

## Elon Musk, Magicians of the 21st Century, Caltech Commencement Address, June, 2012

I'd like to thank you for leaving 'crazy person' out of your introduction. [Laughter].

I was trying to think what's the most useful thing that I can say to be useful to you in the future. And I thought, perhaps tell the story of how I sort of came to be here. How did these things happen? Maybe there are lessons there. I often find myself wondering, how did this happen.

When I was young, I didn't really know what I was going to do when I got older. People kept asking me. Eventually, I thought the idea of inventing things would be really cool. The reason I thought that was because I read a quote from Arthur C. Clark, 'A sufficiently advanced technology is indistinguishable from magic.' That's really true. If you go back say, 300 years, the things we take for granted today, you'd be burned at stake for. Being able to fly. That's crazy. Being able to see over long distance, being able to communicate, the Internet as a group mind of sorts, and having access to all the world's information instantly from anywhere on the earth. This really would be considered magic in times past.

In fact, I think it goes beyond that, there's many things we take for granted today that weren't even imagined in times past, so it goes beyond that. So I thought, If I can do some of those things -- if I can advance technology, that is like magic and that would be really cool.

I always had an existential crisis, trying to figure out 'what does it all mean?' I came to the conclusion that if we can advance the knowledge of the world, if we can expand the scope and scale of consciousness, then, we're better able to ask the right questions and become more enlightened. That's the only way to move forward.

So, I studied physics and business, because in order to do these things you need to know how the universe works and how the economy works and you also need to be able to bring people together to create something. It's very difficult to create something as individuals if it's a significant technology.

So, I came out to California to figure out how to improve the density of electric vehicles, if there's an advanced capacitor, to serve as an alternative to batteries. That was in 1995. That's when the Internet started to happen. I thought I could either pursue this technology, where success may not be one of the possible outcomes, which is always tricky, or participate in the Internet and be part of it. So, I decided to drop out. Fortunately, we're past graduation, so, cannot be accused of recommending that to you. [Laughter]. I did some Internet stuff, [Laughter] you know. I've done a few things here and there. One of which is PayPal.

Maybe it's helpful to say, one of the things important in the creation of PayPal was how it started. Initially, the goal with PayPal was create a conglomeration for financial services, so all financial services could be seamlessly integrated to work smoothly. And we had a little feature, e-mail payments. Whenever we'd show the system off, we'd show the hard part, the conglomeration of financial services, which is difficult to put together. Nobody was interested. Then we showed people e-mail payments, which was easy to put together, and everyone was interested. So, it's important to take feedback from your environment. You want to be as closed-loop as possible.

So, we focused on e-mail payments and tried to make that work. That's when really good things started to take off. But, if we hadn't responded to what people said, we probably would not have been successful. So, it's important to look for things like that and focus on that, and correct your prior assumptions.

Going from PayPal, I thought well, what are some of the other problems that are likely to most affect the future of humanity? Not from the perspective, 'what's the best way to make money,' which is okay, but, it was really 'what do I think is going to most affect the future of humanity.' The biggest terrestrial problem is sustainable energy. Production and consumption of energy in a sustainable manner. If we don't solve that in this century, we're in deep trouble. And the other thing I thought might affect humanity is the idea of making life multi-planetary.

The latter is the basis for SpaceX and the former is the basis for Tesla and SolarCity. When I started SpaceX, initially, I thought that well, there's no way one could start a rocket company. I wasn't that crazy. But, then, I thought, well, what is a way to increase NASA's budget? That was actually my initial goal. If we could do a low cost mission to Mars, Oasis, which would land with seeds in dehydrated nutrient gel, then hydrate them upon landing. We'd have a great photo of green plants with a red background [Laughter]. The public tends to respond to precedence and superlatives. This would be the first life on Mars and the furthest life had ever traveled.

That would get people excited and increase NASA's budget. But the financial outcome would be zero. Anything better would on the upside. So, I went to Russia three times to look at buying a refurbished ICBM... [Laughter] ...because that was the best deal. [Laughter] And I can tell you it was very weird going late 2001-2002 to Russia and saying 'I want to buy two of your biggest rockets, but you can keep the nukes.' [Laughter] The nukes are a lot more. That was 10 years ago.

They thought I was crazy, but, I did have money. [Laughter] So, that was okay. [Laughter] After making several trips to Russia, I came to the conclusion that, my initial impression was wrong about not enough will to explore and expand beyond earth and have a Mars base. That

was wrong. There's plenty of will, particularly in the United States. Because United States is the nation of explorers, people came here from other parts of the world. The United States is a distillation of the spirit of human exploration. If people think it's impossible and it's going to break the budget, they're not going to do it.

So, after my third trip, I said, okay, what we need to do already is try to solve the space transport problem and started SpaceX. This was against the advice of pretty much everyone I talked to. [Laughter]. One friend made me watch videos of rockets blowing up. [Laughter] He wasn't far wrong. It was tough going there in the beginning. I never built anything physical. I never had a company that built something physical. So, I had to bring together the right team of people. We did all that, then, failed three times. It was tough, tough going.

Think about a rocket, the passing grade is 100%. And you don't get to test the real environment that the rocket is going to be in. So, I think the best analogy for rocket engineers, if you want to create complicated software, you can't run as an integrate whole, or run on the computer it's intended to run on, but, first time you run it, it has to run with no bugs. That's the essence of it. So, we missed the mark there.

The first launch, I was picking up bits of rocket at the launch site. And we learned with each successive flight. And were able to, eventually in 2008, reach orbit. Also that was with the last bit of money we had. Thank goodness that happened. Fourth time is the charm? [Laughter].

So, we got the Falcon 1 to orbit. Then, began to scale it up to Falcon 9, with an order of magnitude more thrust, around a million pounds of thrust. We managed to get that to orbit, then developed the Dragon spacecraft, which recently docked to the space station and returned to earth.

[Applause] That was a white knuckle event. [Laughter]. It was a huge relief. I still can't believe it actually happened. Yet, there's more to happen for humanity to become a multi-planet species. It's vitally important. And I hope that some you have will participate in that at SpaceX or other companies. It's really one of the most important things for the preservation and extension of consciousness. It's worth noting that Earth has been around for 4 billion years, but civilization in terms of having writing is only about 10,000 years, and that's being generous.

So, it's really somewhat of a tenuous existence that civilization and consciousness has been on earth. I'm actually fairly optimistic about the future earth. I don't want to give the wrong impression like we're all about to die. [Laughter] I think things will be okay for a long time on earth. Not for sure, but, most likely. But even if it's 99% likely, a 1% chance is still worth the effort to back up the biosphere, and achieved planetary redundancy. [Laughter]. And I think it's really quite important.

And in order to do that, there's great things that is need to occur. Create a rapidly reusable transport system to Mars. It's something right on the borderline of impossible. But, that's the sort of the thing that we're going to try to achieve with SpaceX.

And then, on the Tesla front, the goal was to show what electric cars can do. We had to change people's perceptions. They used to think electric cars were slow and ugly, with low range, like a golf cart. So, we created Tesla Roadster, a vehicle to show that it's fast, attractive and long range. Even though you can show something on paper, and the calculations are clear, until you have physical object, it doesn't really sink in.

If you're going to create a company, you need to create a working prototype. Everything works great on PowerPoint. You can make anything work on PowerPoint. If you have a demonstration model, even in primitive form, that's much more effective in convincing people. So we made the Roadster, and now we're coming out with model S, a 4-door sedan. Some people said, 'sure you can make an expensive small volume car, but can you make a real car?' Okay, fine, we're going to make that, too. [Laughter] So, that's coming out.

And so that's where things are and hopefully, there are lessons to be drawn there.

I think the overreaching point I want to make is you guys are the magicians of the 21th century, don't let anything hold you back. Imagination is the limit. Go out there and create some magic.

Thank you.

[Applause].

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