PROFESSOR: All right, today's the last official day of lecture. We'll finish up Joshua and Kenneth [? Reids ?], and then we'll jump right into post production. Whenever you're ready. Laptops down.

JOSHUA: The science of search. Have you ever found it difficult to find a particular item in your house? Let's say you have lost a pair of gloves. And you spend an entire afternoon looking for it, but you just can't find it. You have encountered the same problem that companies like Google or Yahoo try to solve every single day, the problem of search.

Just like a house, which stores about 1,000 different items, Google stores 45 billion different index pages of information. If each page of information was a sheet of paper and we stack them high altogether, we would create a tower 610 times taller than Mount Everest.

How can a search engine like Google find your results so quickly, when we find it so difficult to find a pair of gloves? Well, it turns out, that searching on the internet is kind of like looking for a person in a hotel room. Let's suppose we're looking for a guest called James. To find James, the simplest way would be to run to every room nearest to you until you find him. But that would take very long.

There's a better way known as binary search. Let's say the people were arranged in alphabetical order in increasing numbers of the hotel rooms. We could run to the room in the middle and check if the name of the person is James. If the person's name starts with the letter before J, we head to the right. If not, we would go to the left. We then head off to the middle room of the newly sectioned area, and we rinse and repeat.

Eventually we'll find James, just like the first method. But we found him much faster than using the first method. How much faster would that be? Well that depends on the people staying in the hotel-- the number of people staying in the hotel. Let's say it takes ten seconds to knock on each hotel door, and that's 500 people. It will take about 80 minutes for the first method, and one and a half minutes for binary search. But if there were 1,000 people in the hotel room, it would take 160 minutes for the first method, but only 1.6 minutes for binary search. Now

that's a whole lot of difference.

A name like James is just a word, but companies like Google taking searches for long combination of words, making it a little bit more complicated. Just like identifying the word James from its first letter, Google identifies unique characteristics of search phrases using over 200 different factors. Also, notice how the better method depends on prearrange the people in alphabetical order? Company scientists are always actively looking for better methods to sort, manage, and eventually retrieve the data.

In the same way, simply by placing your home items in location where they have a natural relationship to make it easier for us to find them. For example, the TV remote goes near the TV. The shoes goes near the shoe rack. The coats go near the cupboard, and the winter gloves goes in the winter jacket. Ah-ha, so that's where my gloves are. And that's the story of search.

PROFESSOR: You're clocking in around three to four minutes, which is a really good place to be. All right, Joshua's script is up on annotation studio. Let me turn this on.

AUDIENCE: Turn to this [INAUDIBLE].

PROFESSOR: Oh, sorry. Joshua, this script has come along a really, really far way. This is really tight, very good. I think the flow of it is very natural. I also thought your delivery was very natural. I don't know if you've been practicing or maybe you've just felt a little more at ease today, but I think the way you pause at certain words, and just sort of the natural feel of it is-- it's nice. It sounds like you're really just talking to us.

JOSHUA: I think I learned a lot of Andrea.

PROFESSOR: From Andrea - yeah.

JOSHUA: [INAUDIBLE] yesterday.

PROFESSOR: When she said-- what was it that you said during class? Remember--

JOSHUA: It was basically just observing how she presented that I learned how [INAUDIBLE].

PROFESSOR: Oh, you were sort of copying her style a little bit. Let's see, here we go. I think something that works really well for this script is that you build complexity. Which is a topic that we sort of talked about earlier in the class, but I think is hard to really understand unless you see a

specific example of it. But he starts off with a very simple example of losing your gloves, and then he clearly relates it to how Google searches for something that is far greater in number and complexity. But he connects it very clearly to the glove analogy, which is why I think it works.

I think this explanation of binary search is very clear, because you're relating it to the context of the hotel analogy. I know in earlier iterations of your script, you were just describing binary search as a concept where people take a set of data, and then they split in half and then they search the data, and then they split in half again. I think that's the tendency that a lot of us would have in defining concepts and topics. But for me, personally, I think that this definition works really well in the context of this video. Did anyone have any thoughts about the script up until this point, up until right here?

PAUL: This is purely cosmetic. I thought the script-- I definitely understand the basics of binary search after listening to you, not even reading the script. I think that's really good. Just something I do, and this is-- you could take it or you can leave it, but whenever I do 610-- I don't know, sometimes if I did hundreds of times of the Mount Everest, that kind of-- it could be 100 or can be up to 1,000 so it scales it a little better, but that's very nick-picky I think. And the other one was over a 1,000 different items, maybe just thousands of items in your house or something. That was it, though. I thought the rest was really good.

FEMALE SPEAKER: I thought it was really beautifully written. Those layers of complexity, the way that they-- I'm not someone who processes particularly well just by hearing something. But the way that you brought me from a simple concept, to making it more complicated and more complicated, and then bringing it back to the simple. It was a beautifully designed piece, really well.

PROFESSOR: But keep in mind this has happened over several iterations. And I wouldn't feel discouraged if maybe you feel like your script isn't in as tight as a place. Because if you look at your earlier iterations, I mean it was a very, very different idea, a very different script. And we talked a lot after class. Pretty much every day last week. But I think-- do you feel happy with how it is right now?

JOSHUA: Yeah, [INAUDIBLE].

PROFESSOR: You feel happy. I think the challenge is going to be in realizing this visually. Because the script itself is very tightly written, but executing the whole hotel analogy, I think, will be really key. And it's nice that you actually have access to a hotel since you're staying in the Hyatt right now. But

scaling back far enough so that people understand, oh, the key to the reason why this works is that people are arranged alphabetically in ascending, numerical hotel rooms is a really vital piece of information that you can use the visuals to convey really well.

Let's see, what about the second half of the script? I don't think you need this last thing right here. I mean that's what I was trying to say yesterday. That oftentimes we feel like we have to continue the ending longer than it needs to be, like this is why this is awesome. And that's the story of search, and this is the definition of prime numbers. It reads a little-- at the end. I personally just don't think it's as necessary. But I like how you tied it back to your opening. I think that's very strong. Does anyone have any comments about this at all?

FEMALE SPEAKER: On the 80 minutes for the first method and then 1 1/2 minutes for binary search, you explain how you derive the 80? Because it's 10 seconds and there are 500 people. But then how do you get the 1 and 1/2? And I guess my point is you might not need the let's say it takes 10 seconds to knock on each door.

PROFESSOR: Yeah, that's an interesting point, because you could explain the calculations you did to get to the binary search estimate. But, again, I don't think it's super necessary to the point of the video.

FEMALE SPEAKER: You don't need the other calculation either and that'll make it a little cleaner. Because I really think the 1 1/2 minutes is very dramatic in the comparison. And I started to picture little pods pop up.

JOSHUA: Because I was also thinking about they could be instead of 500 to 1,000, it could be 500 to 5,000, but I don't know how-- I'm not so sure whether how realistic that would picture be of 5,000 people in a hotel.

PROFESSOR: But, I mean, I understand why you brought up the specific numbers, because you're trying to show sense of scale. That the difference between the two methods isn't as exaggerated when you're only looking through a few hundred items. But when you up that to thousands, or even close to what Google searches, than the difference in the time becomes super, super dramatic. In that sense, I mean, I personally am totally OK with having those numbers in there, because I think that the script is written naturally enough to where I'm not overwhelmed or distracted too much by the numbers.

FEMALE I had one thought. And I know the hotel concept works, because when I think of a hotel, I think

SPEAKER: of a very simple box with a very linear line through it and rooms going off in different directions, which is why it works. But I wondered if having instead of it being a hotel, it's looking for something at MIT. Because then instead of it being grounded at the hotel, it grounds the film on campus.

JOSHUA: Yeah, it could work with-- but I'm not so familiar of the campus. Is there a place where--

FEMALE SPEAKER: Totally.

JOSHUA: --it's very uniform--

FEMALE SPEAKER: --very The infinite corridor, down the middle hallway, is a very, very standard place with doors. That was the only thing that fundamentally felt like if we could shift it, it would help ground this, instead of being at the Hyatt, to being here on campus.

PROFESSOR: Yeah, that's a nice suggestion. And there are a couple fun ways that you could shoot that if you wanted to--

FEMALE SPEAKER: Getting 5,000 people at MIT is very easy.

PROFESSOR: If you wanted to shoot centered like this and start-- whoever is filming you, start relatively close. And you have the classrooms branching off this way. Does this drawing make sense to people?

FEMALE SPEAKER: Yeah.

PROFESSOR: OK, instead-- you'd have to find some sort of dolly, maybe take a rolling chair. But then slowly pan back as he says, but if there were like 5,000 people, and then it's a nice reveal and it's an exaggerated angle too.

MALE SPEAKER: [INAUDIBLE] knocking on every single door.

PROFESSOR: Yeah, yeah, that'd be a nice B-roll to put there.

FEMALE SPEAKER: Or even all-- I mean having a little fun. It's not about [INAUDIBLE] looking for days and then all these funny buildings on campus. I mean not that it takes up all our time, but it's a fun way to

ground this really and being about an MIT experience.

PROFESSOR: Do you want to say something?

FEMALE SPEAKER: I think a really good place for that, and that's where I imagined, is Building 4 if you go on the first floor. That it's just a standard hallway, and all of the rooms I'm pretty sure are classrooms so they're available if you want to enter them. And then also there's an exit to [? Killian ?] Court. That may be a nice location, because there's the dome and grass and all that.

PROFESSOR: Any final thoughts about this script? Again, I think it's come a super long way. This is pretty much ready to film, I think. All right, Kenneth, you are next. Do you mind giving your mic to him?

KENNETH: Do you want to just do some of this? Not the whole thing. Yeah--

FEMALE SPEAKER: It's exactly talking [INAUDIBLE]--

KENNETH: Yeah, but I don't know. I just sent-- I just checked the link it has the doc-- you know what, Google Doc has everything. There's still a few paragraphs below that. It's OK, I'll just read what I have.

FEMALE SPEAKER: When we read together, I'll just pull up the Google Doc.

KENNETH: Yeah, sure. OK, how do you feel if you organize a party and no attends? Pretty much like this one right now. And then it'll show me at the head of the table with lots of food and no one. And I say, oh right, I forgot to send the invites out.

And then they'll cut to a shot of me dropping the-- sticks the envelope into the mailbox. And I say, hmm, wait a minute. I guess the only way that anyone could attend the party right now is if they actually travelled back in time. But if they had received my invite, they would have traveled back in time and I would have seen them, and that means I may not send out this invitations.

Oh, right. And then after that would be-- sorry. This is actually what we call a time paradox, but let me just go in and talk about-- OK, never mind. I'm ad-libbing right now. I'm sorry.

PROFESSOR: That's OK. In your real thing, you'll probably be ad-libbing.

KENNETH: Yeah, then somehow there's a transition. There will be a transition so just [INAUDIBLE]. But wait, could we actually travel through time? This was in fact an experiment conducted by Stephen Hawking in 2009 to show that time travel was probably improbable to be invented, even in the future.

But wouldn't being able to travel through time be cool? We could submit that homework that was due yesterday but only completed today or head to the really cool party that I just organized.

But how could we time travel and is it actually possible? A lot of what we know about time travel, all what we think we know, comes from Einstein's theory of special and general relativity. Now this is all part of what we call modern physics and is still being explored and tested as we speak. It doesn't mean that all of if is wrong. It just means that we're so unfamiliar with much of it, as we are with the universe around us.

Now back to time traveling. When you think about it, we are all actually time traveling, but not in the manner sci-fi movies has often depicted them. We are traveling through time at a pace of one hour per hour. In other words, as our bodies experience an hour of time, the wall around us has also experienced an hour of time.

It sounds simple, but stay with me. This is where it gets interesting. Within Einstein's theory of special relativity, there is a phenomenon he describes, which is known as time dilation. And there will be a subtext that says, dilation means to expend. Now, the gist of this phenomenon states that the faster you travel, the slower time passes around us. In other words, at high speeds, we could be traveling at a higher than one hour per hour. This is, however, only noticeable traveling at really, really high speeds, near the speed of light itself. And then the c equals the 3.0 times 10 above 8 meters per second will appear overhead.

And say I invent a spaceship that could travel at 90% the speed of light and I have a pair of newborn twins. And I'll have two babies in my hands, cartoon babies. And one of them, I'll put into this spaceship, and he will be in a spaceship. And I'll send this spaceship off to space for a year.

After the baby comes back for a year, the baby will have aged a full one year, while the one that remains on the earth will have aged approximately 2 and 1/2 years old. We can see that they have experienced times at different rates and the baby on earth had experienced times

about a 2.3-- has experienced time at a rate of now 2.3 years per year where we travel at [? .049 ?] c.

If my spaceship was capable of traveling at even higher speeds, now I fling the baby's to one side. This rate would increase exponentially, as shown in this particular graph as you travel toward the speed of light, which is-- there will be a graph overlay. As you travel towards the speed of light, the magnitude of the time would change dramatically and exponentially.

We could potentially travel forward in time, we just have to travel extremely high speeds to do so. But, I think the question on everyone's mind is, how do we travel back in time? I mean surely isn't that a lot more interesting and a lot-- sorry, I need to scroll back. Isn't that a lot more interesting than travelling forward in time? Do we have run backwards really, really quickly? And then we'll show the flash running backwards across the screen. All this change is probably just the direction we're facing as we travel, unfortunately, and that doesn't seem to be helping our case.

Now looking back at our previous graph, we can see that the amount of time that passes seems to be asymptote to the speed of light. What happens on the other side of the graph then? Scientists think that the idea to-- think that the secret to time traveling at negative rates, and subtext negative 3 equals time travel backwards, lies on the other side. Rephrasing that, we would have to travel faster than the speed of light to maybe be able to travel back in time. And this is where the dicey part comes in.

In general relativity, Einstein describes another phenomenon known as relativistic mass. When you have an object traveling at high enough speeds, the mass of the object would increase severely. To move an object with higher mass at the same velocity, one would also require a lot more energy. Einstein proposes that as we put more energy into an object, both the speed and mass would increase.

However, as we approach the speed of light, it is more likely that the energy put in increases the mass of the object, rather than the speed of the object. And thus, to be able put in enough energy to push an object beyond the speed of light, that will require possibly an infinite amount of energy, and thus rendering faster than light motion highly improbable.

But why are we so obsessed with time travel? Time travel often come with it's own set of problems. Referring back to my initial problem, and say I do have friends in the future who are capable of traveling back in time. If they received invitations after the party and travelled back

in time to attend it, I wouldn't have had an empty party. Since I don't have an empty party, I wouldn't have to send all my invitations after it, and if I had not sent out my invitations, they may not have received it, and they may not have traveled back in time.

And this is where the whole confusing part comes in, and this is what we call a paradox. In fact, this particular paradox is known as the grandfather paradox, in which two conflicting series of events occurs, based on whether I choose to time travel or not to time travel. This is just one of the three theories of time travel and more details can be seen at a link below, and then they'll be a link to a YouTube description bar. Because if not, the thing gets really, really long.

It seems our current understanding of modern physics-- based on our current understanding of modern physics, time travel might not be possible for us to achieve yet. That's not to say that things might not change over the next decade or the next century as we are slowly figuring out the world around us better. But for now, if they're going to be planning a party, be sure to send out the invitation before it, and don't count on your friends on being able to travel back in time just to attend it.

PROFESSOR: Nice. All right.

KENNETH: And I know this one goes way--

PROFESSOR: Yeah, no, it's OK. This is great stuff to work with, and actually I think that with just a couple fixes, you will also be pretty ready to film as well. This is not your script, you--

KENNETH: Yeah, if you could open Google doc-- I just-- I'm not sure. Because I'm updating it in Word, it's of-- no, I'm Kenneth.

PROFESSOR: Is it this one?

KENNETH: No, I'm Kenneth.

PROFESSOR: Oh wait, oh, I'm so sorry.

KENNETH: It's okay. Yeah, yeah, this should be it.

FEMALE SPEAKER: I feel like I have a fairly easy fix for the time-- speaking of time. I feel like the whole party invite thing is too confusing.

KENNETH: Too confusing, yeah, that's what I felt when I was writing it. But then, the grandfather paradox is--

PROFESSOR: Yeah, I actually-- I like how you explain the paradox at the end because it answers the question, well, if Stephen Hawking proved that time travel wasn't possible, then why are we still thinking about it now? Like what sort of loop holes exist? I think that--

KENNETH: Maybe not mention [INAUDIBLE].

PROFESSOR: I know that you had restructured this. And I'm guessing you restructured it, because George had said earlier, it would be nicer if you could actually get Stephen Hawking in this video as you were talking about the video or as you were talking about the party. But all this can go away. I think that you can explain the set up with just what you had before.

FEMALE SPEAKER: Why do we need-- I mean I get that it's a cool story, but I feel like you explaining this idea of-- I must admit that I have not yet once in my life thought about time travel ever, before this moment. It's not something I think about. In fact, I don't even think that I was capable of thinking about time travel, because it seems like this very abstract idea that my brain probably doesn't think about or capable of thinking about.

You did an incredibly good job at helping me even understand how someone would even think about that idea, which I think is the beauty of your piece. That's like the essence of what you've done is you've simplified really complicated set of theories and all of that into something that I could now follow and be like, oh, I now understand how people devote their life into studying this idea. I would have never, ever thought about this before.

The party, to me, I don't need it all in this to me. Not at the beginning, not at the end. The idea is time travel even possible is interesting enough without that story, from my perspective. That I think the party piece is just-- it's got so many double negatives in it that it's just really complicated to wrap my head around. I just wonder what it would look like if we took the party thing out entirely and focused on--

KENNETH: I was actually thinking an alternate was maybe a B-roll of footage from Hollywood films of people traveling back in time like in Harry Potter or in Star Trek.

FEMALE SPEAKER: I don't think you need it, I mean, personally.

PROFESSOR: Then there's like a whole IP issue, which we're going to talk about it an hour. I mean here's the thing-- and again, this is the part where like personal taste comes into play. I think that the story is nice as a storytelling element. That you end the video nicely, because you reference the beginning, where you're just like just send out your annotations. But I do agree that it takes a really long time to explain it, and I wonder if you can cut this intro down to a sentence. I think this is an OK start, held a party, but you can take out all this stuff.

FEMALE SPEAKER: I guess I get lost with the he sent the invitations, no one came. How does that-- I don't know. It's really-- maybe I'm less adept at thinking this way than the rest of this room, but I really struggle with this.

PROFESSOR: Yeah, PJ?

PAUL: One thing I found when I was redoing my script was-- mine was pretty wordy to begin with and I think the story-- I think it's good, and I think you get a lot of those words based off what we were shooting. There's no one there, and the fact that you're describing again, I don't think you have to do it because they're going to get all that. I like the Stephen Hawking story, but like it was with [INAUDIBLE] doing a sentence based on all the visual queues they're going to get from the video.

PROFESSOR: Because I like that you talk about the grandfather paradox. And I actually didn't super understand the grandfather paradox until I heard you read this paragraph aloud in the context of the party. But again, Paul is totally right. You can complete rely on the visuals to tell a lot of these words for you. So you could say, back in 2009, Stephen Hawking held a party that no one came to you, and he smiled at himself, because he had just proven that time travel was possible. All right, so you're reducing everything down into a sentence.

FEMALE SPEAKER: Not possible.

PROFESSOR: Yeah, is not possible. The reason is that he sent his invitations out after the party had finished, thinking that if people in the future were capable of time travel, they'd receive those invitations after the party had ended and come. So, because the party was empty, time travel is not possible. You know I mean? Really, really condense it down to two sentences. Really challenge yourself to explain the story in two sentences.

FEMALE And I might need a-- I mean, for me, I might actually want an animation in this part too. I don't

SPEAKER: know. I don't know why I find it really complicated.

PROFESSOR: It is, it's a complicated-- it's complicated because you don't really explain it until the very end, which is OK. I agree that it's not vital to your content, that the content is fascinating enough. But it's used really well, right now, as the storytelling device to open and close the video, and then in the middle, you bring it up again.

I think that there's a lot of stuff in the video that you can take out that might give you some time to play around with. For example, this whole chunk can be cut down a lot. Let me change this to-- I'll just resolve this. I think the question that you can set yourself up with is, so time travel-- if you disprove time travel, why are we still fascinated by-- or why do physicists still think about it? Well, what exactly is time travel? A lot of this--

KENNETH: In otherwords--

PROFESSOR: Here, I don't I think you necessarily need these two sentences. I also wonder if you need this paragraph here. Yeah, I mean it's fun. It's going to be a little hard to execute visually given the amount of time you have left. So, just from a production standpoint, it'll be tricky.

FEMALE SPEAKER: Actually, this really worked for me.

PROFESSOR: It did?

FEMALE SPEAKER: Yeah, at least for me. When you-- I mean with the babies, you don't actually need real babies. You can have dolls, right?

KENNETH: No, I was thinking of just cartoon babies.

FEMALE SPEAKER: Yeah, or whatever-- plus, as a mother-- oh, there's no way I would lend you my [INAUDIBLE] for this film. No offense, but there is no way I would lend a child for this film. But I think that this example actually was very concrete and I think [INAUDIBLE].

PROFESSOR: Yes.

PAUL: I'm just going to say that example, I thought, was really good too. But I think you can-- not the sentence before but the paragraph before, you could turn that into one thought, because you're explaining how you travel in hour per hour. I think if you were able to just maybe get a sentence out of that and just get rid of the rest and then blend it with that now I take a pair of

newborn twins' paragraph, that'd be good.

PROFESSOR: Yeah, I think the only issue with it is that it takes so long to getting to explain to how we travel backwards in time, and I don't know from the beginning of the script, that you're planning on explaining that. And then I'm just sort of waiting to see where you'll go next. Maybe if you preface I'm going to explain what time traveling is. You can say, well, first-- in your own words, you can say first I'm going to talk about how we travel forward in time, and then backward in time or somehow indicate that to the viewer. I don't know if anyone else felt that confusion. Sorry, Andrea.

ANDREA: I almost wonder if you shouldn't you lead off with the baby example. As like let's do this experiment, let's do this side experiment where we do this. And it might-- I think it'll help with your pacing. It was difficult for me to listen to. It was pretty wordy. I think if you actually like just grabbed two props as though you're acting it out and ad-lib it and record yourself doing it, you'll get something that flows a lot better, because you'll be able to cut out a lot of words. Because you'd be like, here's a one-year-old baby and here's a 2 and 1/2 year-old toddler.

PROFESSOR: Yeah.

ANDREA: That's what would happen.

PROFESSOR: There are a lot of just little phrases like this like we are with the universe around us that are very poetic. They sound really nice in an essay. But if you actually strip some of this away and really just try to distill it down to the essential facts, I think that's going to save you a lot of time too. But, overall, at this point it seems more like distilling ideas sound. Do people agree with that? I'm glad that you flushed it out, though, because before it was sort of missing some of the essential explanations, and I know you were worried about it getting too long because of it. But I think the overall structure of it is very sound. Yes, Julia?

JULIA: Well, I was going to say that all of the topics involved in the script kind of to me don't seem necessarily connected, because the paradoxes are more in the field of philosophy, and then relativity is physics, and then the twin paradox is a thought experiment so that's closer to philosophy. I think it will be nice to separate the two to mention this is actually scientifically proven and this is just something that people think about.

Also, the most compelling part to me was, and that's something that answers the question of time travel the best, is the part where he talks about traveling forward in time and travelling

backwards in time. And the backward part was not very flushed out whereas there was a lot of time spent on the twin paradox that doesn't necessarily have to do that much with time travel.

Do you think there's a way to restructure it? Or focus on something other than time travel that would be paradoxes that arise when you work with relativity and travelling at the speed of light? That would be the twin paradox and the grandfather paradox, and then you could explain them in more detail. Especially for the grandfather paradox that would help, because you could split up the explanation into different sentences so you wouldn't use would of and had multiple times.

PROFESSOR: Yeah, I mean the only thing is that you are working with a very tight time constraint. And I think all of this information is nice and it's good and, it helps me understand it better. And would work really well if this were a blog post, for instance. But you do only have four or five minutes.

And I actually like the structure that you have waiting until the end to address the paradox, because you're kind of going back to the beginning. And you're saying, why isn't time travel possible, aside from the fact that we can't go beyond the speed of light. How else are you going to support Stephen Hawking's claim that time travel isn't possible? I like that the way you've split up putting the paradox at the end. I don't know how you guys feel about it.

How do you guys feel about the overall structure of the script?

MALE SPEAKER: I think that he has to-- I think a paradox should be at the end. I think time travelling backwards should be after time travelling forward. I think that he-- correct me if I'm wrong, but I think that you don't have enough information for time travelling backwards because nobody knows how to do it. Nobody knows the [INAUDIBLE] travel backwards in time, so you can't give a really concrete example for it.

PROFESSOR: Right, like you can't have an analogous example.

MALE SPEAKER: Yeah, because we don't really know.

MALE SPEAKER: [INAUDIBLE].

PROFESSOR: Nathan, did--

MALE SPEAKER: I think [INAUDIBLE].

PROFESSOR: Yeah, Nathan did you want to say something?

NATHAN: Oh, I just thought that Chris saying the structure-- I actually really liked how everything was laid out. And that I feel like most of the work is just shortening individual parts.

PROFESSOR: Yeah, I agree with Nathan on that. And honestly, the thing about the traveling backwards in time, for me personally, it's just that you don't get to it soon enough, so that I feel like we're wading through a lot of intro and a lot of explanation of moving forward, which are important. I wouldn't say take them out completely or anything. But that I had no idea what any of this was actually before I read this.

And I'm glad that you put it in there, because that's really what the meat of it is. What exactly does it mean to travel back in time? And at first I was like, why is he putting graphs up? This is being really physicsy, but now I understand why you're talking about asymptotes and everything. It's just that it took a really long time to get there. And--

FEMALE SPEAKER: I think, if I hear everyone, we just be ruthless going through paragraphs and cut it-- information that you don't think is essential. Because the overall structure works, but there's just too much.

PROFESSOR: Yeah, I think this paragraph is very vital and I would shorten that unless you're like going to take out fluffy words. If anything, I would take out from this stuff before it. And this stuff is super interesting, and I don't want you to take it out because it's a further explanation of why time travel isn't possible. But it gets really dense here. This is the part when you were talking where I was like what is happening.

FEMALE SPEAKER: That's another video.

PROFESSOR: Yeah, this is OK. But this paragraph, can you just say that would-- it would also need a lot more energy, actually an infinite amount of energy to move it. Traveling faster than the speed of light is highly improbable.

KENNETH: I'm just afraid that it condenses the whole chunk on traveling back in time--

PROFESSOR: --too much.

KENNETH: Yeah, that's why I decided to talk a little more.

PROFESSOR: Yeah. No, and I'm glad that you flush it out. I know that you were hesitant to add more stuff,

because you were aware of the time constraint.

MALE SPEAKER: And mention e equals mc squared.

KENNETH: Not exactly. It's, effectively, he goes--

MALE SPEAKER: [INAUDIBLE] e equals mc squared then as he increase e-- as e increases-- normally you'd think that m stays the same and c increases--

KENNETH: Actually, e equals the [INAUDIBLE] mc squared. That's why I didn't really want to bring it in.

PROFESSOR: Yeah. Yeah, I don't think you should add any equations to this. Aside from the fact that like e equals mc squared is like the characteristic Einstein equation that people--

KENNETH: But the thing is, it doesn't really fully explain this. That's why I didn't really feel like putting the other equation in.

PROFESSOR: I agree with Jamie, overall. The structure, I think, is there. The substance is there. I don't think you necessarily need to add anything except for maybe a transitioner or so. But at this point, I really think it's just, again, being ruthless about taking words out, taking a sentence out or two. You're only over by a few minutes, which actually is an eternity.

FEMALE SPEAKER: [INAUDIBLE] fast.

PROFESSOR: Yeah.

FEMALE SPEAKER: And I will say that slowing down your pace will help people--

PROFESSOR: Yeah, I think I started getting lost around the Einstein, because you were talking a lot faster in that section too. But I'd say at this point it's really just paring it down to the essentials. And we can help you with that during office hours if you want. Any final thoughts for Kenneth? Yeah, Joshua?

JOSHUA: I do agree with your point just now about [INAUDIBLE]. I think it's helpful. It's been a bit confusing the [INAUDIBLE].

KENNETH: Yeah, I was thinking whether I should even mention a paradox straight off or not to mention it at the top. That's why I was just playing around. And, yeah, I think no.

JOSHUA: Is there a to phrase it in the positive?

FEMALE SPEAKER: You're saying because the double negatives are really confusing?

JOSHUA: Yes. I was thinking perhaps it might be something like he was happy because he proved time travelers wrong, and they could not come back in time. So he makes it very clear that once that-- perhaps it's like once [INAUDIBLE] proved time travel wrong.

PROFESSOR: Yeah, maybe just a little wording thing like that.

JOSHUA: He might lose a level of complexity that you would want people-- I guess it's not the intent to help them understand this part. The intent is to tell them that Stephen Hawking proved time travel is wrong? Is that [INAUDIBLE]? Then you might be OK to hide the complexity away. [INAUDIBLE]. Just keep thinking about why is that, why is that-- how did that prove it? How did that prove [INAUDIBLE]?

PROFESSOR: And you talk about it at the end. I think the whole grandfather paradox part is nice, because it is an expansion of why maybe his proof wasn't really a proof and why people are still thinking about time travel even though he supposedly proved that it wasn't possible.

FEMALE SPEAKER: What if you take the structured approach that Josh took in his whole piece in that little part? Make it really simple at first. Stephen Hawking hosted a party. No one showed up. It proved that time travel wasn't possible. Actually, it's a little more complicated, and explain it a little further.

PROFESSOR: Actually, you could open the video like that.

MALE SPEAKER: [INAUDIBLE].

FEMALE SPEAKER: Just really tight and then it allows you to use that story throughout, but not confusing people with all the details.

PROFESSOR: Yeah.

FEMALE SPEAKER: Right?

PROFESSOR: PJ were you going to say something? OK. All right, any final thoughts? I mean this is in good shape too. Again, it's much easier to-- I think it's easier to pair down from something that has too much content then the other way around for sure. And the delivery again will help too.

FEMALE SPEAKER: These have come so far.

PROFESSOR: They really have. I mean I don't know if you guys have looked at your pitches that you made last week. But they really have-- I mean I'm really excited to watch these videos. Yes.

JULIA: I'm just going to say that I really liked how you were able to explain this complex phenomenon in words that are understandable.

KENNETH: [INAUDIBLE].

JULIA: Yeah, I think that's really cool.

PROFESSOR: Yeah, and that's the whole building learning confidence with the viewer too that I talked about on the first day of-- simple explainer videos are so compelling to people even though they're quote unquote boring, because people feel good when they feel like they've mastered a seemingly complex subject. And this is a video that is going to help people understand special relativity. I think that it's going to be a very compelling thing to watch for people. They're going to want to keep watching because they're understanding what you're saying. All right.

FEMALE SPEAKER: You seem so smart when you get something complicated. I'm like, oh wow, I just got a really complicated [INAUDIBLE].

PROFESSOR: Yeah, you're helping them achieve mastery, which is nice.