that frame is like stuffed with as much stuff as possible.

JOSH: Yeah.

ELIZABETH: And then show the feathers and show like a lot more air and space in between the feathers. And you can still put the label "more dense." But maybe there'd be some sort of visual cue associated with that as well.

JOSH: Yeah, potentially. This is a toughie.

JOHN: So you're saying, maybe, we cut to a new shot where we see a rock and a feather side by side? And then maybe we see like, a view of each one under a microscope?

ELIZABETH: Almost, but again, I don't know if that's distracting too much from the main point of the story.

JOSH: Well, I like that idea-- the microscope image. Like, we show like the crystalline structure of the rock is really, it's like a lot of stuff packed in there.

AUDIENCE: What if he was poking? So you can't poke a rock but maybe he takes out a pencil and pokes through the feather. We can do that [INAUDIBLE]

AUDIENCE: I think it's too complicated to go with this concept. Like, I don't know. The word "dense," like, I don't think we have to-- I don't know if we have to explain that right now.

JOSH: Yeah, well, let's think of another strategy here. How necessary do you think this line is in the script? I mean, is it vital to the script itself, I mean, to the whole story? I don't know, I haven't

given you guys a chance to read the whole thing. But maybe this is one of those moments where we take this line out. And we end the paragraph with moving the feathers.

AUDIENCE: Well, it's far easier.

JOSH: Yeah, it is easier. And it might be one of those moments where this line is a distraction from the-- I think that's where we're struggling right now.

JOSH: Yeah, yeah. So let's say, OK, we're going to remove this line for now. And some client is gonna come to you and say, well, why did you guys take that line out? We really need that.

And then you have to argue for that. That's all part of the process, right? Like, well, we talked about this for about an hour. And we realized that this wasn't really important to the process. You know, and that--

AUDIENCE: How often do you feel like you have to, like, you have an artistic vision of what direction it should go?

JOSH: It happens all the time. Yeah,

AUDIENCE: And then you have to comment?

JOSH: In my professional opinion-- and that's when I have to sort of fake this professional persona-- we don't think you should have this line in the script. And in retrospect, this line is in the video we-- but we didn't have 15 people to talk about it with. We only had four.

ELIZABETH: But do you see how-- like, are people OK with taking that line out now? Like, you see why maybe that's a good choice? Would you have reacted that positively to the idea of taking this out maybe five days ago, before we had gone through this class?

Because I feel that is the reaction of a lot of scientists. Like, wait, wait, wait-- this is accurate, but it's not precise, like you were just talking about. You have to talk about density.

And that's sort of-- I mean, I want to tie this back to the work that you guys are doing now. You guys see how this process is really making you examine what is truly necessary and what isn't to the project. Because this is going to happen to your scripts, too.

You're gonna sit down and storyboard. And you're gonna rack your brain over one sentence that you can't think of an appropriate visual for. And maybe that's a key for you to reconsider

whether or not that part is truly vital. But you are not forced to do that until you think about things like storyboarding and think about things like an overall narrative to your video.

Because otherwise you're going to do what most scientists do. And I-- I mean, I say this as a former amateur would. But the tendency is to just throw as much information out there to cover your grounds, right?

JOSH: Yeah, and I think-- if I remember correctly-- this script was a lot more complicated. We received a kind of rough script from the client. And I had to edit it down and get it into something that worked for the medium.

And we had some discussions about well, like, why can't we say that? I mean, exactly what you're talking about happened. And I think that this one just sort of slipped through. This one got through.

And, in retrospect, maybe we shouldn't have produced that line. But I love that we're thinking about this. I think this is a really cool-- this is a really important part of the process.

AUDIENCE: This goes back to the core concept. I mean, the core, number one thing is know your audience. Think about your audience. I was actually earlier today helping one of my graduate fellows apply for the master's in journalism program here.

And she has to write a 500-word piece on a science topic. And she was trying her hardest to consolidate an experiment. And she was trying to think about what the lay audience cares about. And it was so hard for her.

And she distilled it down to two and a half sentences. But I told her even that was too much for a New York Times piece, that no one cares about which mice were chosen and why for this experiment. And then-- that this is the crux of, like, what I think is one of the hardest things.

JOSH: Right. And there was-- I think on Monday we heard this phrase, "kill your darlings." There's that--

AUDIENCE: And that'll come back [INAUDIBLE]. It's my favorite.

JOSH: Yeah, exactly. And I think, in retrospect, introducing the notion of density into this is a real distraction. It's not what this is about. So yeah, I would say let's strike that line-- that we have the luxury of doing that.

So I want to stop there with our portion of it. And then kind of let you guys break up into groups and do maybe the next two paragraphs. If you make it further, that's fine. And then we'll walk around and to you about your ideas.

But-- so how many of us are there? 1-2-- there's seven?

ELIZABETH: There are eight.

JOSH: Eight? OK, so that is nice-- two groups of four. Yeah, I'll let you divide up however you want. If you just want to go with you four over here and then you four over here is fine.

You guys from this-- are you guys, I would say not all three of you guys together because you know each other and all that. But yeah, that's let's get started with that.

ELIZABETH: And if you guys need to take a break to go to the bathroom, this is a wonderful opportunity to do that since we're--

JOSH: That's a good idea. Yeah, yeah. Let's take a break before you start. Thank you.

AUDIENCE: --the student just standing there. So you could have a teacher come in.

AUDIENCE: Second teacher--

AUDIENCE: Yeah. And I guess they sit down and it's like--

JOSH: You could actually use Elizabeth and me. That would be--

AUDIENCE: -gotten behind a word that you're like, oh, that's why we use that word, right? I don't know.

AUDIENCE: They sort of like blow up.

AUDIENCE: There were people--

AUDIENCE: --stuff them inside their shirt. And now they're really big.

JOSH: These people write a press release about a product that hasn't been invented yet.

So what do you guys got? Is this thing on? Sorry. Hot mic. All right.

AUDIENCE: So we've, for the third paragraph-- what it takes to show how-- "Picture a student and a teacher." So we have a student and a teacher. So the student is like, really happy. And then

the teacher is like--

[MAKING A FROWNING FACE]

Plus he has to do this exercise with you, I guess probably to find [INAUDIBLE] And then he zooms out. And you see him there, sitting on a chair. So then you show this shot with him sitting on a chair.

And I haven't drawn the last one here, but, it's supposed to show from, like, the corner angle where you see the student being very small. And then the teacher will be, like, massive to show the difference in this.

JOSH: So you do the classic thing where you have an above shot for the student and a-- from the bottom for the teacher.

AUDIENCE: Yeah.

JOSH: And they're sitting in the chairs.

AUDIENCE: Yes.

JOSH: OK, cool.

AUDIENCE: I guess that stopped with the third paragraph.

JOSH: Yeah, I mean that's enough. I mean it sounds like you guys went further than that.

AUDIENCE: Yeah, we went further than that.

JOSH: OK, go ahead and share it. I'd be curious to see.

AUDIENCE: Where are my-- Ah! So then he-- so he just pushes him off. I guess he wants a little bit of comical-- so you can see from the side.

But because he does rolling chairs with this and things, so the kid will go "whee." Now there's physical distance. But there's this little line they put over to show there's a difference between [INAUDIBLE].

JOSH: OK, cool. I like where that's going. That sounds cool. Did you guys have any thoughts or feelings about the process, like-- does this give you a sense of what it's really like to do this stuff and have to run these scenarios through your brain and visualize them?

AUDIENCE: I think, like, the big thing we found was you have this text but, like, knowing how to read it. So like, we just-- with that first student teacher-- we read it like, "picture a student and teacher." Like that's just-- if we have a frame of a student [INAUDIBLE] a teacher, that would slow that down. So we had to be like, picture a student. Now picture a teacher.

JOSH: Right, right. So you're thinking about directorial sort of things, like how you're going to-- how the voiceover is going to change as a result of these visual decisions you're making. Yeah, that's cool.

You guys? It sounded like there was less of a hum going on over here. Did you guys-- what do you have for that third paragraph?

AUDIENCE G: Well, basically we have the kid that's standing there from the last part, you know, where the feathers have been swept away. And the teacher walks up with two rolling chairs.

JOSH: OK, cool.

AUDIENCE G: They sit down. There's a poof of smoke. And that's where it transitions to live action.

JOSH: OK, I like that. That's a cool idea.

AUDIENCE H: And the teacher grows also. That's how we're sure she's massive.

JOSH: Oh, the teacher grows. In live-- How are you going to grow the teacher?

AUDIENCE H: We stuff her with pillows.

JOSH: Oh, that's funny. So, like, maybe a stop action, where you take a frame. And then you put one more pillow in her.

You take another frame. And you get like-- and then you do between frames. And you've got, like, maybe 30 or 60 frames of the student-- of this teacher getting bigger and bigger.

That could be really funny. Good idea. Any thoughts about the process?

ELIZABETH: What was the hardest part? [INAUDIBLE]?

AUDIENCE H: How to make it visually engaging, I guess. So have enough interesting shots but not too much.

JOSH: Yeah, true. It's like that fine line, right? You don't want to overdo it. You want to-- it really,

really boils down to this kind of empathy for the viewer, for their ability to understand things. And maintaining this balance between your desire to have them engaged and their need to understand-- and kind of threading that line.

ELIZABETH: We'll talk about this a little bit more during our editing lecture. And Chris will talk about it tomorrow. But visual pacing is another thing that storyboarding can show you.

So again, I'm not, like, balancing between the sides. If you have so many shots that are just changing too quickly, then that can be a very nauseating experience for the viewer. And I'm gonna show you guys a rough cut of one of the videos that we made where that happened. And it just felt too rapid. So we slowed it down.

JOSH: OK, yeah, that's really good point. Two last really small things. We didn't get to talk about After Effects. But it's essentially a piece of software that lets you layer video and artwork on top of each other in time. And I'm sure Elizabeth will talk a little bit about it.

But if you want to email me, and you have a specific thing you want to animate, and you want some advice about how to do it, feel free. You can come by the studio and say hey, I've got this problem. How would I animate this? We can give you some tips about how you would go about doing it.

ELIZABETH: And just so you guys know, again, you have free access to Lynda. But there's a computer lab next to 26100, the new media center. And all the Macs are outfitted with FinalCutPro, After Effects, the entire Adobe creative suite. And you guys have access to it anytime. So if you're interested in playing with that software, or going on a media experience, let me know.

AUDIENCE: Is After Effects different from IS&T?

ELIZABETH: It is if you're installing it on a machine at MIT homes. I can ask about maybe getting a license for you guys just for this class.

AUDIENCE: You can also just sign up on Adobe and get a month's free trial of all the Adobe Creative Suite things. So you can just sign up with any email and download the program suite.

JOSH: And then the last thing I wanted to do is to show you the video that we actually ended up producing for this script. So here we go.

[VIDEO PLAYBACK]

-Mass a measure of an object's ability to resist being accelerated by a force. That means the more massive an object is, the harder it is to make it move if it's at rest or to stop it if it's moving. The nifty thing about mass is that doesn't necessarily have to do with size.

Think of a big pile of rocks and a big pile of feathers. Both piles are the same size, or volume. But it would take a lot more effort-- or force-- to move the pile of rocks than it would to move the pile of feathers. The reason? Rocks have more mass than feathers because they're more dense.

To show how it's harder to accelerate something with more mass, picture a student and a teacher each sitting at rest in a rolling chair facing each other. Let's also say the teacher is more massive than the student. When they both push off each other, they go rolling backwards.

Notice how the student goes back much farther and faster than the teacher. The teacher accelerates less, since she is the more massive of the two objects. And it takes more force to accelerate her than it does the student.

All of this has to do with Newton's Second Law of Motion-- f equals ma. It says, for a set acceleration, an object with more mass requires more force to get it moving at that set acceleration. As mass increases, the force required to accelerate or decelerate that mass increases as well. Now don't you feel massively smarter?

-Mm-hmm. Whoa!

[END PLAYBACK]

JOSH:	All right, so that's what we ended up doing. So you can see how the timing allowed us to sort of cheat a few lines, like the density line. We just sort of let it play through. So there's some moments here where you're allowing the viewer to take in what's going on.
	There's not constant action going on, you'll notice. But the action is at key moments where we need to keep things-- This is so abstract. But again, there are no right answers. But there some-- if you do it long enough, you'll sort of start to get a sense of what decisions to make. Yeah, question.
AUDIENCE:	How long did that video take start to finish? Like, from storyboarding.

JOSH: I would say, John, you can help me remember all this. But you know, the script was maybe a couple days, revisions and so forth. And then we probably sat down for at least four to six hours-- almost a whole day-- storyboarding it, every scene.

It was a complex thing. We're not physicists. So we had to understand this stuff. We had to do some background research.

About a day storyboarding, and then about a total of three people doing the animation and illustration. And that took maybe three weeks. So I'd say about a month to do the whole thing.

ELIZABETH: Real quick, because you guys are going to stay on for another class?

JOSH: Sure, I can do that.

ELIZABETH: I mean, if you need to go, that's fine.

JOSH: That's OK. We can hang out.

JOSH: So thanks guys, thanks for listening.

AUDIENCE: Thank you.

[APPLAUSE]

JOSH: Josh gave you guys all his info.

JOSH: Yeah, feel free to get in touch.

ELIZABETH: For today's assignment, you guys will be storyboarding one scene from your script, which is why it'll be a good idea to have some semblance of a script together. I know that you're still revising all that stuff, too, which is why we're only having you storyboard one scene. And then tomorrow, Chris will help you shoot that scene.

So as far as the storyboard goes, you can use these sheets, you can use PowerPoint, you can use note cards. But just upload them as images onto Tumblr. And then all the assignment details are on the syllabus.

I wanted to mention-- this was something that I was going to show you guys during the editing portion. But you can actually storyboard in post-production after you've shot things.

So this was an episode on snot that I'd filmed with George. And basically, after we got all of

the raw footage from the first takes, these are sort of like stills from each major scene of the video.

There was a portion where I did a demo of this, like, fake snot that I made. But I had filmed it in Katharina Ribbeck's lab and the sun had set. And my delivery was terrible. I was super tired that night.

So there were a couple things that jumped out to us after we watched everything. One being that I am lit very dramatically. And I wanted to have more of a casual feel to my parts. And I felt like we should only dramatically light Katharina Ribbeck.

The other was that-- I thought, well, how bad was that decision really? Like, is it really worth shooting again? So we shot it again because we had the time. And then it was a matter of deciding which set of footage to use.

So what we're doing right now is we just put together a cut of the video using both clips. But another thing that you can do is storyboard the stills from the footage that you take day of. So here I can see how that scene looks in the context of everything else we shot.

So I see that, like, I'm wearing a lot of blue. The whole video looks fairly blue. I look a lot more like Katharina Ribbeck in this set of footage than I do the rest of me, right? Like the way I'm lit in all the other scenes is really different from this. So that's what the re-shot footage looks like.

One-- the snot demo went a lot better the second time we did it. My delivery was also a lot better. But I'm also lit a lot more flat.

I actually think that the footage that we had before-- it looks a lot better, like the lighting is a lot more flattering. But it's a lot more formal and traditional. And it's hard to know how much that jumps out in the context of the rest of your video until you line up all these stills and you sort of storyboard this way.

So we haven't actually finished this video. I'm in the process right now. Like, this is exactly where I am with this video. I thought I would show it to you today since we've been talking about storyboarding to show how you can do it not just in pre-production, but also after you've shot material.

So we have about 20 minutes left in class. I thought that it would be good to give you guys a chance to get started on storyboarding your scene while we're around. So if you guys have

questions, I'll be here until the end of class and a little bit later.

You can ask Josh as long as he's around. But does anyone have any questions right now about what they need to do tonight, about storyboarding, writing?

JOSH: How are your scripts, like, what shape are they in? Are you happy with them? Do they still need more work?

ELIZABETH: Yeah, we can also talk about scripts right now, too, because take advantage of Josh's background in writing as well.

JOSH: How long are the scripts? What are you shooting for, three minutes, two minutes?

ELIZABETH: Like three to four minutes. Five is the absolute max.

JOSH: We do 150 words per minute. I don't know if that's something you guys have already talked about.

AUDIENCE: How much is one scene? So what does that entail?

ELIZABETH: Well, I think of scenes as sort of locations almost. And so let me go back to-- sorry, my lap-- bye, Jamie. A scene kind of encompasses a general statement.

So that the way I broke up the storyboard is I basically just did stills of each scene. You can kind of consider the whole top row as, like, a general scene, one which is how I originally scripted it. It was just sort of like the visual introduction to the video.

But breaking it up into scenes is nice, because then you'll notice if one scene has a lot of text. And then you have a scene right afterwards that's very short. And you just have a series of really quick scenes.

Maybe you can think about restructuring or spreading out the material a little bit more. Because, like I said, what you don't want is either really long shots or really long scenes where you're not really changing that much, or if you're doing too many, really quick changes. But I don't know. I don't have a good definition for what a scene technically is.

JOSH: It's kind of a unit of information. When I think about writing, I think about paragraphs. This is kind of a discrete unit that's imparting a certain part of the narrative. And that's-- for me, that's a scene.

ELIZABETH: Yeah. I think the way I'd scripted it, those four shots are all different locations. But I listed it as scene one. Like, where you see Professor Ribbeck and then I'm right there in front of her, I also chunk that together as one scene.

But then, when we were editing and sort of taking note of all the clips, we denoted one as like scene five and then the one after as scene five A. But, in general, like it's the same sort of idea. We're in her lab in that portion. Does anyone have any other questions?

AUDIENCE: What was, like, the motivation in using professor to--

ELIZABETH: So, in this particular one, I wanted to highlight the research that was going on here. And I also wanted to get her involved because I knew her. And I really like her.

And it was sort of like a quirky breaking down the fourth wall moment. So what happens in this scene is-- I set it up in the previous scene as saying snot is more than just this. And then it jumps to her. And she finishes my sentence.

And she goes, it's actually xyz. And then it cuts to a wider shot, revealing that I'm in front of her, interviewing. And you see the camera interviewing her. And I'm, like--

[GESTURING TOWARDS PROFESSOR]

And then I go, she would know. And then her name sort of pops up. Partially because we wanted to have her in the video, but we didn't want it to be really formal. Because that shot is a very traditional formal interview.

So we wanted to make it quirky. And we also wanted to sort of like informalize it. So that's why we broke out of that. And I did the whole like, she would now. And then we could make that setup a little more fun.

AUDIENCE: How do you think about the authority of the host, right? Because you can say things that are easily verifiable. But then if you're going to say something about snot that, like, most people don't know, then on whose authority do you say this?

I've watched like an Alton Brown thing. And I was like, all right, that's wrong. And like, but you are talking about all the things I want to know. And now I don't know when you're lying to me.

ELIZABETH: Yeah, well, I mean, part of it is, that's the responsibility that you have as the host, is that the

viewer has, by default, placed their trust in you. I think with us, we're not going to have as much of a problem to prove because everyone knows that all the hosts are students at MIT. And in our YouTube descriptions, we say that all the scripts were fact-checked by postdoc researchers.

For this, I mean, that was one of the reasons why we used her is because I could explain her research. Or I could just have her say it, which I thought was like a cooler window into the world here, which is what I was talking on the first day. How do you create the window into the world that people don't have access to? I also studied bioengineering for my undergrad. So all the material for the script came from the class I took from Professor Ribbeck.

But I think you don't take the time in your video to introduce yourself necessarily. And maybe you should. That's always something we've considered, is that something that we need to introduce into *Science Out Loud.* The host saying at the beginning, like, I'm Jack and I work at MIT's D-lab.

And that's sort of what we did with Lindsey's episode just a tiny bit. But there are ways of establishing authority where you don't have to vocally do it. So in Lindsey's episode, we filmed at MIT is D-lab.

And instead of saying, like, we're at MIT's D-lab, we just spent a few seconds doing shots of the sign that said D-lab, basically. If you guys want to see it, I can show you later.

But I don't have a good answer for that, because I think that, even if you're Stephen Hawking, people can question your authority to say the things you're saying. And the point of the video isn't necessarily to establish that-- or at least the point of these videos. Your material should be accurate, though.

AUDIENCE: You showed us the next slide, right? And you have this [INAUDIBLE]?

ELIZABETH: Oh, yeah. So George made me wear the goggles, partially because I think he was trying to torture me. But there are some environmental health safety standards. And since we were technically in a lab, even though I wasn't working with anything biohazard related, the lab itself required goggles. So that's why I wore gloves and a lab coat and goggles.

If you guys plan on filming in any sort of environment where that might be an issue, we'll talk about it more during producing. But just keep that in mind, too. We took shots of me with and without the goggles, just in case. Any other questions?

OK, so I'll let you guys work. And we'll just sort of circulate through and see if you need any help. But again, I just wanted to give you some time to make the most of the resources here.