

# Inventing the Future

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A Speech for the Los Angeles World Affairs Council  
November 18, 2013

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## Elon Musk Founder of SpaceX and Tesla

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**Terry:** Thank you for joining us. I know today was a busy day at the office.

**Elon Musk:** Yeah.

**Terry:** I guess everyday is a busy day at the office when you're running two big companies.

**Elon Musk:** Some days are more intense than others. This was on the more intense side.

**Terry:** Let's talk about Tesla. If one were to believe everything one reads in the press -- which I don't as a former journalist -- the recent fires in the Tesla cars sound like the Hindenburg disaster in 1937.

**Elon Musk:** Right -- the humanity.

**Terry:** In reality, it is somewhat different. Tell us what really happened there.

**Elon Musk:** I think first of all that it is fair for a new technology to receive more scrutiny than older technology because it should be held to a higher standard, but there is some reasonable limit to what that standard should be. Since the Model S went into production about a year and a half ago, there have been about a quarter-million gasoline car fires in the U.S. About 400 deaths; 400 serious injuries. Our 3 fires which caused no injury received more headline news than the other quarter-million combined. That seems like an unreasonable ratio.

**Terry:** And I believe all three owners of those cars who crashed wanted to get another one.

**Elon Musk:** Yes. Right. Exactly! Don't take my word for it. Well how soon can they get a loaner car until the insurance gets figured out. Yes, so we gave them one right away. That's the acid test. Does the guy who experienced the fire want to have the same car again?

**Terry:** Do you feel safe in it?

**Elon Musk:** Yes.

**Terry:** And stock price down 10 percent today. Do you care about that?

**Elon Musk:** It kinda sucks running a public company. I mean the stock goes through these huge gyrations for seemingly arbitrary reasons. And then I'm asked to explain why it changed and I have no idea.

**Terry:** It should be pointed out that it's up 300 percent on the year.

**Elon Musk:** Right, on balance that's still good. But when the stock price is way higher and people ask me what I think of the valuation I say well I think it is probably more than we actually deserve. We will probably get there in the long term, and I think we will exceed it, but I would not try and justify that a company with \$2 billion in revenue should be worth \$22 billion in market cap. That does seem pretty high to me.

**Terry:** And it's fair to say you wouldn't be there without government subsidy.

**Elon Musk:** Well, I think it would have taken longer. There's a slight misperception about the history of Tesla, which is that the government funding is pivotal. It was an accelerant, but it was not pivotal. The really pivotal point was an investment from Daimler in early 2009. I had basically spent all the money I had and we had one company that was willing to invest, or one entity that was willing to invest, period, and that was Daimler. And if they hadn't come in with that investment we would definitely be dead.

**Terry:** Dead, bankrupt; finished.

**Elon Musk:** Yeah, gone. Fortunately, they did and we've done a number of vehicle programs with them, such as the Mercedes B class which is not currently produced in the U.S., but it is very popular in Europe and other parts of the world. It will be coming to the U.S., and that will have a Tesla battery pack and power train. It will be the largest electrical vehicle program in Daimler history. We've got a great relationship. They've been a great supporter.

**Terry:** How about self-drive version of Tesla?

**Elon Musk:** I do think that's an important technology, although the difficulty increases exponentially to get to fully self-driving. You have to cover all the corner cases. So I think we can get to maybe 90 percent of miles driven being autopilot – using that sort of aircraft analogy – we can get there pretty soon, maybe in a few years, but covering that last 10 percent is really difficult. Getting from 90 percent to 99 then to 99.9 and then ultimately to be truly self-driving you can fall asleep and the car drives to your destination, which will be really great.

**Terry:** Some people do already, by the way. They died.

**Elon Musk:** Yeah. I think you probably need six lines of reliability. The standard would actually be way higher than the safety of a person. Probably by a factor of ten or a hundred in order for people to be comfortable, otherwise it will be like this fire thing. Our car is basically the safest care you could possibly drive if you care about fires, and that's not the impression one would have reading the headlines. You would have sort of the opposite impression. And for a self-driving, autopilot hopefully the media doesn't do the same thing. Same may be a disproportionate response, but I do think that it should be held to a standard that is maybe ten times better than a person.

**Terry:** And I know Google is working on this too. Ten years, more or less?

**Elon Musk:** Yeah. I think the right path is probably a little bit different from what Google is pursuing. I mean Larry Page is an old friend of mine; I've known him since before he got venture funding for Google. I think he's a really brilliant guy, but Google's not focusing on autonomous cars whereas that's going to be a pretty significant focus for Tesla. And from our standpoint, it only matters if the autopilot capability does not result in a substantial cost increase to the car. The way the Google sensor suite is set up is like \$60 grand, and that's a lot.

**Terry:** I want to ask you about risk-taking because there's a theory that entrepreneurs who hit it out of the park that one time; make that billion dollar plus work are reluctant to do it again. Not because they're afraid of losing money but because they feel as if they were to fail a second time around, then in their own minds maybe they would think well the first time it was just luck, not really my own skill, my own sense of how to run a business. But not only did you, well, you rose PayPal up to \$1.5 billion, and you got out of that. Not only did you invest again twice. Not only that, but you chose probably two of the most risky, capital-intensive industries to go with – rocket technology, which is basically a bomb directed up, and then cars, which are, you know what's happening in Detroit. So what is it that motivates there? To go through the crucible again two times, again.

**Elon Musk:** Yeah, I'm not sure it was the right decision, but...

**Terry:** So far so good?

**Elon Musk:** Yeah. It's much less fun than it may appear. I mean in the case of... what I thought I would do was start and run SpaceX and then create an electric car company with a few other people. Work, but just apply 20 percent of my time and work on the project design because my main thing is engineering and design. That was an illusion. And then, I never really have any choice but to apply a ton of time to Tesla or the company would be definitely dead.

**Terry:** But the other way to do it is you could have stayed in Silicon Valley, started another few Internet companies, made a billion dollars and then you could have bought Chrysler, probably bought NASA too, and you wouldn't have to start from scratch. That seems too easy.

**Elon Musk:** Yeah, yeah. I don't really wanna... the point is not to sort of own a car company, but to accelerate the advent of sustainable transport, and it seems like it would be difficult...

**Terry:** Let's talk about SpaceX. SpaceX, you have said, you started with the specific intention of getting to Mars.

**Elon Musk:** Yeah. Well, the origin of SpaceX was actually not – my interest in space was that it wasn't possible to create a company, and I mistakenly thought that the reason that we're not sending people to Mars was because we've lost the will to explore, or something like that, and I thought well maybe that needs to be reignited. And, so I came up with this idea to do basically a philanthropic mission to Mars with a 100 percent probability of losing all the money in order to reignite interest in that goal. But after a while I realized that was a mistake, particularly in the United States, a nation of explorers that came here from other parts of the world. I think more than any other country it is the distillation of the human spirit of exploration. There's no lack of will, but people need to believe there's a way. A way that's feasible and not going to bankrupt the country, and their living standard won't be materially affected. And I think they're super keen on that goal.

**Terry:** Now as you look out whatever we're talking: ten, fifteen, twenty years to get to Mars, it's not just rocket technology and you've talked about reusable rocket technology. It's also how you shield people from radiation – it's a ten to twelve month trip and what do they do when they arrive. How are they going to live there? Is that something you want to work on too or will you partner with other companies? How do you see that playing out over the next decade?

**Elon Musk:** Well, I actually think the technology required to live on Mars is not particularly difficult, but getting there is really difficult. I mean it's like hundreds of millions of miles.

**Terry:** To get to Death Valley.

**Elon Musk:** Exactly, to get to a place that kind of looks like Arizona, you know? For a cold version of Arizona without quite as much water. I mean at least that's my guess I think if we can get there, the technology required to live there is not really a big challenge. And Mars has some advantages. It's quite sort of Earth-like in some ways. It's got a rotational period of twenty-four and a half hours – by far the closest of any other planet. The atmosphere is carbon dioxide. It's at a low pressure, but if you were to have a transparent dome all you would need is a pump and some fertilizer and you could grow plants on Mars, and the plants would convert the CO<sub>2</sub> to oxygen.

**Terry:** The other thing that's been big in the news recently is the Hyperloop, which you have sketched out your estimate from LA to San Francisco in 35 minutes.

**Elon Musk:** Yeah, you could push that a little bit, but...

**Terry:** I would be happy if I could get from Santa Monica to Downtown LA in 35 minutes.

**Elon Musk:** I know.

**Terry:** I know you have your personal issues with the I-405.

**Elon Musk:** The I-405 is like the most brutal construction project I've ever personally witnessed. It's mind-boggling.

**Terry:** I also know that you sketched this out, and I know that your plans for the Hyperloop have been put in some pretty sophisticated simulation technology.

**Elon Musk:** Yeah.

**Terry:** And it looks like it actually might work. Am I right?

**Elon Musk:** Yeah, and we did run simulations at SpaceX and Tesla, so we thought it would work. I actually don't think it's particularly... I think the engineering that it would work is actually pretty obvious. The larger issues are political – getting the political support to do something like that – and then making sure the economics panned out. And yeah, I hope someone does it because I think it would be cool. It would be great to have something like that. It doesn't seem like our mass transportation is getting better... it keeps kind of getting worse, so that's not a good future.

**Terry:** You said something -- that you hope someone else will do it. I am curious. What makes you so unique is not only your ability to dream big, but to execute. There are lots of utopian thinkers out there, but they cannot execute. But there are some other people who can do good things, and I'm wondering what seems to motivate you. You seem to see things that frustrate you, or not as good as you like, and then you try and fix them. You've worked on solar power, you've worked on electric cars, and you've worked on interplanetary space travel, and I'm wondering what other things about America and about the world for that matter would you like to see fixed either by a company you might do yourself or by some other smart entrepreneur. What else out there is feasible? You know we all want to get rid of world poverty and get rid of childhood diseases, but what other problems out there could feasibly be fixed in our lifetime?

**Elon Musk:** Well, I mean, I think first of all the world is actually pretty great right now. I mean, arguably better than any other point in history, and this is sometimes lost if you read the newspapers. They're like a magnification of all the world's problems. Newspapers seem to be attempting to answer the question: what was the worst thing that happened on Earth today?

**Terry:** If it bleeds, it leads.

**Elon Musk:** Yeah. And I think there's an evolutionary reason for that. It makes more sense to prioritize danger over reward because if you get eaten by the lion it's game over, but if you forget where you left some snack that's okay, so it's not quite the same in terms of the rest of the world balance, but we didn't evolve with newspapers and global media so like our brains having a fear response to a bunch of dangers that are extremely unlikely to ever effect us.

**Terry:** You have, I believe, about 3,000 people at Tesla.

**Elon Musk:** We have 6,000.

**Terry:** 6,000? I'm not informed. And SpaceX?

**Elon Musk:** Is 3,500.

**Terry:** So that's a massive conglomeration of engineering talent – huge.

**Elon Musk:** Yeah.

**Terry:** If I could take the metaphor of a ship, how much time do you have to go down to the engine room, roll up your sleeves, get your hands dirty and fix stuff as an engineer and how much time do you spend on the bridge steering and looking at the distant horizon.

**Elon Musk:** Well, not a lot on that last point. I mean there is a constant flurry of executional challenges, so I try to triage my time according to what would be best for my companies, and still have some time to see my kids because I don't want to miss them growing up. So it can vary from big issues to things that seem small, but actually could have a really big impact. So it's all the way from design aesthetics to the details of the vehicle functionality or in the case of the rocket, the avionics propulsion system and air frame. I mean the rocket has more of a concentrated pucker factor because you've got these launches and at least for the car you can do a recall or do a software update; that's not going to happen with the rocket. So it's like passing grade is 100 percent, which induces anxiety, you know.

**Terry:** How do you handle launch anxiety when you're actually waiting at the countdown we saw on here?

**Elon Musk:** Well these ones actually... I mean I have quite a lot of anxiety... so I think oh, there must be something that we did wrong, and is there anything I could have done to prevent this hypothetical bad thing from occurring. I mean, the last roughly ten launches have worked, but the three launches we started off with did not, so by far the worst emotional stress was the fourth launch of Falcon-1 because the first three launches did not make it to orbit. They got to sort of space on launches two and three, but they did not get to full orbital velocity, and when I started out I figured I would have enough money for three launches... yeah, so we squeaked by on the fourth one.

**Terry:** And we sent out a link today – I don't know how many of [the audience] saw it – but it's of you using your hands as 3-D molding sort of tools for stuff you're doing on a computer screen, and it's a rocket engine that you're able to manipulate with your hands. And I know that you've told John Favreau who produced or directed Iron Man that that was the inspiration because we see Tony Stark doing this in the movie.

**Elon Musk:** Oh yeah, absolutely.

**Terry:** And I know also, you know, I've read a bit of Isaac Asimov's Foundation series – you've also said has been an inspiration, so I'm wondering...

**Elon Musk:** Yeah, yeah I'm a big fan of Asimov actually.

**Terry:** When you're on the cutting edge of technology today in the fields that you're in, do you feel you've almost got one foot in science fiction? Do you have to be that far ahead?

**Elon Musk:** Well, you have to imagine an outcome in order to head in that direction, and science fiction explores a lot of different ideas so it can be helpful as a source of inspiration. And books, TV shows; movies – they're all a big source of inspiration. Most of the movies and TV shows about space are totally wrong, but they still have interesting ideas like the Star Trek communicator was an inspiration for the cell phone.

**Terry:** With the flip, right?

**Elon Musk:** Right, yeah, exactly.

**Terry:** And I'm...

**Elon Musk:** In fact the weird thing is the phones we have in our pocket vastly exceed what was on Star Trek.

**Terry:** We're going to take some of our students' questions, but first one more, and I'm a big James Bond fan. You just bought the Lotus Esprit they used in *The Spy Who Loved Me*, which goes underwater.

**Elon Musk:** Yeah.

**Terry:** And you're going to make that work?

**Elon Musk:** So it's definitely a back-burner project.

**Terry:** But my question is: When do we get to see a functioning version of the Millennium Falcon?

**Elon Musk:** That's a tricky one because it's not actually the right shape.

**Terry:** Uh oh! Note to George Lucas.

**Elon Musk:** Yeah, I mean the Falcon-9 rocket was named after the Millennium Falcon even though it looks nothing like it. That's not the shape you'd want for a space ship really.

**Terry:** Okay, so if we can swing the camera to our student tables; we'll get a couple of questions from them and then I'll go to the written questions from the rest of the audience.

**Student #1:** Good evening sir, my name is Ariel Hymiss, I'm from Vaughn Next Century. Referring to Merlin-9, does SpaceX have a working prototype, and when will it be ready to launch?

**Elon Musk:** Well, Merlin is the name of our engine, and Falcon-9 is the name of the rocket. We've done several launches of Falcon-9, and an important milestone happened a few months ago which was the launch of the next generation Falcon-9, which is designed to be able to return and land at the launch pad. We came close on the initial mission, but didn't quite get there. We need to make a few corrections, but I think we have a good chance of getting there next year.

**Terry:** Okay, let's go for that one there.

**Student #2:** Hi I'm Kennedy Green from Harvard Westlake. So I've seen you speak at a TED Talk, and I remember you spoke pretty emphatically about the success of your innovations, and how you kind of take a physics approach where you take the idea, and boil it down to its basics, and from there start to build up. So can you talk about an example where you used that process?

**Elon Musk:** Well I think... an important thing in innovation, or trying to create new things, is to try really hard to do that, which may sound incredibly obvious, but that is where I find what people don't do. They actually don't try super hard to come up with something new. And it is helpful to have cross-pollination of industries. I mean it's been quite difficult to run SpaceX and Tesla. There has been... good ideas... since I got both in my mind space there's good ideas going back and forth. For example, on the car – with respect to the car – the Model S is the only all-aluminum body and chassis car made in North America. Very few cars are all aluminum. In the aerospace industry, that is the default. So it seemed like obviously the right move in order to minimize the non-battery pack mass of the car. So in order to offset a fairly heavy battery pack, we had to make the rest of the car light, but still achieve a five star safety rating. I don't think it would have been possible to do that if we had used steel, which is the traditional method. And what's helped SpaceX is that the car industry is really good at making complicated objects at a low cost. I mean, it is actually quite incredible that one can buy a decent car for \$20,000. All the stuff that's in that car is... I mean it is nutty how much stuff is in a car. So, at SpaceX I hired a bunch of people from the auto industry to run manufacturing, which has worked out reasonably well.

**Terry:** Let's take two more student questions, and then we'll come to the other written questions.

**Student #3:** Hello. I'm Natalie Watson from Marlborough School and we have a sort of two-part question that builds, so... why do you think Tesla succeeded whereas car companies have failed in their methods of electric cars and is the location in Silicon Valley an important part of this?

**Elon Musk:** Yeah, I think being in Silicon Valley is an important part of this because what's really critical with electric cars is electrical engineering, software, and electronics. And Silicon Valley has the best concentration of talent in those areas in the world. And... yeah. Sorry, what was

the first part of the question?

**Terry:** Why did you succeed?

**Elon Musk:** Oh why did we succeed? Oh, yeah, alright.

**Student #3:** I'm sorry, what was your question? Oh, the first part. Okay. Why do you think Tesla succeeded whereas other car companies failed in their methods of electric cars? Like why do you think Tesla is the leader in this idea?

**Elon Musk:** Well, there haven't been that many car company start-ups. There was sort of Fisker, Coda, and then a few smaller ones, and then the rest has sort of been... some fairly small scale efforts by the big companies. I think if we say: what was the difference between say Fisker and Tesla – because that is maybe the most direct comparison – Tesla is a hardcore engineering company, and Fisker is based on styling. Styling is good and important, but that's not the reason we don't have electric cars. So it's not therefore styling – and we would have electric cars – that's not the reason. So, in the case of Fisker, they made a car that a lot of people think looked really good, but didn't work properly. So, then people don't want to buy the car. That's a pretty reasonable thing. And, yeah... If you think about it what's the point of a company existing? The point is that it's a group of people that have gathered together to create a product. If the product is good, the company should exist, and if it is not good, the company should not exist. That seems fundamental to the nature of companies. So, I mean clearly one should focus on making the absolute best product you can, otherwise you reduce the probability of success. But a lot of companies focus on things that aren't really to do with the product, as though a company has any basis for existing apart from doing useful things. That's kind of strange.

**Terry:** One more student question please.

**Student #4:** Good evening sir, my name is Eric Pilio from Vaughn Next Century. And regarding the proposed Mars expedition, how exactly do you plan on making it cost efficient.

**Elon Musk:** Sure, well now that is indeed a tricky problem. I feel reasonable positive that success is at least one of the possible outcomes. This is pretty important when you're trying to do something it is like well, can that be one of the outcomes? I wasn't actually confident about that until a few years ago. Now, I'm not saying we will get there, but I am confident that it is at least possible. And the key to that is having a fully reusable Mars transportation system, so that all you're replacing between flights, aside from maintenance, is the propellant. I mean, reusability is so fundamental to having a major change in space flight, it's difficult to overstate its importance.

With analogy to other modes of transport, you can imagine that if airplanes could only be used once, very few people would fly because it would be super crazy expensive. Like a 747 costs a quarter billion dollars. You'd need two of them just for a roundtrip. People are not paying half a billion dollars just to fly back and forth to London. And that's because you can use a 747 like twenty thousand times. And for a rocket, you know, a Falcon-9 rocket costs about \$60 million

to build, and it can be used once – that’s obviously a \$60 million capital cost, but if it can be used a thousand times then it’s only a \$60,000 capital cost. It is the fundamental difference, so you have to make sure that the propellant used is as low-cost as possible, so our next generation rockets will be using methane as a fuel.

Methane is the lowest cost source-fuel on the planet by a good margin. So I think if your propellant costs are low and the system is fully reusable, then I think it should be possible to move to Mars for less than half a million dollars, which I think is an important threshold because if people can sell all their stuff on Earth and move to Mars, and there is enough people who can do that combined with those who actually want to do that then that’s the fundamental thing needed to have a growing colony on Mars. Kind of like the way the U.S. was with the early British colonies in America, when it became affordable for people to sell all their stuff in England and move to America, it grew really fast. In the absence of that it would just require humungous amounts of government support, and probably wouldn’t result in a self-sustaining civilization. So the economics of it are fundamental. Thanks.

**Terry:** Okay, I’m going to go to some questions that we got from the floor, and the first one I want to ask is: what is the next battery technology after lithium-ion. I guess lithium-ion has sort of reached its ceiling, more or less?

**Elon Musk:** No, I think there are substantial improvements that will occur with lithium-ion batteries without any – no miracles required. The thing with lithium-ion technology in terms of the cost and energy density is the average improvement per year is 8 percent, which isn’t that noticeable on a one year basis, but compound interest is a very powerful force. So after four or five years, the cost is cut in half. There’s a strong forcing function that I believe electric cars provide. So I feel pretty good about achieving a substantial reduction in the cost of the battery pack in the three or four year time horizon.

**Terry:** Still way behind Moore’s Law for microchips, which is doubling every year.

**Elon Musk:** Oh yeah, sure. The only thing that operates at Moore’s Law speed is Moore’s Law. Semiconductors just have this incredible advantage that as you make them tinier, they get way more efficient. For something that’s a macrostructure, like a battery pack, you just don’t have... or really almost anything, I mean essentially, in fact, anything except microprocessors and memory does not improve at that pace.

**Terry:** Another question here. It’s about medical technology. Is there a medical application or technology that you would like to change, or see somebody else change/work on?

**Elon Musk:** Well, a medical technology... well I think the thing that would most profoundly affect people would be to be able to recode genetics, which is obviously a dodgy situation, but that’s the thing. We’re close to saturation on lifespan. It’s sort of pretty much leveled out. Even if you solve one particular disease, you maybe slightly improve life expectancy, but not a lot. You kind of have a genetic programming – any given species for a certain lifespan – like you cannot make a fruit fly live for ten years. No matter what you do. I mean no amount of healthy living,

vitamins; anything.

**Terry:** Ray Kurzweil's fruit flies lived for twenty years.

**Elon Musk:** That would be a truly astounding achievement. But yeah so, I mean it's a really tricky subject that's fraught with all sorts of moral issues, but that's the thing that would most affect people's lives. But I mean it certainly is a double-edged sword, so...

**Terry:** Here's another question – from a Tesla owner – why is there no coat hook in the back?

**Elon Musk:** Yeah.

**Terry:** He says you can design a rocket, but you forgot the coat hooks?

**Elon Musk:** Well I didn't actually forget it. I intentionally didn't like it so I didn't put it there. The aesthetics of it really bothered me. And I know some people obviously disagree with that decision. But I think we might have a retroactive fix for that, if someone has the panoramic roof, which is to basically have a hook on the bow section in the middle of the roof, and then the coat could hang down in the secondary passenger footwell, which is actually slightly better than having a coat hook which is stuck on the side of the car. So I think we'll probably do that. Yeah.

**Terry:** Wherever that question came from – hold on!

**Elon Musk:** It's not the first time I've heard that question.

**Terry:** I'm sure. Is there a future in hydrogen-fueled engines?

**Elon Musk:** Yeah, actually I'm going to share one little anecdote, which is in the beginning of my last production I also didn't have reading lights in the second row because I thought people were really going towards e-Books... Kindle and iPad and that kind of thing, so they have their own light; they don't need an actual light in the back. And then I was driving with one of my kids, and he was trying to read his book.

**Terry:** Daddy...

**Elon Musk:** Yeah, he said this is the stupidest car in the world. Alright, we'll put the light back in.

**Terry:** Hydrogen fuel engines. Do they have a future?

**Elon Musk:** You know, I don't think so. Hydrogen is a very difficult energy storage mechanism, and essentially the means of storing energy chemically, but if you want to do that there are way better materials than hydrogen. Like, I'd go with methane and propane way before hydrogen. In fact, the way they make the hydrogen is by taking methane and chopping the carbon atom off. So well like, that seems like a waste. Or they'll do electrolysis, which is even worth. So it is

a really energy-intensive – it's either you start mining hydrocarbons on a large scale or you're applying massive amounts of electricity to separate H<sub>2</sub>O. And sometimes they will say hydrogen is the most common element in the universe. Yes, but not on Earth, which is an important consideration. It's one of those things that it is the future, and it always will be.

**Terry:** And then there's the Hindenburg issue.

**Elon Musk:** Yeah, I mean in the case of the Hindenburg, my understanding is that the main issue was the paint on the outer surface, as opposed to the hydrogen itself, but hydrogen does combust extremely well. Hydrogen has... there is a good argument for hydrogen as a fuel in the upper stage of a rocket. Saturn V in the second or third stages had hydrogen. And particularly for the upper stage of a rocket, where you're not volumetrically constrained, or rather you're mass constrained while involometrically constrained. Hydrogen is good if you care about mass and terrible if you care about volume. And it's also horrible from a handling standpoint because it's a really tiny molecule and it goes all over the place.

**Terry:** You look at Apple after Steve Jobs and Microsoft after Bill Gates struggled to keep up the momentum. I wonder if you have thought about the future of your companies – Tesla and SpaceX – and I know you've talked about giving away a lot of your money.

**Elon Musk:** Yeah.

**Terry:** But then I know you've had some other thoughts about that and you looked at Ford and wondered if you wanted to... where are you at on that succession issue right now?

**Elon Musk:** Well, I don't know if... I'm not sure about the whole sort of family dynasty from a wealth standpoint thing. I mean, that seems to often work out worse than if the kid wasn't given a huge sum of money. I mean, unless they've actually demonstrated a higher belief to be a good steward of capital, then it's not going to work out, I believe, to give them a huge sum of money. Now, that said, I'm wavering a little on that because if you look at the example of Ford and GM like GM went bankrupt; Ford did not. Ford had the Ford family as a stabilizing influence. There could be some merit to having a family stabilizing influence, but maybe not necessarily complete control.

**Terry:** We're going to end with two questions on the Hyperloop, which has clearly aroused a lot of emotion in Los Angeles. And one is from UCLA Anderson. I know that Gene Block is here who runs UCLA, and they want to know: how do you envision the Hyperloop as an open source project to be run in traditional enterprise fashion which would make profits? Does that make sense?

**Elon Musk:** Yeah, I guess. I mean I think it's going to be quite difficult for someone to execute the Hyperloop, and the thing that will really matter is how good is that company at executing as opposed to the basic sort of ideas of the system. I don't think a company has to worry too much about creating value if they're really good at execution. And probably the best example of open source is Linux, and there are lots of companies that are quite valuable even though Linux is

open source.

**Terry:** And then the follow-up to that is from somebody else who wants to know: when will the Hyperloop potentially be ready, and can we get to Australia?

**Elon Musk:** That would be... I would not recommend it for going to Australia because Australia is really far. So, where something like the Hyperloop would work best if for distances that are maybe about five hundred miles, but probably not more than a thousand, and that's because if you compare it to an alternative, being supersonic air transport, in order to go really fast in a plane, you have to climb pretty high because the atmosphere is like molasses when you're going fast. So, therefore distances certainly under five hundred miles you spend all your time ascending and descending, and you don't really get an opportunity to spend time at cruise.

Something like the Hyperloop can compete really well in that arena because you almost instantly enter a low-pressure environment. So, the tube contains a low pressure environment, that's, you know, like the cruising altitude of – well it's like the very high altitude atmosphere basically. And so you don't have to spend any time ascending or descending, so there's no way – so it would be extremely difficult for a plane to be faster than the Hyperloop for distances under five hundred miles. Because of the ascend-descend thing. However, once you get to long distances, then the cost of the tube starts to become a big factor. And, so then I'd say it's probably the right move is to go to supersonic transport because then you're spending a large percentage of your time at cruise. And you could probably get there faster with a supersonic aircraft.

**Terry:** Interesting. So no kangaroos in the Hyperloop, and I know you have an insane schedule. I know that you have to go from here back to your office tonight.

**Elon Musk:** Yeah, I apologize for not being at my best. This has been – working most of last night – so...

**Terry:** We are deeply grateful you came and gave us some time. Thank you so much.