

TEDTALK ANNOTATED VIDEO TRANSCRIPTS

Unit 1 BRIAN COX

Why We Need the Explorers

Part 1

We live in difficult and challenging economic times, of course. And one of the first **victims**¹ of difficult economic times, I think, is public spending of any kind, but certainly **in the firing line**² at the moment is public spending for science, and particularly curiosity-led science and exploration. So I want to try and convince you in about 15 minutes that that's a ridiculous and ludicrous thing to do.

[. . .] The first thing I want to say, and this is straight from **Wonders of the Solar System**³, is that our exploration of the solar system and the universe has shown us that it is indescribably beautiful. This is a picture that actually was sent back by the **Cassini space probe**⁴ around Saturn, after we'd finished filming *Wonders of the Solar System*. So it isn't in the series. It's of the moon Enceladus. So that big sweeping, white sphere in the corner is Saturn, which is actually in the background of the picture. And that crescent there is the moon Enceladus, which is about as big as the British Isles. It's about 500 kilometers in diameter. So, tiny moon. What's fascinating and beautiful . . . this an unprocessed picture, by the way, I should say, it's black and white, straight from Saturnian orbit.

What's beautiful is, you can probably see on the limb there some faint, sort of, wisps of almost smoke rising up from the

limb. This is how we **visualize**⁵ that in *Wonders of the Solar System*. It's a beautiful graphic. What we found out were that those faint wisps are actually fountains of ice rising up from the surface of this tiny moon. That's fascinating and beautiful in itself, but we think that the mechanism for powering those fountains requires there to be lakes of liquid water beneath the surface of this moon. And what's important about that is that, on our planet, on Earth, wherever we find liquid water, we find life. So, to find strong evidence of liquid, pools of liquid, beneath the surface of a moon 750 million miles away from the Earth is really quite astounding. So what we're saying, essentially, is maybe that's a habitat for life in the solar system. Well, let me just say, that was a graphic. I just want to show this picture. That's one more picture of Enceladus. This is when Cassini flew beneath Enceladus. So it made a very low pass, just a few hundred kilometers above the surface. And so this, again, a real picture of the ice fountains rising up into space, absolutely beautiful.

[. . .] Our exploration of the solar system has taught us that the solar system is beautiful. It may also have pointed the way to answering one of the most profound questions that you can possibly ask, which is: "**Are we alone in the universe?**"⁶ Is there any other use to exploration and science, other than just a sense of wonder? Well, there is. This is a very famous picture taken, actually, on my first

¹ Cox uses "victims" here to talk about budget cuts during hard economic times.

² Something that is "in the firing line" is being criticized or likely to be gotten rid of. The expression refers to a prisoner being executed by a squad of soldiers firing their guns.

³ *Wonders of the Solar System* is a TV series that Cox presented.

⁴ The Cassini space probe was sent to Saturn in 2004.

⁵ By "visualize," Cox is explaining that the image he is showing is a computer graphic made for his TV show.

⁶ The question "Are we alone in the universe?" is referring to the existence of alien life forms.

Christmas Eve, December 24th, 1968, when I was about eight months old. It was taken by **Apollo 8**⁷ as it went around the back of the moon. **Earthrise**⁸ from Apollo 8. A famous picture; many people have said that it's the picture that saved 1968, which was a turbulent year—the student riots in Paris, the height of the Vietnam War. The reason many people think that about this picture, and Al Gore has said it many times, actually, on the stage at TED, is that this picture, arguably, was the beginning of the environmental movement. Because, for the first time, we saw our world, not as a solid, immovable, kind of indestructible place, but as a very small, fragile-looking world just hanging against the blackness of space.

Part 2

What's also not often said about the space exploration, about the Apollo program, is the economic contribution it made. I mean, while you can make arguments that it was wonderful and a tremendous achievement and delivered pictures like this, it cost a lot, didn't it? Well, actually, many studies have been done about the economic effectiveness, the economic impact of Apollo. The biggest one was in 1975 by Chase Econometrics. And it showed that for every \$1 spent on Apollo, 14 came back into the U.S. economy. So the Apollo program **paid for itself**⁹ in inspiration, in engineering,

achievement and, I think, in inspiring young scientists and engineers 14 times over. So exploration can pay for itself.

What about scientific discovery? What about driving innovation? Well, this looks like a picture of virtually nothing. What it is, is a picture of the spectrum of hydrogen. See, back in the 1880s, 1890s, many scientists, many observers, looked at the light given off from atoms. And they saw strange pictures like this. What you're seeing when you put it through a prism is that you heat hydrogen up and it doesn't just glow like a white light, it just emits light at particular colors, a red one, a light blue one, some dark blue ones. Now that led to an understanding of atomic structure because the way that's explained is atoms are a single nucleus with electrons going around them. And the electrons can only be in particular places. And when they jump up to the next place they can be, and fall back down again, they emit light at particular colors.

And so the fact that atoms, when you heat them up, only emit light at very specific colors, was one of the key drivers that led to the development of the **quantum theory**¹⁰, the theory of the structure of atoms.

[. . .] Now, that sounds **esoteric**¹¹, and indeed it was an esoteric pursuit, but the quantum theory quickly led to an understanding of the behaviors of electrons in materials

⁷ Apollo 8 was a spacecraft that took three American astronauts into space in 1968. The craft orbited the moon and returned. It was the first to leave Earth's orbit with humans aboard.

⁸ "Earthrise" is the name of a photograph taken by an astronaut aboard Apollo 8. The image, which students can see in the video, shows the Earth rising above the moon's horizon.

⁹ Something that "pays for itself" creates either a direct or indirect income stream that helps reimburse its cost.

¹⁰ The "quantum theory" explains how molecules move and behave.

¹¹ Something that is "esoteric" is considered intellectual and often specialized in something that the average person knows nothing about.

like **silicon**¹², for example. The way that silicon behaves, the fact that you can build transistors, is a purely quantum phenomenon. So without that curiosity-driven understanding of the structure of atoms, which led to this rather esoteric theory, quantum mechanics, then we wouldn't have transistors, we wouldn't have silicon chips, we wouldn't have pretty much the basis of our modern economy.

[. . .] This is a beautiful quote that I found—we're talking about **serendipity**¹³ there—from **Alexander Fleming**¹⁴: "When I woke up just after dawn on September 28, 1928, I certainly didn't plan to revolutionize all medicine by discovering the world's first antibiotic." Now, the explorers of the world of the atom did not intend to invent the transistor. And they certainly didn't intend to describe the mechanics of supernova explosions, which eventually told us where the building blocks of life were synthesized in the universe. So, I think science can be—serendipity is important. It can be beautiful. It can reveal quite astonishing things. It can also, I think, finally

reveal the most profound ideas to us about our place in the universe and really the value of our home planet.

[. . .] The argument has always been made, and it will always be made, that we know enough about the universe. You could have made it in the 1920s; you wouldn't have had penicillin. You could have made it in the 1890s; you wouldn't have the transistor. And it's made today in these difficult economic times: *Surely, we know enough. We don't need to discover anything else about our universe.*

Let me leave the last words to someone who's rapidly becoming a hero of mine, **Humphrey Davy**¹⁵, who did his science at the turn of the 19th century. He was clearly under assault all the time. "We know enough at the turn of the 19th century. Just exploit it; just build things." He said this, he said, "Nothing is more fatal to the progress of the human mind than to presume that our views of science are ultimate, that our triumphs are complete, that there are no mysteries in nature, and that there are no new worlds to conquer."

This is an edited version of Cox's 2010 TED Talk. To watch the full talk, visit TED.com.

¹² The material "silicon" is used in semi-conductors, which means that modern electronics would not be possible without it.

¹³ "Serendipity" is the luck some people have in discovering something valuable by chance.

¹⁴ Alexander Fleming, a scientist from Scotland, invented penicillin by accident. He had gone on an extended holiday and not cleaned up his research area in his laboratory. When he returned, the mold that had formed would lead to his discovery of the first antibiotic for medicine.

¹⁵ Humphrey Davy was a well-known scientist and inventor in England in the 1700s. He was known for his work in electrolysis, as well as the discovery of elements, including calcium.

How to Learn? From Mistakes

Part 1

I have been teaching for a long time, and in doing so have acquired **a body of knowledge**¹ about kids and learning that I really wish more people would understand about the potential of students. In 1931, my grandmother—bottom left for **you guys over here**²—graduated from the eighth grade. She went to school to get the information because that's where the information lived. It was in the books; it was inside the teacher's head; and she needed to go there to get the information, because that's how you learned. **Fast-forward**³ a generation: This is the one-room schoolhouse, Oak Grove, where my father went to a one-room schoolhouse. And he again had to travel to the school to get the information from the teacher, stored it in the only portable memory he has, which is inside his own head, and take it with him, because that is how information was being transported from teacher to student and then used in the world. When I was a kid, we had a set of encyclopedias at my house. It was purchased the year I was born, and it was extraordinary, because I did not have to wait to go to the library to get to the information. The information was inside my house, and it was awesome. This was different than either generation had experienced before, and it changed the way I interacted with information even **at just a small level**⁴. But the information was closer to me. I could get access to it.

[. . .] Fast-forward to Pennsylvania, **where I find myself today**⁵. I teach at the **Science Leadership Academy**⁶, which is a partnership school between the Franklin Institute and the school district of Philadelphia. We are a **9 through 12**⁷ public school, but we do school quite differently. I moved there primarily to be part of a learning environment that validated the way that I knew that kids learned, and that really wanted to investigate what was possible when you are willing to let go of some of the paradigms of the past, of information scarcity when my grandmother was in school and when my father was in school and even when I was in school, and to a moment when we have information surplus. So what do you do when the information is all around you? Why do you have kids come to school if they no longer have to come there to get the information?

Part 2

In Philadelphia we have **a one-to-one laptop program**⁸, so the kids are bringing in laptops with them every day, taking them home, getting access to information. And here's the thing that you need to get comfortable with when you've given the tool to acquire information to students, is that you have to be comfortable with this idea of allowing kids to fail as part of the learning process. We deal right now in the **educational landscape**⁹ with an infatuation with the culture of one right

¹ Having “a body of” something refers to a large amount of it.

² When Laufenberg says “you guys over here,” she is addressing her audience directly, to explain where her grandmother is in the picture.

³ Laufenberg uses the term “fast-forward” a couple of times during her talk to explain the passage of time in her story.

⁴ A synonym for “at a small level” is “on a small scale.”

⁵ When Laufenberg says “where I find myself today,” she is referring to her workplace, the school she now works at, and not to the TED conference venue.

⁶ Students can find out more about her school at scienceleadershipacademy.org.

⁷ The expression “nine through 12” refers to the high school years. The four years of high school in the U.S. are ninth, tenth, 11th, and 12th grades.

⁸ A “one-on-one laptop program” means that every student in the school is given a laptop to use by the school.

⁹ The noun “landscape” is used here to describe the state of a particular subject. In this case, it's education.

answer that can be **properly bubbled**¹⁰ on the average multiple-choice test, and I am here to share with you: It is not learning. That is the absolute wrong thing to ask, to tell kids to never be wrong. To ask them to always have the right answer doesn't allow them to learn. So we did this project, and this is one of the artifacts of the project. I almost never show them off because of the issue of the idea of failure.

My students produced these infographics as a result of a unit that we decided to do at the end of the year responding to the oil spill. I asked them to take the examples that we were seeing of the infographics that existed in a lot of mass media, and take a look at what were the interesting components of it, and produce one for themselves of a different man-made disaster from American history. And they had certain criteria to do it. They were a little uncomfortable with it, because we'd never done this before, and they didn't know exactly how to do it. They can talk—they're very smooth, and they can write very, very well, but asking them to communicate ideas in a different way was a little uncomfortable for them. But I gave them the room to just do the thing. Go create. Go **figure it out**¹¹. Let's see what we can do. And the student that persistently turns out the best visual product did not disappoint. This was done in like two or three days. And this is the work of the student that consistently did it.

And when I sat the students down, I said, "Who's got the best one?" And they immediately went, "There it is." Didn't read anything. "There it is." And I said, "Well, what makes it great?" And they're like, "Oh, the design's good, and he's using good color. And there's some . . ." And they went through all that we processed out loud. And I said, "Go read it." And they're like, "Oh, that one wasn't so awesome." And then we went to another one—it didn't have great visuals, but it had great information—and spent an hour talking about the learning process, because it wasn't about whether or not it was perfect, or whether or not it was what I could create. It asked them to create for themselves, and it allowed them to fail, process, learn from. And when we do another round of this in my class this year, they will do better this time, because learning has to include an amount of failure, because failure is instructional in the process.

[. . .] The main point is that if we continue to look at education as if it's about coming to school to get the information and not about experiential learning, empowering student voice, and embracing failure, we're **missing the mark**¹². And everything that everybody is talking about today isn't possible if we keep having an educational system that does not value these qualities, because we won't get there with a standardized test, and we won't get there with a culture of one right answer. We know how to do this better, and it's time to do better.

This is an edited version of Laufenberg's 2010 TED Talk. To watch the full talk, visit TED.com.

¹⁰ "Properly bubbled" is used here to refer to students guessing the right answer with no real knowledge.

¹¹ To "figure something out" means to come to understand it or solve it.

¹² To "miss the mark" in a situation means to fail to achieve the intended result.

Why We Have Too Few Women Leaders

Part 1

So for any of us in this room today, let's start out by admitting we're lucky. We don't live in the world our mothers lived in, our grandmothers lived in, where career choices for women were so limited. And if you're in this room today, most of us grew up in a world where we had basic civil rights, and amazingly, we still live in a world where some women don't have them. But **all that aside**¹, we still have a problem, and it's a real problem. And the problem is this: Women are not making it to the top of any profession anywhere in the world. The numbers tell the story quite clearly. 190 heads of state—nine are women. Of all the people in parliament in the world, 13 percent are women. In the corporate sector, women at the top, **C-level jobs**², board seats—tops out at 15, 16 percent. The numbers have not moved since 2002 and are going in the wrong direction. And even in the non-profit world, a world we sometimes think of as being led by more women, women at the top: 20 percent.

We also have another problem, which is that women face harder choices between professional success and personal fulfillment. A recent study in the U.S. showed that, of married senior managers, two-thirds of the married men had children and only one-third of the married women had children.

[. . .] So the question is, how are we going to fix this? How do we change these numbers at the top? How do we make this different? I want to start out by saying, I talk about this—about keeping women in the workforce—because I really think that's the answer. In the high-income part of our

workforce, in the people who end up at the top—**Fortune 500**³ CEO jobs, or the equivalent in other industries—the problem, I am convinced, is that women are dropping out. Now people talk about this a lot, and they talk about things like **flextime**⁴ and mentoring and programs companies should have to train women. I want to talk about none of that today, even though that's all really important. Today, I want to focus on what we can do as individuals. What are the messages we need to tell ourselves? What are the messages we tell the women who work with and for us? What are the messages we tell our daughters?

Now, at the outset, I want to be very clear that this speech comes with no judgments. I don't have the right answer. I don't even have it for myself. I left San Francisco, where I live, on Monday, and I was getting on the plane for this conference. And my daughter, who's three, when I dropped her off at preschool, did that whole hugging-the-leg, crying, "Mommy, don't get on the plane" thing. This is hard. I feel guilty sometimes. I know no women, whether they're at home or whether they're in the workforce, who don't feel that sometimes. So I'm not saying that staying in the workforce is the right thing for everyone.

My talk today is about what the messages are if you do want to stay in the workforce, and I think there are three. One, sit at the table. Two, make your **partner**⁵ a real partner. And three, don't leave before you leave.

[. . .]

¹ The expression "all that aside" is used to say that what was previously said is not relevant for what will be said next.

² "C-level jobs" refers to those at the head of companies: CEO, CFO, COO, etc. The "C" stands for "Chief."

³ "Fortune 500" refers to a list of the top 500 companies in the world published yearly by Fortune magazine.

⁴ "Flexitime" is a system of flexible work hours that some companies offer.

⁵ Note that the term "partner" is used by Sandberg here to refer to marriage partner or life partner, not business partner.

Part 2

[W]omen systematically underestimate their own abilities. If you test men and women, and you ask them questions on totally objective criteria like **GPAs**⁶, men get it wrong slightly high, and women get it wrong slightly low. Women do not negotiate for themselves in the workforce. A study in the last two years of people entering the workforce out of college showed that 57 percent of boys entering, or men, I guess, are negotiating their first salary, and only seven percent of women. And most importantly, men attribute their success to themselves, and women attribute it to other external factors. If you ask men why they did a good job, they'll say, "I'm awesome. Obviously. Why are you even asking?" If you ask women why they did a good job, what they'll say is someone helped them, they got lucky, they worked really hard. Why does this matter? Boy, it matters a lot because no one gets to **the corner office**⁷ by sitting on the side, not at the table, and no one gets the promotion if they don't think they deserve their success, or they don't even understand their own success.

I wish the answer were easy. I wish I could just go tell all the young women I work for, all these fabulous women, "Believe in yourself and negotiate for yourself. **Own your own success**⁸." I wish I could tell that to my daughter. But it's not that simple. Because what the data shows, above all else, is one thing, which is that success and likeability are positively correlated for men and negatively correlated for women. And everyone's nodding, because we all know this to be true.

There's a really good study that shows this really well. There's a famous Harvard Business School study on a woman named Heidi Roizen. And she's an operator in a company in **Silicon Valley**⁹, and she uses her contacts to become a very successful **venture capitalist**¹⁰. In 2002—not so long ago—a professor who was then at Columbia University took that case and made it [Howard] Roizen. And he gave the case out, both of them, to two groups of students. He changed exactly one word: *Heidi* to *Howard*. But that one word made a really big difference. He then surveyed the students, and the good news was the students, both men and women, thought Heidi and Howard were equally competent, and that's good. The bad news was that everyone liked Howard. He's a great guy. You want to work for him. You want to spend the day fishing with him. But Heidi? Not so sure. She's a little **out for herself**¹¹. She's a little political. You're not sure you'd want to work for her. This is the complication. We have to tell our daughters and our colleagues, we have to tell ourselves to believe we got the A, to reach for the promotion, to sit at the table, and we have to do it in a world where, for them, there are sacrifices they will make for that, even though for their brothers, there are not.

The saddest thing about all of this is that it's really hard to remember this. And I'm about to tell a story which is truly embarrassing for me, but I think important. I gave this talk at Facebook not so long ago to about 100 employees, and a couple hours later, there was a young woman who works there sitting outside my little desk, and she wanted to talk to

⁶ "GPA" refers to grade-point average, a score that measures overall educational success in school based on the average grades received in all classes.

⁷ The expression "the corner office" refers to a position of success. Traditionally, the head of a company usually has the large corner office with a view.

⁸ When you "own something" that you did, it means you take accountability for it and say you are responsible.

⁹ Silicon Valley is an area in California where many major technology companies have their offices.

¹⁰ A "venture capitalist" invests in companies, often new ones.

¹¹ Someone who is "out for themselves" is selfishly motivated.

me. I said, OK, and she sat down, and we talked. And she said, “I learned something today. I learned that I need to keep my hand up.” I said, “What do you mean?” She said, “Well, you’re giving this talk, and you said you were going to take two more questions. And I had my hand up with lots of other people, and you took two more questions. And I put my hand down, and I noticed all the women put their hand down, and then you took more questions, only from the men.” And I thought to myself, wow, if it’s me—who cares about this, obviously—giving this talk—and during this talk, I can’t even notice that the men’s hands are still raised, and the women’s hands are still raised, how good are we as managers of our companies and our organizations at seeing that the men are reaching for opportunities more than women? We’ve got to get women to sit at the table.

[. . .] My generation really, sadly, is not going to change the numbers at the top. They’re just not moving. We are not going to get to where 50 percent of the population—in my generation, there will not be 50 percent of [women] at the top of any industry. But I’m hopeful that future generations can. I think a world that was run where half of our countries and half of our companies were run by women, would be a better world. And it’s not just because people would know where the women’s bathrooms are, even though that would be very helpful. I think it would be a better world. I have two children. I have a five-year-old son and a two-year-old daughter. I want my son to have a choice to contribute fully in the workforce or at home, and I want my daughter to have the choice to not just succeed, but to be liked for her accomplishments.

This is an edited version of Sandberg’s 2010 TED Talk. To watch the full talk, visit TED.com.

Unit 4 J.J. ABRAMS

The Mystery Box

Part 1

[. . .] Why do I do so much stuff that involves mystery? And I started trying to figure it out. And I started thinking about why do I do any of what I do, and I started thinking about my grandfather. I loved my grandfather. Harry Kelvin was his name, my mother's father. He died in 1986. He was an amazing guy. And one of the reasons he was amazing: After World War II, he began an electronics company. He started selling surplus parts, kits, to schools and stuff. So he had this incredible curiosity. As a kid, I saw him come over to me with radios and telephones and all sorts of things. And he'd open them up, he'd unscrew them, and reveal the inner workings—which many of us, I'm sure, **take for granted**¹. But it's an amazing gift to give a kid. To open up this thing and show how it works and why it works and what it is. He was the ultimate deconstructor, in many ways.

[. . .] He sort of **humored**² my obsession to other things, too, like magic. The thing is, we'd go to this magic store in New York City called Lou Tannen's Magic. It was this great magic store. It was a **crappy**³ little building in **Midtown**⁴, but you'd be in the elevator, the elevator would open—there'd be this little, small magic store. You'd be in the magic store. And it was just, it was a magical place. So I got all these sort of magic tricks. Oh, here. I'll show you. This is the kind of thing. So it would be like, you know. Right? Which is good, but now I can't move. Now, I have to do this, the rest of the thing, like this. I'm like, "Oh, wow. Look at my computer over there!"

Anyway, so one of the things that I bought at the magic store was this: Tannen's Mystery Magic Box. The **premise**⁵ behind the mystery magic box was the following: 15 dollars buys you 50 dollars worth of magic. Which is a savings. Now, I bought this decades ago and I'm not kidding. If you look at this, you'll see it's never been opened. But I've had this forever. Now, I was looking at this, it was in my office, as it always is, on the shelf, and I was thinking, why have I not opened this? And why have I kept it? Because I'm not a **pack rat**⁶. I don't keep everything, but for some reason I haven't opened this box. And I felt like there was a key to this, somehow, in talking about something at TED that I haven't discussed before, and bored people elsewhere. So I thought, maybe there's something with this. I started thinking about it. And there was this giant question mark. I love the design, for what it's worth, of this thing. And I started thinking, why haven't I opened it? And I realized that I haven't opened it because it represents something important—to me. It represents my grandfather. Am I allowed to cry at TED? Because—no, I'm not going to cry. But—the thing is, that it represents infinite possibility. It represents hope. It represents potential. And what I love about this box, and what I realize I sort of do in whatever it is that I do, is I find myself drawn to infinite possibility, that sense of potential. And I realize that mystery is the catalyst for imagination. Now, it's not the most **groundbreaking**⁷ idea, but when I started to think that maybe there are times when mystery is more important than knowledge, I started getting interested in this.

¹ When we "take something for granted" we don't fully appreciate it.

² To "humor" someone means to go along with what someone wants even if you don't agree.

³ The adjective "crappy" is a colloquial term used to describe something of poor quality.

⁴ "Midtown" refers to an area of Manhattan in New York City.

⁵ A "premise" is a fundamental idea that shapes something.

⁶ A "pack rat" is a person who saves everything, including things that are no longer useful.

⁷ Something that is "groundbreaking" is innovative and new.

[. . .] What's a bigger mystery box than a movie theater? You know? You go to the theater, you're just so excited to see anything. The moment the lights go down is often the best part, you know? And you're full of that amazing—that feeling of excited anticipation. And often, the movie's, like, there and it's going, and then something happens and you go, "Oh—" and then something else, and you're, "Mmm . . ." Now, when it's a great movie, you're along for the ride 'cause you're willing to give yourself to it.

Part 2

[. . .] This is something online; I don't know if you've seen it before. Six years ago, they did this. This is an online thing done by guys who had some visual effects experience. But the point was that they were doing things that were using these mystery boxes that they had—everyone has now. What I've realized is what my grandfather did for me when I was a kid, everyone has access to now. You don't need to have my grandfather, though you wished you had. But I have to tell you—this is a guy doing stuff on a **Quadra 950 computer**⁸—the resolution's a little bit low—using **Infinity software**⁹ they stopped making 15 years ago. He's doing stuff that looks as amazing as stuff I've seen released from Hollywood.

The most incredible sort of mystery, I think, is now the question of what comes next. Because it is now **democratized**¹⁰. So now, the creation of media is—it's everywhere. The stuff that I was lucky and begging for to get when I was a kid is now ubiquitous. And so, there's an

amazing sense of opportunity out there. And when I think of the filmmakers who exist out there now who would have been silenced, you know—who have been silenced in the past—it's a very exciting thing.

I used to say in classes and lectures and stuff, to someone who wants to write, "Go! Write! Do your thing." It's free, you know, you don't need permission to go write. But now I can say, "Go make your movie!" There's nothing stopping you from going out there and getting the technology. You can lease, rent, buy stuff off the shelf that is either as good, or just as good, as the stuff that's being used by the, you know, **quote unquote**¹¹ "legit people." No community is best served when only the elite have control. And I feel like this is an amazing opportunity to see what else is out there.

Part 3

When I did *Mission: Impossible III*, we had amazing visual effects stuff. **ILM**¹² did the effects; it was incredible. And sort of like my dream to be involved. And there are a couple of sequences in the movie, like these couple of moments I'll show you. There's that.

OK, obviously I have an obsession with big crazy explosions. So my favorite visual effect in the movie is the one I'm about to show you. And it's a scene in which **Tom's**¹³ character wakes up. He's drowsy. He's crazy—out of it. And the guy wakes up, and he shoves this gun in his nose and shoots this little capsule into his brain that he's going to use later to kill him, as bad guys do.

⁸ The "Quadra 950 computer" refers to an early Apple computer that was discontinued in the mid-1990s.

⁹ "Infinity software" refers to an outdated software program.

¹⁰ Something that is "democratized" is available to everyone.

¹¹ The expression "quote unquote" is a spoken phrase which refers to putting quotation marks before and after the next word that you say. This is usually done to indicate that the words are not something that the speaker would agree with.

¹² ILM is the special effects company, Industrial Light & Magic.

¹³ Abrams is referring to actor Tom Cruise who starred in *Mission: Impossible III*.

Bad Guy: Good morning.

OK, now. When we shot that scene, we were there doing it, the actor who had the gun, an English actor, Eddie Marsan—sweetheart, great guy—he kept taking the gun and putting it into Tom’s nose, and it was hurting Tom’s nose. And I learned this very early on in my career: Don’t hurt Tom’s nose. There are three things you don’t want to do. Number two is: Don’t hurt Tom’s nose. So Eddie has this gun—and he’s the greatest guy—he’s this really sweet English guy. He’s like, “Sorry, I don’t want to hurt you.” I’m like—you gotta—we have to make this look good. And I realized that we had to do something ‘cause it wasn’t working just as it was. And I literally, like, thought back to what I would have done using the **Super 8 camera**¹⁴ that my grandfather got me sitting in

that room, and I realized that hand didn’t have to be Eddie Marsan’s. It could be Tom’s. And Tom would know just how hard to push the gun. He wouldn’t hurt himself.

So we took his hand and we painted it to look a little bit more like Eddie’s. We put it in Eddie’s sleeve, and so the hand that you see—I’ll show you again, that’s not Eddie’s hand, that’s Tom’s. So Tom is playing two roles. And he didn’t ask for any more money. So here, here. Watch it again. There he is. He’s waking up. He’s drowsy, been through a lot. Tom’s hand. Tom’s hand. Tom’s hand. Anyway. So. Thanks. So you don’t need the greatest technology to do things that can work in movies. And the mystery box, in honor of my grandfather, stays closed. Thank you.

*This is an edited version of Abrams’ 2007 TED Talk.
To watch the full talk, visit TED.com.*

¹⁴ The “Super 8 camera” was a popular home motion picture camera in the 1960s and 1970s using 8mm format. Abrams wrote and directed a film called *Super 8*.

The Good News on Poverty (Yes, There's Good News)

Part 1

[. . .] So I thought, forget the rock opera, forget the bombast, my usual tricks. The only thing singing today would be the facts, for I have truly embraced my inner nerd.

So exit the rock star. Enter the evidence-based activist, the factivist.

Because what the facts are telling us is that the long, slow journey, humanity's long, slow journey of equality, is actually speeding up. Look at what's been achieved. Look at the pictures these data sets print. Since the year 2000, since the turn of the millennium, there are eight million more AIDS patients getting life-saving antiretroviral drugs. Malaria: There are eight countries in sub-Saharan Africa that have their death rates cut by 75 percent. For kids under five, child mortality, kids under five, it's down by 2.65 million a year. That's a rate of 7,256 children's lives saved each day. Wow. Wow.

Let's just stop for a second, actually, and think about that. Have you read anything anywhere in the last week that is remotely as important as that number? Wow. Great news. It drives me nuts that most people don't seem to know this news. Seven thousand kids a day. Here's two of them. This is Michael and Benedicta, and they're alive thanks in large part to **Dr. Patricia Asamoah**¹—she's amazing—and **the Global Fund**², which all of you financially support, whether you know it or not. And the Global Fund provides antiretroviral

drugs that stop mothers from passing HIV to their kids. This fantastic news didn't happen by itself. It was fought for, it was campaigned for, it was innovated for. And this great news gives birth to even more great news, because the historic trend is this. The number of people living in back-breaking, **soul-crushing**³ extreme poverty has declined from 43 percent of the world's population in 1990 to 33 percent by 2000 and then to 21 percent by 2010. **Give it up**⁴ for that. Halved. Halved.

Now, the rate is still too high—still too many people unnecessarily losing their lives. There's still work to do. But it's heart-stopping. It's **mind-blowing**⁵ stuff. And if you live on less than \$1.25 a day, if you live in that kind of poverty, this is not just data. This is everything. If you're a parent who wants the best for your kids—and I am—this rapid transition is a route out of despair and into hope. And guess what! If the trajectory continues, look where the amount of people living on \$1.25 a day gets to by 2030. Can't be true, can it? That's what the data is telling us. If the trajectory continues, we get to, wow, the zero zone.

[. . .]

Part 2

So why aren't we jumping up and down about this? Well, the opportunity is real, but so is the jeopardy. We can't get this done until we really accept that we can get this done. Look at

¹ Dr. Patricia Nkansah-Asamoah is a Ghanaian doctor and activist known for her work with HIV-positive mothers in Accra. She is involved with Bono's organization ONE.

² The Global Fund invests millions of dollars every year in programs that aim to solve problems caused by malaria, tuberculosis, and AIDS. Learn more at globalfund.org.

³ Something that is "soul-crushing" makes you feel that there is no hope.

⁴ The expression "give it up" is used to encourage an audience to applaud.

⁵ Something that is "mind-blowing" is amazing.

this graph. It's called inertia. It's how we **screw it up**⁶. And the next one is really beautiful. It's called momentum. And it's how we can **bend the arc of history**⁷ down towards zero, just doing the things that we know work.

So inertia versus momentum. There is jeopardy, and of course, the closer you get, it gets harder. We know the obstacles that are in our way right now, in difficult times. In fact, today in your capital, in difficult times, **some who mind the nation's purse**⁸ want to cut life-saving programs like the Global Fund. But you can do something about that. You can tell politicians that these cuts [can cost] lives.

Right now today, in Oslo as it happens, oil companies are fighting to keep secret their payments to governments for extracting oil in developing countries. You can do something about that, too. You can join the One Campaign, and leaders like **Mo Ibrahim**⁹, the telecom entrepreneur. We're pushing for laws that make sure that at least some of the wealth under the ground ends up in the hands of the people living above it.

And right now, we know that the biggest disease of all is not a disease. It's corruption. But there's a vaccine for that, too. It's called transparency, open data sets, something the TED community is really on it. Daylight, you could call it, transparency. And technology is really **turbocharging**¹⁰ this. It's getting harder to hide if you're doing bad stuff.

So let me tell you about the U-report, which I'm really excited about. It's 150,000 **millennials**¹¹ all across Uganda, young

people armed with 2G phones, an SMS social network exposing government corruption and demanding to know what's in the budget and how their money is being spent. This is exciting stuff.

Look, once you have these tools, you can't not use them. Once you have this knowledge, you can't un-know it. You can't delete this data from your brain, but you can delete the clichéd image of supplicant, impoverished peoples not taking control of their own lives. You can erase that, you really can, because it's not true anymore.

It's transformational. 2030? By 2030, robots, not just serving us Guinness, but drinking it. By the time we get there, every place with a rough semblance of governance might actually be on their way.

So I'm here to—I guess we're here to try and infect you with this virtuous, data-based virus, the one we call factivism. It's not going to kill you. In fact, it could save countless lives. I guess we in the One Campaign would love you to be contagious, spread it, share it, pass it on. By doing so, you will join us and countless others in what I truly believe is the greatest adventure ever taken, the ever-demanding journey of equality.

[. . .]

*This is an edited version of Bono's 2013 TED Talk.
To watch the full talk, visit TED.com.*

⁶ To “screw something up” means to ruin the chance for success.

⁷ An event or happening that “bends the arc of history,” has a far-reaching effect that changes the course of the human race.

⁸ To “mind a purse” means to be in control of the money. In this case, Bono is referring to federal budgets.

⁹ Mo Ibrahim gained financial success as a telecom entrepreneur, and then set up the Mo Ibrahim Foundation to encourage more responsibility in governments in Africa.

¹⁰ A synonym for “turbocharge” is “accelerate.”

¹¹ The term “millennials” is usually considered to apply to individuals who reached adulthood around the turn of the 21st century.

Ancient Wonders Captured in 3-D

Part 1

I'd like to start with a short story. It's about a little boy whose father was a history buff and who used to **take him by the hand**¹ to visit the ruins of an ancient metropolis on the outskirts of their camp. They would always stop by to visit these huge winged bulls that used to guard the gates of that ancient metropolis, and the boy used to be scared of these winged bulls, but at the same time they excited him. And the dad used to use those bulls to tell the boy stories about that civilization and their work.

Let's **fast-forward**² to the San Francisco Bay Area many decades later, where I started a technology company that brought the world its first 3D laser scanning system. Let me show you how it works.

[Video] *Female Voice: Long-range laser scanning works by sending out a pulse that's a laser beam of light. The system measures the beam's time of flight, recording the time it takes for the light to hit a surface and make its return. With two mirrors, the scanner calculates the beam's horizontal and vertical angles, giving accurate x, y, and z coordinates. The point is then recorded into a 3D visualization program. All of this happens in seconds.*

You can see here, these systems are extremely fast. They collect millions of points at a time with very high accuracy and very high resolution. A **surveyor**³ with traditional survey tools would **be hard-pressed to**⁴ produce maybe 500 points

in a whole day. These **babies**⁵ would be producing something like ten thousand points a second. So, as you can imagine, this was a **paradigm shift**⁶ in the survey and construction as well as in reality-capture industry.

Approximately ten years ago, my wife and I started a foundation to do good, and right about that time, the magnificent Bamiyan Buddhas, hundred and eighty foot tall in Afghanistan, were blown up by the Taliban. They were gone in an instant. And unfortunately, there was no detailed documentation of these Buddhas. This clearly devastated me, and I couldn't help but wonder about the fate of my old friends, the winged bulls, and the fate of the many, many heritage sites all over the world. Both my wife and I were so touched by this that we decided to expand the mission of our foundation to include digital heritage preservation of world sites. We called the project CyArk, which stands for Cyber Archive.

Part 2

To date⁷, with the help of a global network of partners, we've completed close to fifty projects. Let me show you some of them: Chichen Itza, Rapa Nui—and what you're seeing here are the cloud of points—Babylon, Rosslyn Chapel, Pompeii, and our latest project, Mt. Rushmore, which happened to be one of our most challenging projects. As you see here, we had to develop a special rig to bring the scanner up close and personal. The results of our work in the field are used to

¹ When you “take someone by the hand” you hold their hand and lead them.

² Students also heard TED speaker Diana Laufenberg use the term “fast-forward” to move a story ahead in Unit 2.

³ A “surveyor” has the job of measuring three-dimensional points between distances. It is a common job in the construction industry.

⁴ When someone “is hard-pressed” to do something, that person is going to face difficulties accomplishing it, likely because of not having enough time or money.

⁵ The term “baby” is used colloquially sometimes to refer to machines, especially impressive ones.

⁶ A “paradigm shift” completely changes the way something has been done up until that point.

⁷ The phrase “to date” means “up until the present time.”

produce media and **deliverables**⁸ to be used by conservators and researchers. We also produce media for dissemination to the public—free through the CyArk website. These would be used for education, cultural tourism, etc.

What you're looking at in here is a 3D viewer that we developed that would allow the display and manipulation of [the] cloud of points in real time, cutting sections through them and extracting dimensions. This happens to be the cloud of points for **Tikal**⁹. In here you see a traditional 2D architectural engineering drawing that's used for preservation, and of course we tell the stories through fly-throughs. And here, this is a **fly-through**¹⁰ the cloud of points of Tikal, and here you see it rendered and photo-textured with the photography that we take of the site. And so this is not a video. This is actual 3D points with two- to three-millimeter accuracy. And of course the data can be used to develop 3D models that are very accurate and very detailed. And here you're looking at a model that's extracted from the cloud of points for Stirling Castle. It's used for studies, for visualization, as well as for education.

And finally, we produce mobile apps that include narrated virtual tools. The more I got involved in the heritage field, the more it became clear to me that we are losing the sites and the stories faster than we can physically preserve them. Of course, earthquakes and all the natural phenomena—floods,

tornadoes, etc.—**take their toll**¹¹. However, what occurred to me was human-caused destruction, which was not only causing a significant portion of the destruction, but actually it was accelerating. This includes arson, urban sprawl, acid rain, not to mention terrorism and wars. It was getting more and more apparent that we're **fighting a losing battle**¹². We're losing our sites and the stories, and basically we're losing a piece—and a significant piece—of our collective memory. Imagine us as a human race not knowing where we came from.

[. . .] Let me close with another short story. Two years ago, we were approached by a partner of ours to digitally preserve an important heritage site, a UNESCO heritage site in Uganda, the Royal Kasubi Tombs. The work was done successfully in the field, and the data was archived and publicly disseminated through the CyArk website. Last March, we received very sad news. The Royal Tombs had been destroyed by suspected arson. A few days later, we received a call: "Is the data available and can it be used for reconstruction?" Our answer, of course, was yes.

Let me leave you with a final thought. Our heritage is much more than our collective memory—it's our collective treasure. We owe it to our children, our grandchildren, and the generations we will never meet to keep it safe and to pass it along. Thank you.

This is an edited version of Kacyra's 2011 TED Talk. To watch the full talk, visit TED.com.

⁸ A "deliverable" is a general term used to describe a product to be provided.

⁹ Tikal is a Mayan ruin in Guatemala.

¹⁰ A "fly-through" usually refers to a computer simulated experience that lets you view a site from above, as though you are flying through it.

¹¹ When something "takes its toll," it means that it creates a negative impact.

¹² The expression "fighting a losing battle" is used when it seems that success is impossible because the obstacles to overcome are too strong or too many.

How Food Shapes Our Cities

Part 1

How do you feed a city? It's one of the great questions of our time. Yet it's one that's rarely asked. We **take it for granted**¹ that if we go into a shop or restaurant, or indeed into this theater's foyer in about an hour's time, there is going to be food there waiting for us, having magically come from somewhere.

But when you think that every day for a city the size of London, enough food has to be produced, transported, bought and sold, cooked, eaten, disposed of, and that something similar has to happen every day for every city on Earth, it's remarkable that cities get fed at all.

We live in places like this as if they're the most natural things in the world, forgetting that because we're animals and that we need to eat, we're actually as dependent on the natural world as our ancient ancestors were. And as more of us move into cities, more of that natural world is being transformed into extraordinary landscapes like the one behind me—it's soybean fields in Mato Grosso in Brazil—in order to feed us. These are extraordinary landscapes, but few of us ever get to see them.

And increasingly, these landscapes are not just feeding us either. As more of us move into cities, more of us are eating meat, so that a third of the annual grain crop globally now gets fed to animals rather than to us human animals. And given that it takes three times as much grain—**actually ten times as much grain**²—to feed a human if it's passed through an animal first, that's not a very efficient way of feeding us.

And it's an **escalating problem**³, too. By 2050, it's estimated that twice the number of us are going to be living in cities. And it's also estimated that there is going to be twice as much meat and dairy consumed. So meat and urbanism are rising hand in hand. And that's going to pose an enormous problem. Six billion hungry carnivores to feed, by 2050. That's a big problem. And actually if we carry on as we are, it's a problem we're very unlikely to be able to solve.

Nineteen million hectares of rain forest are lost every year to create new arable land. Although at the same time we're losing an equivalent amount of existing arables to **salinization**⁴ and erosion. We're very hungry for fossil fuels, too. It takes about 10 calories to produce every calorie of food that we consume in the West. And even though there is food that we are producing at great cost, we don't actually value it. Half the food produced in the U.S.A. is currently thrown away. And to end all of this, at the end of this long process, we're not even managing to feed the planet properly. A billion of us are obese, while a further billion starve. None of it makes very much sense.

And when you think that 80 percent of global trade in food now is controlled by just five multinational corporations, it's a **grim picture**⁵. As we're moving into cities, the world is also embracing a Western diet. And if we look to the future, it's an unsustainable diet. [. . .]

Part 2

Here we have food—that used to be the center, the social core of the city—at the periphery. It used to be a social event, buying and selling food. Now it's anonymous. We used to cook; now we just add water, or a little bit of an egg if you're making a cake or something. We don't smell food to see if it's OK to eat. We just read the back of a label on a packet. And we don't value food. We don't trust it. So instead of trusting it, we fear it. And instead of valuing it, we throw it away.

One of the great ironies of modern food systems is that they've made the very thing they promised to make easier much harder. By making it possible to build cities anywhere and any place, they've actually distanced us from our most important relationship, which is that of us and nature. And also they've made us dependent on systems that only they can deliver, that, as we've seen, are unsustainable.

So what are we going to do about that? It's not a new question. 500 years ago, it's what Thomas More was asking himself. This is the frontispiece of his book **Utopia**⁶. And it

¹ When we "take something for granted," we don't appreciate it at the time. J.J. Abrams also used this expression in his TED talk.

² Students should note that Steel corrects her statistic here. She first mistakenly says "three times."

³ An "escalating problem" is one that is getting worse and worse.

⁴ The process of salinization involves putting salt into something, usually water.

⁵ A "grim picture" is a very negative situation.

⁶ Thomas Moore's book *Utopia* was the first time the word "utopia" was used. It is now a common word for talking about an ideal place.

was a series of semi-independent city-states, if that sounds remotely familiar, a day's walk from one another where everyone was basically farming-mad, and grew vegetables in their back gardens, and ate communal meals together, and so on. And I think you could argue that food is a fundamental ordering principle of Utopia, even though More never framed it that way.

[. . .] *Utopia* was actually a word that Thomas More used deliberately. It was a kind of joke, because it's got a double derivation from the Greek. It can either mean a good place, or no place. Because it's an ideal. It's an imaginary thing. We can't have it. And I think, as a conceptual tool for thinking about the very deep problem of human dwelling, that makes it not much use. So I've come up with an alternative, which is *Sitopia*, from the ancient Greek, "sitos" for food, and "topos" for place.

I believe we already live in *Sitopia*. We live in a world shaped by food, and if we realize that, we can use food as a really powerful tool—a conceptual tool, design tool, to shape the world differently. So if we were to do that, what might *Sitopia* look like? Well, I think it looks a bit like this. I have to use this slide. It's just the look on the face of the dog. But anyway, this is—it's food at the center of life, at the center of family life, being celebrated, being enjoyed, people taking time for it. This is where food should be in our society.

But you can't have scenes like this unless you have people like this. By the way, these can be men as well. It's people who think about food, who think ahead, who plan, who can stare at a pile of raw vegetables and actually recognize them. We need these people. We're part of a network. Because without these kinds of people, we can't have places like this. Here, I deliberately chose this because it is a man buying a vegetable. But networks, markets where food is being grown locally. It's common. It's fresh. It's part of the social life of the city. Because without that, you can't have this kind of place, food that is grown locally and also is part of the landscape,

and is not just a **zero-sum commodity**⁷ off in some unseen **hell-hole**⁸. Cows with a view. Steaming piles of humus. This is basically bringing the whole thing together.

And this is a community project I visited recently in Toronto. It's a greenhouse, where kids get told all about food and growing their own food. Here is a plant called Kevin, or maybe it's a plant belonging to a kid called Kevin. I don't know. But anyway, these kinds of projects that are trying to reconnect us with nature is extremely important.

So *Sitopia*, for me, is really a way of seeing. It's basically recognizing that *Sitopia* already exists in **little pockets**⁹ everywhere. The trick is to join them up, to use food as a way of seeing. And if we do that, we're going to stop seeing cities as big, metropolitan, unproductive blobs, like this. We're going to see them more like this, as part of the productive, organic framework of which they are inevitably a part, symbiotically connected. But of course, that's not a great image either, because we need not to be producing food like this anymore. We need to be thinking more about permaculture, which is why I think this image just sums up for me the kind of thinking we need to be doing. It's a re-conceptualization of the way food shapes our lives.

The best image I know of this is from 650 years ago. It's **Ambrogio Lorenzetti's**¹⁰ "Allegory of Good Government." It's about the relationship between the city and the countryside. And I think the message of this is very clear. If the city looks after the country, the country will look after the city. And I want us to ask now, what would Ambrogio Lorenzetti paint if he painted this image today? What would an allegory of good government look like today? Because I think it's an urgent question. It's one we have to ask and we have to start answering. We know we are what we eat. We need to realize that the world is also what we eat. But if we take that idea, we can use food as a really powerful tool to shape the world better. Thank you very much.

*This is an edited version of Steel's 2009 TED Talk.
To watch the full talk, visit TED.com.*

⁷ Something that is a "zero-sum commodity" is one that one group gains while another one loses. Steel believes modern food production makes food a zero-sum commodity that humans gain from while the planet's environment loses.

⁸ A "hell-hole" is a terrible place.

⁹ The term "little pockets" is used here to describe small areas where certain things are happening.

¹⁰ Ambrogio Lorenzetti was an Italian painter who lived in the 1300s.

What Will Future Jobs Look Like?

Part 1

The writer **George Eliot**¹ cautioned us that, among all forms of mistake, prophecy is the most gratuitous. The person that we would all acknowledge as her 20th-century counterpart, **Yogi Berra**², agreed. He said, “It’s tough to make predictions, especially about the future.”

I’m going to ignore their cautions and make one very specific forecast. In the world that we are creating very quickly, we’re going to see more and more things that look like science fiction, and fewer and fewer things that look like jobs. Our cars are very quickly going to start driving themselves, which means we’re going to need fewer truck drivers. We’re going to hook Siri up to Watson and use that to automate a lot of the work that’s currently done by customer service reps and troubleshooters and diagnosers, and we’re already taking **R2D2**³, painting him orange, and putting him to work carrying shelves around warehouses, which means we need a lot fewer people to be walking up and down those aisles.

Now, for about 200 years, people have been saying exactly what I’m telling you—the age of technological unemployment is at hand—starting with the Luddites smashing looms in Britain just about two centuries ago, and they have been wrong. Our economies in the developed world have **coasted along**⁴ on something pretty close to full employment.

Which brings up a critical question: Why is this time different, if it really is? The reason it’s different is that, just in the past few years, our machines have started demonstrating skills they have never, ever had before: understanding, speaking, hearing, seeing, answering, writing, and they’re still acquiring new skills. For example, mobile humanoid robots are still incredibly primitive, but the **research arm**⁵ of the Defense Department

just launched a competition to have them do things like this, and if the track record is any guide, this competition is going to be successful. So when I look around, I think the day is not too far off at all when we’re going to have androids doing a lot of the work that we are doing right now. And we’re creating a world where there is going to be more and more technology and fewer and fewer jobs. It’s a world that **Erik Brynjolfsson**⁶ and I are calling “the new machine age.” The thing to keep in mind is that this is absolutely great news.

Part 2

[. . .] We are seeing an amazing flourishing taking place. In a world where it is just about as easy to generate an object as it is to print a document, we have amazing new possibilities.

The people who used to be craftsmen and hobbyists are now makers, and they’re responsible for massive amounts of innovation. And artists who were formerly constrained can now do things that were never, ever possible for them before. So this is a time of great flourishing, and the more I look around, the more convinced I become that this quote, from the physicist Freeman Dyson, is not **hyperbole**⁷ at all. This is just a plain statement of the facts. We are in the middle of an astonishing period.

“Technology is a gift of God. After the gift of life it is perhaps the greatest of God’s gifts. It is the mother of civilizations, of arts and of sciences.” — Freeman Dyson

Which brings up another great question: What could possibly go wrong in this new machine age, right?

[. . .]

¹ George Eliot was an English writer in the 1800s. Eliot wrote under a pen name. Her real name was Mary Ann Evans.

² Yogi Berra is a popular American sports figure who played catcher, as well as worked as coach and manager, for the New York Yankees baseball team.

³ “R2D2” refers to a robot character that appears in the Star Wars movie series.

⁴ Something that “coasts along” continues at a steady speed.

⁵ The noun “arm” can be used to describe a division in a company or organization.

⁶ Erik Brynjolfsson is a professor of Internet Technology Productivity at MIT.

⁷ The noun “hyperbole” is used to describe a statement that is exaggerated.

Part 3

To tell you the kinds of societal challenges that are going to come up in the new machine age, I want to tell a story about two stereotypical American workers. And to make them really stereotypical, let's make them both white guys. And the first one is a college-educated professional, creative type, manager, engineer, doctor, lawyer, that kind of worker. We're going to call him "Ted." He's at the top of the American middle class. His counterpart is not college-educated and works as a laborer, works as a clerk, does low-level **white collar**⁸ or **blue collar**⁹ work in the economy. We're going to call that guy "Bill."

And if you go back about 50 years, Bill and Ted were leading remarkably similar lives. For example, in 1960 they were both very likely to have full-time jobs, working at least 40 hours a week. But as the social researcher **Charles Murray**¹⁰ has documented, as we started to automate the economy, and 1960 is just about when computers started to be used by businesses, as we started to progressively inject technology and automation and digital stuff into the economy, the fortunes of Bill and Ted diverged a lot. Over this time frame, Ted has continued to hold a full-time job. Bill hasn't. In many cases, Bill has left the economy entirely, and Ted very rarely has. Over time, Ted's marriage has stayed quite happy. Bill's hasn't. And Ted's kids have grown up in a two-parent home, while Bill's absolutely have not over time. Other ways that Bill is dropping out of society? He's decreased his voting in presidential elections, and he's started to go to prison a lot more often. So I cannot tell a happy story about these social trends, and they don't show any signs of reversing themselves. They're also true no matter which ethnic group or demographic group we look at, and they're actually getting so severe that they're in danger of overwhelming even the amazing progress we made with the Civil Rights Movement.

And what my friends in Silicon Valley and Cambridge are overlooking is that they're Ted. They're living these amazingly busy, productive lives, and they've got all the benefits to show from that, while Bill is leading a very different life. They're actually both proof of how right Voltaire was when he talked about the benefits of work, and the fact that it saves us from not one but three great evils. "*Work saves a man from three great evils: boredom, vice, and need.*" — Voltaire

Part 4

[W]ith these challenges, what do we do about them?

The **economic playbook**¹¹ is surprisingly clear, surprisingly straightforward, in the short term especially. The robots are not going to take all of our jobs in the next year or two, so the classic **Econ 101**¹² playbook is going to work just fine: Encourage entrepreneurship, **double down**¹³ on infrastructure, and make sure we're turning out people from our educational system with the appropriate skills.

But over the longer term, if we are moving into an economy that's heavy on technology and light on labor, and we are, then we have to consider some more radical interventions, for example, something like a guaranteed minimum income. [. . .] And if you find yourself worried that something like a guaranteed income is going to stifle our drive to succeed and make us kind of complacent, you might be interested to know that social mobility, one of the things we really pride ourselves on in the United States, is now lower than it is in the northern European countries that have these very generous **social safety nets**¹⁴. So the economic playbook is actually pretty straightforward.

The societal one is a lot more challenging. I don't know what the playbook is for getting Bill to engage and stay engaged throughout life.

⁸ "Low-level white collar" work refers to jobs in offices that require a low skill level, such as photocopying.

⁹ "Blue collar" work refers to manual, physical labor.

¹⁰ Charles Murray has written extensively on social policy in the U.S.

¹¹ A "playbook" refers to a book with tactics and strategies written in it, usually used for sports. McAfee uses the term as a synonym for "strategy."

¹² "Econ 101" refers to the basic economics class that all college and university students take to learn the fundamentals of economics.

¹³ The term "double down" is a gambling term used when doubling a bet. McAfee is saying we have to invest much more in infrastructure.

¹⁴ A "social safety net" refers to public programs in place that help people in difficult financial situations.

I do know that education is a huge part of it. I witnessed this firsthand. I was a Montessori kid for the first few years of my education, and what that education taught me is that the world is an interesting place and my job is to go explore it. The school stopped in third grade, so then I entered the public school system, and it felt like I had been sent to the **Gulag**¹⁵. With the benefit of hindsight, I now know the job was to prepare me for life as a clerk or a laborer, but at the time it felt like the job was to kind of bore me into some submission with what was going on around me. We have to do better than this. We cannot keep turning out Bills.

[. . .] I started my talk with quotes from wordsmiths who were separated by an ocean and a century. Let me end it with words from politicians who were similarly distant.

Winston Churchill came to my home of MIT in 1949, and he said, "If we are to bring the broad masses of the people in every

land to the table of abundance, it can only be by the tireless improvement of all of our means of technical production."

Abraham Lincoln realized there was one other ingredient. He said, "I am a firm believer in the people. If given the truth, they can be depended upon to meet any national crisis. The great point is to give them the plain facts."

So the optimistic note, great point that I want to leave you with is that the plain facts of the machine age are becoming clear, and I have every confidence that we're going to use them to chart a good course into the challenging, abundant economy that we're creating.

Thank you very much.

*This is an edited version of McAfee's 2013 TED Talk.
To watch the full talk, visit TED.com.*

¹⁵ Someone who is "sent to the Gulag" is put in a prison-like environment. Gulags were forced labor camps in Stalin era Russia.

Unit 9 PATRICIA KUHL

The Linguistic Genius of Babies

Part 1

I want you to take a look at this baby. What you're drawn to are her eyes and the skin you love to touch. But today I'm going to talk to you about something you can't see—what's going on up in that little brain of hers. The modern tools of neuroscience are demonstrating to us that what's going on up there is nothing short of rocket science. And what we're learning is going to **shed some light**¹ on what the romantic writers and poets described as the “celestial openness” of the child's mind.

[. . .] Work in my lab is focused on the first critical period in development—and that is the period in which babies try to master which sounds are used in their language. We think, by studying how the sounds are learned, we'll have a model for the rest of language, and perhaps for critical periods that may exist in childhood for social, emotional, and cognitive development. So we've been studying the babies using a technique that we're using all over the world and the sounds of all languages. The baby sits on a parent's lap, and we train them to turn their heads when a sound changes—like from “ah” to “ee.” If they do so at the appropriate time, the black box lights up and a panda bear pounds a drum. A **six-monther**² adores the task.

What have we learned? Well, babies all over the world are what I like to describe as “citizens of the world.” They can discriminate all the sounds of all languages, no matter what country we're testing and what language we're using, and that's remarkable because you and I can't do that. We're

culture-bound listeners. We can discriminate the sounds of our own language, but not those of foreign languages. So the question arises: When do those citizens of the world turn into the language-bound listeners that we are? And the answer: before their first birthdays. What you see here is performance on that head-turn task for babies tested in Tokyo and the United States, here in Seattle, as they listened to “ra” and “la”—sounds important to English, but not to Japanese. So at six to eight months, the babies are totally equivalent. Two months later, something incredible occurs. The babies in the United States are getting a lot better, babies in Japan are getting a lot worse, but both of those groups of babies are preparing for exactly the language that they are going to learn.

So the question is: What's happening during this critical two-month period? This is the critical period for sound development, but what's going on up there? So there are two things going on. The first is that the babies are listening intently to us, and they're taking statistics as they listen to us talk—they're taking statistics. So listen to two mothers speaking **motherese**³—the universal language we use when we talk to kids—first in English and then in Japanese.

[Video] *English Mother: Ah, I love your big blue eyes—so pretty and nice.*

Japanese Mother: [Japanese]

Part 2

During the production of speech, when babies listen, what they're doing is taking statistics on the language that they

¹ To “shed some light” on something means to explain it.

² Kuhl refers to a six-month old baby as a “six-monther.”

³ Kuhl uses the expression “motherese” to describe the animated way of speaking to babies that many mothers use.

hear. And those distributions grow. And what we've learned is that babies are sensitive to the statistics, and the statistics of Japanese and English are very, very different. English has a lot of Rs and Ls. The distribution shows. And the distribution of Japanese is totally different, where we see a group of intermediate sounds, which is known as the Japanese "R." So babies absorb the statistics of the language and it changes their brains; it changes them from the citizens of the world to the culture-bound listeners that we are. But we as adults are no longer absorbing those statistics. We're governed by the representations in memory that were formed early in development.

So what we're seeing here is changing our models of what the critical period is about. We're arguing from a mathematical standpoint that the learning of language material may slow down when our distributions stabilize. It's raising lots of questions about bilingual people. Bilinguals must keep two sets of statistics in mind at once and flip between them, one after the other, depending on who they're speaking to.

[. . .] We want to get inside the brain and see this thing happening as babies are in front of televisions, as opposed to in front of human beings. Thankfully, we have a new machine, **magnetoencephalography**⁴, that allows us to do this. It looks like a hair dryer from Mars. But it's completely safe, completely **non invasive**⁵, and silent. We're looking at millimeter accuracy with regard to spatial and millisecond accuracy using 306

SQUIDS—these are Superconducting QUantum Interference Devices—to pick up the magnetic fields that change as we do our thinking. We're the first in the world to record babies in an MEG machine while they are learning.

So this is little Emma. She's a six-monther. And she's listening to various languages in the earphones that are in her ears. You can see, she can move around. We're tracking her head with little pellets in a cap, so she's free to move completely unconstrained. It's a **technical tour de force**⁶. What are we seeing? We're seeing the baby brain. As the baby hears a word in her language, the auditory areas light up, and then subsequently areas surrounding it that we think are related to coherence, getting the brain coordinated with its different areas, and causality, one brain area causing another to activate.

We are embarking on a grand and golden age of knowledge about child's brain development. We're going to be able to see a child's brain as they experience an emotion, as they learn to speak and read, as they solve a math problem, as they have an idea. And we're going to be able to invent **brain-based interventions**⁷ for children who have difficulty learning. Just as the poets and writers described, we're going to be able to see, I think, that wondrous openness, utter and complete openness, of the mind of a child. In investigating the child's brain, we're going to uncover deep truths about what it means to be human, and in the process, we may be able to help keep our own minds open to learning for our entire lives.

*This is an edited version of Kuhl's 2011 TED Talk.
To watch the full talk, visit TED.com.*

⁴ The magnetoencephalography, or MEG machine, is an apparatus that measures human brain activity by mapping electric currents in the brain. Students can see a picture of it on page 145 of the Student Book.

⁵ A device that is "non-invasive" is one that does not go inside the body at all. The MEG machine sits on the child's head, like a helmet.

⁶ A synonym for "tour de force" is "masterpiece."

⁷ By "brain-based interventions" Kuhl means that new ways to help children with learning disabilities will focus on that child's brain activity while learning.

Unit 10 BILL GATES

Innovating to Zero!

Part 1

I'm going to talk today about energy and climate. And that might seem a bit surprising because my full-time work at the **Foundation**¹ is mostly about vaccines and **seeds**², about the things that we need to invent and deliver to help the poorest two billion live better lives. But energy and climate are extremely important to these people—in fact, more important than to anyone else on the planet. The climate getting worse means that many years, their crops won't grow: There will be too much rain, not enough rain, things will change in ways that their fragile environment simply can't support. And that leads to starvation, it leads to uncertainty, it leads to unrest. So, the climate changes will be terrible for them.

Also, the price of energy is very important to them. In fact, if you could pick just one thing to lower the price of, to reduce poverty, by far you would pick energy. Now, the price of energy has come down over time. Really advanced civilization is based on advances in energy. The coal revolution fueled the **Industrial Revolution**³, and, even in the 1900s we've seen a very rapid decline in the price of electricity, and that's why we have refrigerators, air-conditioning, we can make modern materials and do so many things. And so, we're in a wonderful situation with electricity in the rich world. But, as we make it cheaper—and let's go for making it twice as cheap—we need to meet a new constraint, and that constraint **has to do with**⁴ CO₂.

CO₂ is warming the planet, and the equation on CO₂ is actually a very straightforward one. If you sum up the CO₂ that gets emitted, that leads to a temperature increase, and that temperature increase leads to some very negative effects: the effects on the weather; perhaps worse, the indirect effects, in that the natural ecosystems can't adjust to these rapid changes, and so you get ecosystem collapses.

Now, the exact amount of how you map from a certain increase of CO₂ to what temperature will be and where the **positive feedbacks**⁵ are, there's some uncertainty there, but not very much. And there's certainly uncertainty about how bad those effects will be, but they will be extremely bad. I asked the top scientists on this several times: Do we really have to get down to near zero? Can't we just cut it in half or a quarter? And the answer is that until we get near to zero, the temperature will continue to rise. And so that's a big challenge. It's very different than saying **"We're a twelve-foot-high truck trying to get under a ten-foot bridge, and we can just sort of squeeze under."**⁶ This is something that has to get to zero.

Now, we put out a lot of carbon dioxide every year, over 26 billion tons. For each American, it's about 20 tons; for people in poor countries, it's less than one ton. It's an average of about five tons for everyone on the planet. And, somehow, we have to make changes that will bring that down to zero. It's been constantly going up. It's only various economic changes that have even flattened it at all, so we have to go from rapidly rising to falling, and falling all the way to zero.

¹ "The Foundation" refers to the Bill & Melinda Gates Foundation.

² When Gates mentions "seeds," he is referring to the areas of agriculture that his foundation focuses on helping.

³ The "Industrial Revolution" refers to the period from the mid-1700s to mid-1800s that saw a new age of manufacturing technology.

⁴ If something "has to do with" something else, the two things are related in some way.

⁵ The term "positive feedbacks" in regards to climate change refers to something that will increase the effect of the CO₂ emissions.

⁶ Gates uses the analogy of a twelve-foot truck and a ten-foot bridge to give an example of a small gap that maybe could be manipulated. Whereas what Gates is talking about, the gap between where carbon emissions are now and zero, is very large and will require a major change in how things are done.

Part 2

This equation has four factors, a little bit of multiplication: So, you've got a thing on the left, CO_2 , that you want to get to zero, and that's going to be based on the number of people, the services each person's using on average, the energy on average for each service, and the CO_2 being put out per unit of energy. So let's look at each one of these and see how we can get this down to zero. Probably, one of these numbers is going to have to get pretty near to zero. Now that's back from high school algebra, but let's take a look.

First, we've got population. The world today has 6.8 billion people. That's **headed up**⁷ to about nine billion. Now, if we do a really great job on new vaccines, health care, reproductive health services, we could lower that by, perhaps, 10 or 15 percent, but there we see an increase of about 1.3.

The second factor is the services we use. This encompasses everything: the food we eat, clothing, TV, heating. These are very good things: Getting rid of poverty means providing these services to almost everyone on the planet. And it's a great thing for this number to go up. In the rich world, perhaps the top one billion, we probably could cut back and use less, but every year, this number, on average, is going to go up, and so, overall, that will more than double the services delivered per person. Here we have a very basic service: Do you have lighting in your house to be able to read your homework? And, in fact, these kids don't, so they're going out and reading their schoolwork under the street lamps.

Now, efficiency, E , the energy for each service, here finally we have some good news. We have something that's not going up. Through various inventions and new ways of doing lighting, through different types of cars, different ways of building buildings—there are a lot of services where you can bring the energy for that service down quite substantially. Some individual services even bring it down by 90 percent. There are other services like how we make fertilizer, or how we do air transport, where the rooms for improvement are far, far less. And so, overall here, if we're optimistic, we may get a reduction of a factor of three to even, perhaps, a factor of six. But for these first three factors now, we've gone from 26 billion to, at best, maybe 13 billion tons, and that just won't cut it.

So let's look at this fourth factor—this is going to be a key one—and this is the amount of CO_2 put out per each unit of energy. And so the question is: Can you actually get that to zero? If you burn coal, no. If you burn natural gas, no. Almost every way we make electricity today, except for the emerging renewables and nuclear, puts out CO_2 . And so, what we're going to have to do **at a global scale**⁸, is create a new system. And so, we need energy miracles.

Now, when I use the term "miracle," I don't mean something that's impossible. The microprocessor is a miracle. The personal computer is a miracle. The Internet and its services are a miracle. So the people here have participated in the creation of many miracles. Usually, we don't have a deadline, where you have to get the miracle by a certain date. Usually,

⁷ In regards to numbers, something that is "headed up" is increasing.

⁸ When something happens on "a global scale," it affects the entire world.

you just kind of stand by, and some come along, some don't. This is a case where we actually have to **drive at full speed**⁹ and get a miracle in a pretty tight timeline.

Part 3

[. . .] So let's think: How should we measure ourselves? What should our **report card**¹⁰ look like? Well, let's go out to where we really need to get, and then look at the intermediate. For 2050, you've heard many people talk about this 80 percent reduction. That really is very important, that we get there. And that 20 percent will be used up by things going on in poor countries, still some agriculture, hopefully we will have cleaned up forestry, cement. So to get to that 80 percent, the developed countries, including countries like China, will have had to switch their electricity generation altogether. So, the other grade is: Are we deploying this zero-emission technology, have we deployed it in all the developed countries and we're in the process of getting it elsewhere? That's super important. That's a key element of making that report card.

So, **backing up**¹¹ from there, what should the 2020 report card look like? Well, again, it should have the two elements. We should go through these efficiency measures to start getting reductions: The less we emit, the less that sum will be of CO₂, and, therefore, the less the temperature. But in some ways, the grade we get there, doing things that don't get us

all the way to the big reductions, is only equally, or maybe even slightly less, important than the other, which is the pace of innovation on these breakthroughs.

[. . .] So this is a wish. It's a very **concrete**¹² wish that we invent this technology. If you gave me only one wish for the next 50 years—I could pick who's president, I could pick a vaccine, which is something I love, or I could pick that this thing that's half the cost with no CO₂ gets invented—this is the wish I would pick. This is the one with the greatest impact. If we don't get this wish, the division between the people who think short term and long term will be terrible, between the U.S. and China, between poor countries and rich, and most of all the lives of those two billion will be far worse.

So what do we have to do? What am I appealing to you to step forward and drive? We need to go for more research funding. When countries get together in places like Copenhagen, they shouldn't just discuss the CO₂. They should discuss this innovation agenda, and you'd be stunned at the ridiculously low levels of spending on these innovative approaches. We do need the market incentives—CO₂ tax, cap and trade—something that gets that price signal out there. We need to get the message out. We need to have this dialogue be a more rational, more understandable dialogue, including the steps that the government takes. This is an important wish, but it is one I think we can achieve.

*This is an edited version of Gates's 2010 TED Talk.
To watch the full talk, visit TED.com.*

⁹ Gates uses the metaphor “drive at full speed” to illustrate that we are moving quickly in the direction of extreme environmental damage due to carbon emissions and global warming.

¹⁰ A “report card” refers to the grades that students get at the end of a school year in the U.S.

¹¹ The term “backing up” is used by Gates here to indicate that he is moving backwards on the time line he is talking about, from 2050 to 2020.

¹² When an idea or wish is described as “concrete,” it means it is specific and fixed.