Without them, we wouldn't be able to produce enough to feed the world's population.

When it comes to humans, there are currently 7 billion people on the planet.

In less than 40 years our population will be 9 billion.

And the problem is simple. Do we have enough phosphorus to feed future generations?

So where can we find phosphorus to understand these issues?

Let me explain.

But first, let's assume that we are using 100% of the prescribed dose of phosphorus.

Of this 100 percent, only 15 percent goes to the factory. 85 percent lost.

It enters the soil and its journey ends in a lake. As a result, excess phosphorus builds up in the lake, which leads to the cyanobacteria problem.

So it turns out that there is an illogical problem here.

100 percent of the phosphorus is used, but only 15 percent goes to the factory.

I would say it's a waste.

Yes, it is. What's worse is that it's very expensive.

No one wants to throw their money out the window, but unfortunately that's what's happening here.

80% of each dose of phosphorus is lost.

Modern agriculture depends on phosphorus.

And to supply 15% of that to the factory, all the rest is lost, so we need to add more.

Now, where does this phosphorus come from?

Basically take it out of the mine.

It was the cover of a stunning paper published in Nature in 2009 that kickstarted the discussion of the phosphorus crisis in earnest.

Phosphorus, an essential nutrient for life, is scarce and nobody talks about it.

and everyone agrees. Politicians and scientists alike agree that we are headed for a phosphorus crisis.

What you see here is an open pit mine in the United States. To give you an idea of ​​the scale of this mine, if you look in the upper right corner you can see a small crane, and it's a giant crane.

It really puts it in perspective.

That is, you get phosphorus from mines.

Compared to oil, there is the oil crisis, we talk about it, we talk about global warming, but we never mention the phosphorus crisis.

Back to the oil issue, oil is fungible.

Biofuels, solar power, and hydropower can be used, but phosphorus is an essential element for life and cannot be replaced.

What is the current state of the world's phosphorus reserves?

This graph gives a rough idea of ​​the current situation.

The black line represents the projected phosphorus reserves.

It will reach its peak in 2030.

By the end of this century they will all be gone.

A dotted line indicates the current position.

As you can see, they meet in 2030 and I will be retired by then.

But we are certainly heading towards a great crisis. I would like people to be aware of this issue.

Is there any solution?

what should we do? we are faced with a contradiction.

Less and less phosphorus is available.

By 2050, there will be 9 billion humans, and according to the United Nations Food and Agriculture Organization, we will need to produce twice as much food by 2050 as we do today.

So you have less phosphorus, but you have to produce more food.

what should we do

It's a paradoxical situation.

Are there any solutions or alternatives that can optimize the use of phosphorus?

Remember that 80% is doomed to be lost.

The solution I propose today, which has existed for a very long time, before plants existed on earth, is a microscopic mushroom that is very mysterious, very simple, yet very complex.

I have been fascinated by this little mushroom for over 16 years.

This allowed me to take my research further and use it as a model for my laboratory studies.

This mushroom lives symbiotically with the root.

Symbiosis means a two-way reciprocal relationship, also called mycorrhizae.

This slide shows mycorrhizal elements.

You are looking at the root of wheat, one of the most important plants in the world.

The roots usually find the phosphorus themselves.

Go find Lynn, but only to within 1 millimeter of it.

Above 1 millimeter, roots are ineffective.

You can't go any further in your search for Lynn.

Now imagine this tiny, minute mushroom.

It grows much faster and is much better designed to look for phosphorus.

Seek out phosphorus beyond 1mm of roots.

I haven't invented anything. It's a biotechnology that has been around for 450 million years.

And over time, the mushroom has evolved to seek out even the tiniest amount of phosphorus and adapt it to make it available to plants.

What you're looking at here is a real world carrot root and a mushroom with very fine fibers.

A closer look reveals that this mushroom has a very gentle penetration.

It proliferates between root cells and eventually begins to penetrate cells and form typical dendritic structures, greatly increasing the exchange interface between plant and mushroom.

And through this structure, mutual exchange is born.

This is a win-win deal. I give you phosphorus and you feed me.

Exactly symbiotic.

Now let's add a mycorrhizal plant to the diagram we used earlier.

And instead of using a 100 percent dose, I'm going to cut it down to 25 percent.

Of this 25 percent, we find that the majority, over 90 percent, benefits the plants.

A very small amount of phosphorus remains in the soil.

It's perfectly natural.

Moreover, in some cases it is not even necessary to add phosphorus.

Remember the graph I showed earlier? Eighty-five percent of the phosphorus is lost in the soil, making it inaccessible to plants.

Even if it exists in the soil, it exists in an insoluble form.

Plants can only seek out soluble forms.

Mushrooms can dissolve this insoluble form and make it available to plants.

To further support my claim, here is a photo that speaks for itself.

These are trials in the sorghum field.

On the left is the yield produced using conventional agriculture with 100 percent phosphorus dosage.

Meanwhile, the dose was reduced by 50%. Look at the yield.

Higher yields were achieved with only half the dose.

This is just to show that this method works.

And in Cuba, Mexico, and India, doses can be reduced to 25 percent in some cases, while mushrooms are so well adapted to finding phosphorus and pulling it out of the soil that in others phosphorus additions may not be necessary at all.

This is an example of soybean production in Canada.

Mycorrhizal fungi were used in one field but not in the other.

Here, blue indicates good yields and yellow indicates low yields.

Black rectangles are plots with mycorrhizae added.

In other words, as I said, I didn't invent anything.

Mycorrhizae have been around for 450 million years and have contributed to the diversification of modern plant species.

So this is not something that has been lab tested yet.

Mycorrhizal fungi exist, function, are produced on an industrial scale, and are commercialized worldwide.

The problem is that people don't realize it.

People such as food producers and farmers are still unaware of this problem.

We have the technology in place, and if used correctly, it can alleviate some of our burden on the world's phosphorus reserves.

In conclusion, I am a scientist and a dreamer.

I am passionate about this subject.

So, if you ask me what my retirement dream is, it's the moment when I reach the peak of Lynn. It uses one label, "with mycorrhizal fungi," and my children and grandchildren will buy products with that label.

Thank you for your attention.

(applause)

A typical type of individual comes to mind when talking about corruption.

There is an ex-Soviet megalomaniac.

Saparmurat Niyazov was one of them.

Until his death in 2006, he was the all-powerful leader of Turkmenistan, a Central Asian country rich in natural gas.

Well, he loved issuing executive orders.

Some also changed the names of the months of the year, including their names and that of their mother.

He spent millions of dollars crafting strange cults of personality, and his crowning glory was erecting a 40-foot-tall gold-plated statue of himself that stood proudly in the capital's central square and revolved to follow the sun.

He was a strange person.

And then there is the cliché of African dictators, ministers and officials.

My name is Theodorine Obian.

So his father is president-for-life of Equatorial Guinea, a West African country with a truly appalling human rights record despite exporting billions of dollars of oil since the 1990s.

Despite a per capita income comparable to that of Portugal, the majority of the population lives in truly dire poverty.

Obiang Jr. bought himself a $30 million mansion in Malibu, California.

I went to the main gate.

I'd say it's a great development.

He also bought an €18 million art collection that belonged to fashion designer Yves Saint Laurent, a pile of awesome sports cars worth $1 million apiece, oh, Gulfstream jets.

Now look at this. Until recently, his official monthly salary was less than $7,000.

And then there's Dan Etete.

Well, he was Nigeria's former oil minister under President Abacha, but he also happens to be a convicted money launderer.

We have spent a great deal of time investigating the billion dollar oil deal he was involved in. And what we discovered was pretty shocking. But more on that later.

So it's easy to assume that corruption is happening somewhere, by greedy tyrants or groups of malevolent individuals in countries where we personally know little and feel totally irrelevant and unaffected by what's really going on.

But does it only happen there?

Well, at 22, I was very lucky.

My first job out of college was to investigate the illegal ivory trade in Africa.

Thus began my relationship with corruption in earnest.

In 1993, together with two friends, my colleagues Simon Taylor and Patrick Alley, we founded an organization called Global Witness.

Our first campaign was to investigate the role of illegal logging in war financing in Cambodia.

It's been a few years now, it's 1997 and I'm in Angola going undercover for Blood Diamonds.

You've probably seen the Hollywood movie "Blood Diamond" starring Leonardo DiCaprio.

Well, part of it came out of our work.

Luanda was filled with mine victims struggling to survive on the streets, war orphans living in sewers under the roads, and the petite, very wealthy elite gossiping about shopping trips to Brazil and Portugal.

And it was kind of a weird place.

So I'm sitting in a hot, very stuffy hotel room feeling completely overwhelmed.

But it wasn't about Blood Diamond.

Because I was talking to a lot of people there, and they were talking about a different problem, the huge web of corruption worldwide and the millions of missing petrodollars.

And even starting to figure out how to go about it, which was a very small organization of just a few people at the time, was a huge challenge.

And in all my years of service and all of us doing election campaigns and research, I have seen time and time again that it is not just greed or misuse of power or the vague term "weak governance" that enables massive corruption on a global scale.

So yes, that's all, but corruption is made possible by the actions of global promoters.

Now, let's go back to some of the people we talked about earlier.

Now, they are all people we have investigated, they are all people who could not do anything by themselves.

Take Obiang Jr. for example. Well, he didn't get his hands on fine art or luxury homes without help.

He was doing business with global banks.

He had company accounts in Paris banks, one of which was used to buy art, and an American bank poured $73 million into America, part of which was used to buy a mansion in California.

And he didn't do all this to his own name either.

He used a dummy company.

He used one to buy the property and the other, which was in someone else's name, to pay the huge bills for running the place.

and Dan Etete.

When he was Oil Minister, he sold an oil block that is now worth over $1 billion to a company whose, well, he was the secret owner.

Now, much later, with the kind assistance of the Nigerian government - and now I must be careful to say here - it was traded to subsidiaries of two major oil companies, Shell and Italy's Eni.

In reality, the forces of corruption exist far beyond the shores of countries such as Equatorial Guinea, Nigeria and Turkmenistan.

This impetus is driven by our international banking system, the problem of anonymous shell companies, and the secret that we provide massive oil, gas and mining operations, and most of all, our politicians' failure to back up their rhetoric and do anything really meaningful and systematic to address this issue.

Let's look at banks first.

Well, it wouldn't surprise me to say that banks accept dirty money, but they also prioritize profits in other destructive ways.

For example, Sarawak, Malaysia.

Currently, only 5 percent of the forest in the region remains untouched. 5 percent.

So how did it happen?

That's because the elite and their champions have made millions of dollars over the years supporting logging on an industrial scale.

So we sent an undercover agent to covertly film a meeting with the ruling elite, and the resulting footage made some people very angry. You can watch it on YouTube, but this footage proved what we had suspected for a long time. for it showed how he used his control over land and forest permits to enrich himself and his family, even though the Chief Minister later denied it.

And we know that HSBC was funding the region's largest logging company, which was responsible for some of the destruction in Sarawak and elsewhere.

The bank violated its own sustainability policy in the process, but made a profit of about $130 million.

Well, shortly after our disclosure, shortly after the disclosure earlier this year, the banks announced a policy review on this.

And is this progress? Perhaps, but we will pay close attention to the incident.

And then there's the issue of anonymous paper companies.

Well, I think we've all heard about what they are, and we all know they're used quite a bit by people and businesses trying to avoid paying a proper burden on society known as taxes.

But what is usually hidden from the public is how shell companies are being used to steal huge, transformative money from poor countries.

Almost every corruption case we investigated featured shell companies, and in some cases it was impossible to determine who was actually involved in the transaction.

A recent study by the World Bank investigated 200 corruption cases.

More than 70% of them were found to be anonymous shell companies, valued at about $56 billion.

This is not just an offshore problem, but an onshore problem as many of these companies are now dependent on the US and UK, their overseas territories and the King.

Shell companies, they are the center of clandestine deals that may benefit the wealthy elite rather than the general public.

One of the more striking recent cases we investigated is how the government of the Democratic Republic of Congo sold a series of valuable state-owned mining assets to shell companies in the British Virgin Islands.

So we spoke to local sources and combed through company documents and other information to try to piece together the true picture of the transaction.

And we were alarmed to learn that these dummy companies were quick to transfer much of their assets to a large London-listed international mining company for huge profits.

The African Progress Panel, led by Kofi Annan, now estimates that Congo may have lost more than $1.3 billion in these deals.

This is almost double the country's combined annual health and education budget.

And will the Congolese people get their money back?

Now, the answer to that question, and who was really involved and what really happened, will probably remain locked up in secret business registers in the British Virgin Islands and elsewhere unless we all do something.

But what about oil, gas and mining companies?

Well, talking about them might be a bit cliche.

Corruption in the field is not surprising.

Corruption is everywhere, so why focus on that area?

Well, because there are many dangerous things.

In 2011, natural resource exports outpaced aid flows by almost 19 to 1 in Africa, Asia and Latin America. 19 to 1.

There are now a huge number of schools, colleges, hospitals and entrepreneurs, many of which have not and will never come to fruition simply because part of their funding has been stolen.

Now, back to the oil and mining companies, back to Dan Etete and that billion dollar deal.

forgive me please. This is a very real problem, so read the next part. My lawyer has looked into this matter in some detail and wants me to get it right.

Now, on the surface, the deal seemed easy.

Shell and Eni subsidiaries paid the Nigerian government for the block.

The Nigerian government transferred exactly the same amount, converted in dollars, to an account dedicated to a dummy company called Etete, whose hidden owner was.

Now, arresting convicted money launderers is not a bad thing.

And here comes the problem.

After months of poring over hundreds of pages of court documents, I found evidence that indeed Shell and Eni knew the money would be transferred to shell companies. Frankly, it's hard to believe they didn't know who they were actually dealing with there.

Now, it shouldn't take much effort to find out where the money from a deal like this has gone.

So these are national assets.

They should be used for the benefit of the people of the country.

However, in some countries, citizens and journalists who attempt to expose such stories are harassed, arrested, or risk their lives.

And finally, there are those who believe that corruption is inevitable.

It's the way some kind of business is done.

Too complicated and hard to change.

So what is it really? we just accept it.

But as a campaigner and researcher, I have a different view. Because we've seen what can happen when an idea gains momentum.

For example, in the oil and mining sector, a truly global transparency standard is now beginning that could address some of these issues.

In 1999, when Global Witness called on oil companies to make their payments transparent, some laughed at the extreme naivety of the small idea.

But literally hundreds of civil society groups around the world have rallied to fight for transparency, which is now rapidly becoming the norm and law.

Two-thirds of the value of oil and mining companies globally is now covered by transparency laws. two thirds.

This means change is happening.

This is progress.

But we're not quite there yet.

Because it's not really about corruption somewhere, is it?

In a globalized world, corruption is a truly globalized business, requiring a global solution supported and driven by all of us here as global citizens.

thank you.

(applause)

There are three words that describe why I am here.

They are "Amy Klaus Rosenthal".

At the end of Amy's euphoric life at home on morphine and hospice, on March 3, 2017, The New York Times published an article she wrote in its "Modern Love" column.

Read by over 5 million people worldwide.

It was excruciatingly sad, ironically funny, and brutally honest.

It was certainly about our lives together, but the focus of this piece was me.

It was called "You Might Want to Marry My Husband."

It was a creative play on personal advertising for me.

Amy literally left me an empty space to fill with another love story.

Amy has been my wife for half my life.

She was my partner in raising three wonderful children who are now adults, and in fact she was my girl.

we had a lot in common.

We loved the same art, the same documentaries, the same music.

Music was a big part of our lives.

And we shared the same values.

We are in love and our love only grew stronger until her last day.

Amy was a prolific writer.

In addition to her two groundbreaking memoirs, she has published over 30 children's books.

A book she wrote posthumously with her daughter Paris, Dear Girl, reached number one on the New York Times bestseller list.

She was a self-proclaimed little filmmaker.

She is 5ft 1in tall and her movies weren't that long.

(Laughter) Her films demonstrate her natural ability to bring people together.

She is also a great public speaker and has spoken to children and adults of all ages from all over the world.

Now, my story of grief is unique only in the sense that it is fairly public.

But the grieving process itself wasn't just about me.

I am very grateful to Amy for giving me permission to move forward.

It's been a little over a year since I started my new life and I've learned a few things.

I would like to share with you some of the processes of overcoming grief and moving forward with grief.

But before that, I think it's important to talk a little bit about the end of life. Because it shapes how my emotions have been since then.

Death is a very taboo subject, isn't it?

Amy last dined on January 9, 2017.

She somehow managed to live another two months without eating solid food.

Her doctors said she could do hospice at home or in a hospital.

They didn't tell us that Amy would shrink to half her weight, that she would never sleep with her husband again, or that walking upstairs to her bedroom would feel like running a marathon.

Home hospice has the aura of being the perfect environment to die in.

How nice it would be to not have machines constantly beeping and turning on and off, not be interrupted by forced drug administrations, and not die at home with their families.

We did our best to make those weeks as meaningful as possible.

We talked a lot about death.

Sure, we all know it happens to us, but being able to talk about it openly has been liberating.

We discussed topics such as parenting.

I asked Amy how she could be the best parent to her children while she was away.

During those conversations, she gave me confidence by emphasizing that I had great relationships with everyone and that I could do it.

There will be many times when I wish she and I could make decisions together.

We were always so in sync.

It's a very bold thing to do, but I encourage you to have these conversations now while you're healthy.

Please don't wait.

As part of our hospice experience, we organized a group of visitors.

How brave of Amy to let them in, even though her body was beginning to decline.

We spent a claus night with her parents and 3 brothers.

Friends and family followed.

Each told a beautiful story about Amy and us.

Amy had a great influence on her loyal friends.

But home hospice isn't all that pretty for families left behind.

I want to talk a little bit more personally here, but I want to tell you that to this day, the memories of those last few weeks still haunt me.

I remember walking backwards to the bathroom, helping Amy with each step.

I felt very strong.

I'm not a very big guy, but my arms looked and felt very healthy compared to Amy's frail body.

And the body failed at home.

On March 13th of last year, my wife passed away in bed from ovarian cancer.

I carried her lifeless body down the stairs, through the dining room and living room, to a stretcher waiting to be cremated.

I can't get that image out of my head.

If anyone has had a hospice experience, acknowledge it.

I heard a guy named Jason talk about how hard it was to have that memory, and if they want to talk about it, just tell them you're there.

They may not want to talk, but it's nice to connect with someone who lives every day with those memorable images.

Believe it or not, I have never been asked such a question.

I experienced public grief because of Amy's essay.

Many of the readers who contacted me wrote beautiful tributes.

Amy's sphere of influence was deeper and richer than we or her family knew.

In some of the responses I received, humor helped me through the intense grieving process, like this email I received from a female reader who read the article. The content was to declare, "I will marry you when you are ready, on the condition that you stop drinking permanently (laughs)."

No other conditions.

I promise to outlive you.

thank you very much. "

Now, I like good tequila, but that's not my problem.

But how can you say no to that proposal?

(Laughter) I laughed through tears when I read this note from a family friend. "I remember Amy showing me how to make cornbread croutons at your house for Shabbat dinner.

Only Amy can find creativity in croutons. ”

(Laughter) On July 27th, just months after Amy's death, my father passed away from complications related to his decades-long battle with Parkinson's disease.

I couldn't help but wonder how far the human condition could endure.

How are we able to cope with this huge loss and still continue to operate?

was this a test?

Why my family and wonderful children?

Unfortunately, it's a lifelong mission to search for answers, but the key I'm able to pull through is Amy's explicit and very public mandate that I must continue.

Over the past year, I have done just that.

I tried to go out and seek the joy and beauty I know this life can offer.

But here is the reality. Family gatherings, attending weddings, and events honoring loving Amy were all very difficult to endure.

People say I'm amazing.

"How do you deal with yourself then?"

They say, "You do it so gracefully."

Well, what do you think?

It's often really sad.

I often feel like I'm kind of confused, but I know these feelings apply to other surviving spouses, children, parents, and other family members.

In Japanese Zen there is the word “life and death”.

Nothing separates life from death except the thin line that connects life and death.

Birth, or the joy of life, the splendor, the important part, and death, which we want to get rid of, are said to face each other in equal measure.

In my new life, I am doing my best to embrace this notion and move forward with grief.

But in the first few months after Amy's death, I was convinced that a sense of hopelessness was always present and would overwhelm everything.

I was lucky enough to receive some promising advice right away.

Many members of widowed clubs have reached out to me.

One friend in particular, who lost a life partner, repeated, “Jason, you will surely find joy.”

I didn't even understand what she was saying.

How was that possible?

But now that Amy has publicly allowed me to find happiness, I get to experience joy from time to time.

I danced the night away at LCD Soundsystem concerts, traveled with my brother and best friend, went on a boys' trip with a friend from college, and met some of the most amazing groups of guys I've ever met.

Watching the sun blaze from the deck on a cold day, I lay out there and the warmth consumed my body.

Joy is due to my three wonderful children.

In it, his son Justin sent an email with a picture of him with an elderly gentleman with huge, muscular forearms, and a big smile on his face with the caption, "I just met Popeye."

(Laughter) His brother Miles was walking to the train on his first day out of college and he stopped and looked at me and asked, "What are you forgetting?"

I immediately told him I was 100% ready, I know.

And my daughter, Paris, was walking with me through London's Battersea Park early in the morning when the leaves were tall and the sun was shining on the way to yoga.

I will add that there is also something to discover in beauty. In other words, it refers to the beauty of wabi-sabi, but it is still beauty.

On the other hand, when I see something that falls into this category, I want to say, "Amy, did you see that? Did you hear that?"

Too beautiful, please don't share with me. ”

On the other hand, I am now experiencing these moments in a whole new way.

There was beauty I found in music, like the moment when "The Alien" transitioned seamlessly into "The Sunshine" on the latest Manchester Orchestra album, or the haunting beauty of Luke Sitaru-Singh's lyrics in the chorus of "Killing Me."

I live happily, but I feel guilty. ”

There's beauty in the simple moments that life offers, and it's a way of seeing the world that's part of Amy's DNA. For example, watching the sun reflect off Lake Michigan during my morning commute, or stopping to observe how the light shines in the house we built together at different times of the day. Even after the storm in Chicago, I noticed fresh snow all over my neighborhood. Peeking into my daughter's room where she's practicing her bass guitar.

Listen, I want to make it clear that I am a very lucky person.

I have a wonderful family who love and support me.

I have resources for personal growth during times of grief.

But whether it's a divorce, the loss of a job you've worked so hard for, the sudden death of a family member, or a slow, painful death, I want to offer you what you've been given: a blank sheet of paper.

What do you do with the intentionally empty space in your new start?

thank you.

(applause)

On the coast of Northern Ireland, a vast plateau of basalt slabs and columns called the Giant's Causeway stretches down to the sea.

The scientific explanation for this is that it is the result of molten lava cooling, shrinking and crumbling after a volcanic eruption.

However, there is another explanation in ancient Irish mythology.

Legend has it that the giant Finn McCool lived happily on the coast of North Antrim with his wife Oona.

The only thing that confused them was the ridicule and threats of the giant Benandonner, or Red Man, who lived in Scotland across the sea.

The two yelled curses, threw stones at each other, and displayed dramatic strength.

Once, Finn tore up a large chunk of land and lifted it towards his rival, but did not reach land.

Instead, the mass became the Isle of Man, and the crater from the turbulent Earth filled with water and became Loch Neagh.

The giants' bitter talks continued until one day Benandonner challenged Finn to a fight.

So the Irish giant threw enough rocks into the sea to create a stepping-stone bridge to the Scottish coast.

Finn marched in rage.

He recognized Benandonner from a distance as Scotland closed in on him.

Finn was of considerable size, but his courage flinched at the sight of a monstrous foe thundering at him.

At one glance at Benandonner's thick neck and clenched fists, Finn turned and ran.

Back home, Finn shivered as Benandonner rapidly approached, explaining to Woorner the enemy's big name.

They knew that if he faced Benandonner head-on, he would be crushed.

So Oona devised a cunning plan. I had to keep Finn out of sight while creating the illusion of size, implying that Finn was a mountain-sized human being.

As Benandonner neared the end of the bridge, Wooner stuffed him into a giant cradle.

Finn lay quietly disguised as a giant baby while Benandonner banged on the door.

The house shook as he stepped inside.

Ms Wooner told the furious visitor that her husband wasn't home but welcomed her to sit and eat while she waited.

As Benandonner bit into the cake in front of him, he let out a scream of pain as his teeth shattered from the metal Oona had hidden inside.

She said it was Finn's favorite bread, sowing doubts in Benandonner's mind that he would rival his rivals.

As Finn screamed, Benandonner's attention was drawn to the giant baby in the corner.

The baby was so heavy swathed under the pile of blankets that Benandonner shuddered to imagine what his father would look like.

He decided he didn't want to be known.

In his escape, Benandonner ripped through the rocks connecting the shore and destroyed the causeway.

What remains are two identical rock formations. One is on the North Antrim Coast of Ireland and the other is across the sea at Fingal's Cave in Scotland.

The villain Dr. Schrödinger has developed a growth ray and plans to create a giant army of cats to terrorize the city.

Your secret agent team tracked him down to an underground lab.

When I rushed in... it was a trap!

Dr. Schrödinger sneaked into the next room to activate the device and disabled the control panel upon exiting.

Luckily, your teammates are master espionage.

Agent Delta has successfully hacked into the control panel and restarted some of its functions.

Meanwhile, Agent Epsilon checks the surveillance cameras and finds codes 2, 10, and 14 on the door.

Just enter these numbers and it's free.

But there is a problem.

The control panel has only three buttons. A button to add 5 to the displayed number, a button to add 7, and a button to take the square root.

I want the display to output the numbers 2, 10, 14 in that order.

It doesn't matter if it prints different numbers along the way, but there's no way to reset the display, so once you get to 2, you have to continue with 10, 14, and so on.

Not only that, Agent Delta explains that the panel contains other traps as well.

The room will explode if the same number appears multiple times, or any number over 60 or any non-integer number appears.

The display is now showing zero and the time is running out.

There is only one way to solve the puzzle, with some minor variations.

How do you enter the code to escape Dr. Schrödinger's lair and save the day?

Pause the video now if you want to figure it out for yourself.

The answer is 3 2 1.

you consider your options.

Adding 5 or 7 increases the number and using the square root button decreases it.

However, only options 4, 9, 16, 25, 36, and 49 are available for that button.

I would like to make 4 or 16.

Then press the square root button once or twice to get 2.

However, neither can be created with just the 5 and 7 buttons.

what will you do?

Explore other possible options for numbers that can be square rooted.

I can't reach 9 people.

25 and 49 return to 5 or 7, but each of them can already be reached.

36 is the only option.

Add 5, 7, 5, 7, 5, 7 and press the square root button.

Why 5 and 7 in a row?

This is somewhat arbitrary, but you'll find that 10, 14, and the perfect square should be avoided as you'll need them later.

This makes 6.

Does it help?

Looking at the options, we can see that 16 is in the field of view.

To get to this, add another 5 twice.

Then press the square root twice.

Now it's 2.

On the way!

Come on, up to 10.

You can't get there straight by just adding, so you have to reach another square.

You can find that taking the square root of 9 or 25 gets you to a good value, but you can't get from 2 to 25.

So add 7 to get 9 and take the square root again.

Now it's 3.

Add 7 and you get 10.

Eventually 14 should be reached.

Go back in time and imagine where you are by 2:00 PM 7:00 or 9:00 PM.

But 9 doesn't work because it already uses 9.

However, if you reach 49 first, you may reach 7.

Keep moving towards your goals, being careful not to fall into the numbers you've achieved so far.

Proceed cautiously, adding five fives and two sevens.

Then take the square root of 7 and add 7 to it.

The door will open and you can get out of the trap.

Thanks to their problem-solving skills, the team gets Schrödinger's cat out of the box in the nick of time.

One thing is certain about Schrödinger. He's going to spend a lot of time in his box.

this is my grandfather

And this is my son.

When I was young, my grandfather taught me to work with trees. He also taught me the idea that if you cut down a tree to make something, you should respect the life of the tree and make it as beautiful as possible.

My young son reminded me that there are all kinds of technology and toys out there, but sometimes stacking small wooden blocks high is actually incredibly inspiring.

These are my buildings.

I build around the world from offices in Vancouver and New York.

And we build buildings of different sizes, styles and different materials depending on the location.

But I want to talk about wood because it is the material that I love the most.

One of the reasons I love it is because I find that every time people enter my wooden building, their reaction is completely different.

I've never seen anyone walk into my building and hug a steel or concrete pillar, but I've seen it happen in a wooden building.

I've seen people actually touch wood, and I think there's a reason for that.

Like snowflakes, no two pieces of wood are the same everywhere on Earth.

That's great.

I believe that wood leaves a mark of mother nature on a building.

It is Mother Nature's fingerprint that our buildings connect us with nature in its environment.

I currently live in Vancouver, near a forest that grows 33 stories high.

Here in California's coastline, sequoia forests grow 40 stories high.

But the buildings we think of in wood are only four stories high in most places on earth.

In fact, many places have building codes that limit building much higher than four stories, and that's true here in the United States.

Now there are exceptions, but I hope some exceptions are necessary and things will change.

I think so because half of us live in cities today and that number will increase to 75 percent.

Cities and densities mean that our buildings will continue to grow, and I think wood has a role to play in cities.

I feel that way because today, in the next 20 years, 3 billion people around the world will need a new home.

This represents 40% of the world's need for new buildings over the next 20 years.

Today, one in three city dwellers actually lives in a slum.

That means 1 billion people in the world live in slums.

100 million people worldwide are homeless.

A major challenge that architects and society have to deal with in architecture is finding solutions to accommodate these people.

But the challenge is, as we move to cities, cities are built with two materials, steel and concrete, and these are good materials.

material from the last century.

However, they are also very high-energy materials that emit very large amounts of greenhouse gases in the process.

Steel accounts for about 3% of mankind's greenhouse gas emissions, while concrete accounts for more than 5%.

So 8% of our contribution to greenhouse gases today comes from these two substances alone.

We don't think about it much, and unfortunately I don't think we really think about buildings as much as we should.

Here are US statistics on greenhouse gas impacts.

Nearly half of greenhouse gases are associated with the building industry, and when we look at energy as well.

You'll notice that transportation is second from the bottom of that list, and that's the conversation we hear most often.

A lot of it is about energy, but a lot of it is about carbon.

The problem, I think, is that, ultimately, the clash of how to solve the problem of serving the three billion people who need homes and climate change is a head-on conflict that is either about to happen or has already happened.

This challenge means we have to start thinking in new ways. I think wood will be part of the solution. I will tell you why.

As an architect, wood is the only large material I can build, already grown by the power of the sun.

As trees grow in forests, they give off oxygen and take up carbon dioxide, which when they die and fall to the forest floor, is returned to the atmosphere or the ground.

Burning in forest fires also releases carbon back into the atmosphere.

But when we put that wood into buildings, furniture, or even wooden toys, it actually has an amazing ability to store and sequester carbon to us.

One cubic meter of wood stores one tonne of carbon dioxide.

Now, our two solutions to the climate are clearly reducing emissions and finding storage.

Wood is the only major building material I can build that can actually fulfill both of these two functions.

So while we believe we have an ethic that the earth grows our food, we need to shift in this century to an ethic that the earth should grow our homes.

Well, if urbanization continues as it is, and wooden buildings are only considered up to four stories, what will you do?

We need to reduce the amount of concrete and steel to increase the scale, and we are working on a 30-story wooden building.

We've designed them with an engineer named Eric Kirsch who works with me. We are doing this new job because we have new wood products that we can use and we call them mass timber panels.

These are panels made by gluing together young trees, small growing trees, and small pieces of wood to create giant panels that are 8 feet wide, 64 feet long, and of various thicknesses.

I think the best way to describe this is that when we think of wood, we are all used to two-by-four construction.

People jump to conclusions.

Two-by-four building is like the little 8-dot blocks of Lego we played with as kids, and with that size of Lego and two-by-four, you can build all sorts of amazing things.

But remember when you were a kid, sifting through piles in your basement and finding a big 24-dot Lego brick? "Wow, this is great. We can make something really big, and this is going to be great."

That's the change.

Mass timber panels are 24-dot bricks.

They are changing the scale of what we can do and what we have developed is called FFTT. This is a Creative Commons solution for constructing a highly flexible architectural system using these large panels that can tilt six floors at once as needed.

This animation shows very briefly how the buildings fit together, but these buildings can now be constructed by architects and engineers around the world for different cultures, different architectural styles and characteristics.

We designed these buildings to be safe to build, in fact, even though they are 30 stories high, to function in the earthquake-prone Vancouver environment.

Now, obviously, every time I talk about this, even here at conferences, people say, "Are you serious? Thirty stories? How's that going?"

And I got a lot of really good and important questions that I spent quite a lot of time trying to find the answers to when putting together the report and the peer review report.

Let's start with fire, focusing on some of them. Because I think fire is probably the first thing you think about right now.

fair enough.

And here's how I describe it.

If you bring a match, light it, and tell me to hold a log over and light the log, that doesn't happen, right? we all know that.

However, to start a fire, you can start with small pieces of wood and work your way up, eventually adding logs to the fire. And if you add a log to the fire, of course it will burn, but slowly.

Well, a new product we're using called mass timber panels looks a lot like a log.

It's hard to light, but when you do, it burns surprisingly predictably. We can use fire science to predictably make these buildings as safe as concrete and as safe as steel.

The next big problem is deforestation.

18% of our contribution to global greenhouse gas emissions is the result of deforestation.

The last thing we want to do is cut down trees.

Or cutting down the wrong tree is the last thing you want.

There is a model of sustainable forestry that allows trees to be harvested properly, and that is the only tree suitable for use in this kind of system.

Now I really think these ideas will change the economics of deforestation.

Countries with deforestation problems need to find ways to provide better value for their forests and actually encourage people to make money through very fast growth cycles. 10, 12 and 15 year old trees make these products and allow construction on this scale.

We calculated a building with 20 floors. Enough wood grows every 13 minutes in North America.

It takes that long.

The carbon story here is a really good one.

If you were to build a 20-story building out of cement and concrete, the process would generate cement and 1,200 tons of carbon dioxide.

If this solution were to be done with wood, it would sequester about 3,100 tons, for a net difference of 4,300 tons.

This equates to about 900 vehicles being removed from the road each year.

Remember the 3 billion people in need of new homes. This may have contributed to the population decline.

We hope to be at the beginning of a revolution in building methods. Because this is probably the first new way to build skyscrapers in over 100 years.

But the challenge is to change society's perception of possibilities, and that's a big challenge.

Engineering is the easy part in this, honestly.

And here's how I describe it.

The first skyscraper, strictly speaking, believe it or not, the definition of a skyscraper is 10 stories. But the first skyscraper was this one in Chicago, and people were afraid to walk under it.

But just four years after its construction, Gustave Eiffel was building the Eiffel Tower. As he built the Eiffel Tower, he transformed and changed the skylines of cities around the world, creating competition between places like New York City and Chicago. There, developers began constructing larger and larger buildings, pushing the boundaries further and further with better and better engineering.

We actually built this model in New York. In fact, the reason for choosing this location as a theoretical model for the soon-to-be-constructed engineering college campus was simply to show what these buildings might look like. Because the appearance is subject to change.

It is the very structure that we are talking about.

The reason we chose it is because this is a university of engineering and I believe wood is the most technologically advanced material I can work with.

Mother Nature just happens to have the patent, and we don't like it very much.

But it should be, a natural imprint in the built environment.

We are looking for this opportunity to create Eiffel Tower moments, so-called Eiffel Tower moments.

Buildings are being built all over the world.

In London, there are 9-story buildings, and I think the newer ones that have just been completed in Australia are 10 or 11 stories.

We are starting to push the height of these wooden buildings and hopefully in the not too distant future my hometown of Vancouver might actually announce the tallest building in the world at around 20 stories and I hope so too.

That moment at the Eiffel Tower would break the ceiling—the arbitrary ceiling of height—and allow wooden architecture to join the competition.

And I believe that eventually the race will start.

thank you.

(applause)

After 13.8 billion years of cosmic history, our universe has awakened and became self-aware.

From a small blue planet, a small conscious part of our universe began staring into space with a telescope and discovered something humbling.

We have discovered that our universe is far more magnificent than our ancestors imagined, and that life appears to be an almost imperceptibly small perturbation to a universe that should have died.

But we also found something inspiring. It means that the technologies we are developing have the potential to help life flourish like never before, not just for centuries, but for billions of years, and not just on Earth, but across much of this amazing universe.

I think of the earliest life as "Life 1.0". Because it was really stupid like bacteria and I never learned anything in my life.

We think of humans as "Life 2.0". Because we can learn. You might think of learning, as we geeks call it, installing new software into your brain, such as a language or a job skill.

Of course, "Life 3.0" that can design not only software but also hardware does not exist yet.

But maybe our technology is already making us "Life 2.1" with artificial knees, pacemakers and cochlear implants.

So let's take a closer look at our relationship with technology.

As an example, the Apollo 11 lunar exploration was successful and impressive. This shows that, if we humans use technology wisely, we can achieve things our ancestors could only dream of.

But there's an even more thrilling journey propelled by something more powerful than a rocket engine, and the passengers aren't just three astronauts, they're all of humanity.

Let's talk about our collective journey into a future powered by artificial intelligence.

My friend Jaan Tarin likes to point out that just like with rockets, making technology powerful isn't enough.

Also, if you're going to do something really ambitious, you have to think about how you want to steer it and where you want it to go.

Now let's talk about all three of artificial intelligence: power, steering, and destination.

Let's start with power.

I define intelligence very comprehensively. We want to include both biological and artificial intelligence, so simply define it as the ability to accomplish complex goals.

And I want to avoid the silly carbon-nauvinist idea that you can't be smart if you're not made of meat.

The growth in the power of AI these days really amazes me.

Think about it.

Not long ago, robots could not walk.

Now I can do a backflip.

Not long ago there were no self-driving cars.

Now we have self-flying rockets.

Not long ago, AI couldn't do facial recognition.

AI can now generate fake faces and simulate your face saying things you never said.

Not long ago, AI could not beat us at Go.

And Google DeepMind's AlphaZero AI took 3,000 years of human Go games and Go wisdom and ignored them all to become the best player in the world just by playing against itself.

And the most impressive feat here isn't crushing human gamers, but crushing human AI researchers who have spent decades handcrafting gameplay software.

And AlphaZero beat human AI researchers not just at Go, but at chess, something we've been working on since 1950.

This amazing recent advancement in AI really raises questions. “How far will AI go?”

I like to think of this question in terms of the abstract landscape of tasks. Elevation represents how difficult it would be for the AI ​​to perform each task at human level, and sea level represents what the AI ​​can do today.

As sea levels rise with advances in AI, a kind of global warming is occurring in the task environment.

And the obvious lesson is to avoid waterside careers -- (laughter) that will soon be automated and destroyed.

But there are even bigger questions.

How high will the water level eventually rise?

Will it eventually flood everything and rival human intellect at every task?

This is the definition of artificial general intelligence, AGI. AGI has been the holy grail of AI research since its birth.

By this definition, anyone who says, "Oh, there will always be jobs that humans can do better than machines," is simply saying that we will never have AGI.

Sure, we may still choose to have human jobs, or we may choose to give humans income and purpose in their work, but either way, AGI will transform life as we know it, as humans are no longer the most intelligent.

Now, if the water level reaches AGI, further advances in AI will be driven primarily by AI rather than humans. This means that further advances in AI could be much faster than the typical multi-year time frame of human R&D, raising the controversial potential for an intelligence explosion in which recursively self-improving AI will rapidly displace human intelligence by far, giving birth to what is known as superintelligence.

Now, let's face it: Are you planning to get AGI anytime soon?

Some prominent AI researchers like Rodney Brooks think it won't happen for hundreds of years.

But others, like Google DeepMind founder Demis Hassabis, are more optimistic and are working to make it happen sooner.

And a recent survey shows that most AI researchers actually share Demis' optimism, hoping that we'll have AGI within a few decades—in many of us's lifetimes.

If machines can do everything cheaper than us, what role do we want humans to play?

The way I see it, we are faced with a choice.

One option is to be content with the status quo.

we can say "Oh, let's build a machine that can do everything it can without worrying about the consequences.

So what could go wrong if we build technology that makes all humans obsolete? ”

(laughs) But I think that's embarrassingly lame.

In the spirit of TED, I think we should be more ambitious.

Envision a truly inspiring high-tech future and steer towards it.

Now let's move on to the second part of the rocket metaphor: steering.

We are making AI more powerful, but how can we steer toward a future in which AI thrives on humanity instead of afflicting it?

To help with this, I co-founded the Future of Life Institute.

This is a small non-profit organization that promotes the use of beneficial technology, and our goal is simply that the future of life exists and is as exciting as possible.

As you know, I love technology.

Technology is what makes us better today than we were in the Stone Age.

And I'm optimistic that we can create a truly inspiring high-tech future...

If, and this is a big assumption, we win the wisdom race, the race between the growing power of technology and the growing wisdom of managing it.

However, our old strategy has learned from its failures, so this will require a change in strategy.

We invented fire, failed many times, and invented the fire extinguisher.

(Laughter) We invented the car and failed many times. He invented traffic lights, seat belts, and airbags. But with more powerful technologies like nuclear weapons and AGI, learning from mistakes is a terrible strategy, don't you think?

(Laughter) It's much better to be proactive than to be passive. Plan ahead and get things right the first time. Because it may be the only time we have.

But it's funny because sometimes people say to me, "Max, shhh, don't say that."

It's a Luddite threat. ”

But it's not a threat.

That's what we at MIT call safety engineering.

please think about it. Before starting the Apollo 11 mission, NASA systematically considered all the problems that could arise if people were placed on top of explosive fuel tanks and launched where no one could help them.

And there were a lot of things that could go wrong.

Was it a threat?

no.

It's exactly the safety engineering that ensures mission success, and I think that's exactly the strategy we should take with AGI.

Think about what could go wrong to make sure it works.

So, in this spirit, we convened a conference of leading AI researchers and other thinkers on how to foster the wisdom needed to sustain AI's usefulness.

Our last conference was held in Asilomar, California last year and produced this list of 23 principles, signed by more than 1,000 AI researchers and key industry leaders since then. I would like to talk about three of these principles.

One is to avoid an arms race and lethal autonomous weapons.

The idea here is that any science can be used for new ways to help people or new ways to hurt people.

For example, biology and chemistry are much more likely to be used in new drugs and treatments than in new ways to kill people. This is because biologists and chemists have pushed hard, and successfully, to ban biological and chemical weapons.

And in the same spirit, most AI researchers want to stigmatize and ban lethal autonomous weapons.

Another principle of Asilomar AI is the need to mitigate income inequality caused by AI.

It would be a shame if AI could grow the economic pie dramatically, but we still don't know how to distribute this pie to make everyone's life better.

(Applause.) So if you've ever had a computer crash, raise your hand.

(laughs) Wow, that's a lot of manpower.

Now, you can understand this principle that we should invest more in AI safety research. As we entrust more decisions and infrastructure to AI, we need to figure out how to turn today's buggy and hackable computers into truly reliable and robust AI systems. Otherwise, all this wonderful new technology could malfunction and harm us, or be hacked and turned against us.

And this AI safety effort must include work on adjusting the value of AI. Because the real threat from AGI isn't the malice of stupid Hollywood movies, but the ability, the AGI, to achieve goals that don't quite align with our goals.

For example, when we humans exterminated the black rhino in West Africa, we didn't do it because we were an evil group of rhinophobes, right?

We did it because we were smarter than them and our goals weren't aligned with theirs.

But AGIs are inherently smarter than we are, so if we don't want to put ourselves in a rhinoceros' position when creating AGIs, we need to find ways to make machines understand our goals, adopt them, and keep them.

And whose goals should these be, in the first place?

What kind of goals should you set?

This brings us to the third part of the rocket metaphor: the destination.

We're looking to make AI more powerful and how to steer it, but where do we want it to go?

This is the elephant in the room that almost no one (even here at TED) talks about because we're so fixated on short-term AI challenges.

See, our species is motivated by curiosity and economics to build AGI, but if it succeeds, what kind of future society do we want?

We recently did a poll on this and were surprised to find that most people actually want to build superintelligence, an AI that is far smarter than us in every way.

The most common agreement was that we should be ambitious and help spread life into space, but not as much agreement about who or what should be responsible.

And I was actually pretty amused to see that there are people who want to make it just a machine.

(Laughter) And even at the most basic level, there was complete disagreement about what the human role should be. So let's take a closer look at the future we may choose to turn around.

So don't get me wrong here.

I'm not talking about space travel, I'm just talking about mankind's metaphorical journey into the future.

So one of the preferred options of some of my AI colleagues is to build a superintelligence, put it under human control, cut off from the internet, like an enslaved god, and used to create unimaginable technology and wealth for whoever controls it.

But Lord Acton warned that power corrupts and absolute power corrupts absolutely. So you might worry that perhaps we humans aren't smart enough to handle this much power, or even smart enough.

Also, aside from our moral trepidation about enslaving superior intelligence, we may worry that perhaps a superintelligence might outsmart us and take over.

But some of our colleagues are willing to allow AI to take over and even exterminate humanity, as long as they feel they are our worthy offspring, like our children.

But how do we know that AI is adopting our best values ​​and not unconscious zombies trying to trick us into anthropomorphizing us?

And shouldn't people who don't want the human race to die also have a say in this issue?

Now, if you don't like either of these two high-tech options, it's important to remember that low-tech is suicidal from a cosmic perspective. Because if we're not far beyond today's technology, the question is not whether humanity will be annihilated, but simply whether it will be annihilated by the next nasty asteroid, supervolcano, or other problem that better technology could have solved.

So how about eating our cake...

Are AGIs not enslaved but treating us well because their values ​​align with ours?

That's the gist of what Eliza Yudkowski called "friendly AI," and it would be great if we could do it.

It can not only rid us of negative experiences such as disease, poverty, crime and other suffering, but it can also give us the freedom to choose from a wonderful new variety of positive experiences, essentially making us masters of our own destinies.

In summary, our technology landscape is complex, but the big picture is fairly simple.

Most AI researchers expect AGI to happen within a few decades, and if you suddenly stumble upon it unprepared, it's probably the biggest mistake in human history - let's be honest.

It could enable unprecedented inequality, brutal global dictatorship with surveillance and pain, and possibly even the extinction of the human race.

But if we steer carefully, we can end up with a wonderful future where the poor get richer, the rich get richer, and everyone is healthy and free to pursue their dreams, and everyone has a better life.

Now wait a minute.

Do you want a politically right-wing or left-wing future?

Do you want a godly society with strict moral rules, or a hedonistic and free society like Burning Man 24/7?

Do you want beautiful beaches, forests and lakes, or do you want a computer to rearrange parts of the atom to make virtual experiences possible?

With friendly AI, we can easily build all these societies and give people the freedom to choose which society they want to live in. Because we are no longer limited by our intellect or simply by the laws of physics.

So the resources and space for this would be literally astronomical.

So our choice is this.

We either content ourselves with our future as a blind belief that any new technology is guaranteed to be beneficial, or we just say it to ourselves over and over as a mantra as we drift like rudderless ships towards our own obsolescence.

Or we can be ambitious. Think hard about how you steer your technology and where you want to go with it to create an age of wonder.

We are all here to celebrate an age of wonder. I feel that the essence of it should be to empower rather than overwhelm our technology.

thank you.

(applause)

Diana Reese: You might think you're looking through a window at a playfully spinning dolphin, but what you're actually seeing is a double-sided mirror in which the dolphin is playfully spinning at itself.

This is a self-aware dolphin.

This dolphin has self-awareness.

A young dolphin named Bailey.

For the past 30 years, I have been very interested in understanding the nature of dolphin intelligence.

How can we explore the intelligence of this animal, which is so different from ours?

I used a very simple research tool, a mirror, and it gave me great information that reflected the animal mind.

Dolphins aren't the only animals—that is, non-humans—that exhibit mirror-like self-awareness.

We thought this was an ability unique to humans, but it turns out that our closest relatives, the great apes, also exhibit this ability.

Then showed it with dolphins, then with elephants.

We have done this research in my lab with dolphins and elephants, and it was recently demonstrated with magpies.

Now, this is interesting. Because we accept the continuity of physical evolution, Darwin's view of this physical continuity.

But we were far less muted, and much slower, in recognizing the continuity of cognition, emotion, and consciousness in other animals.

Other animals are conscious.

they are emotional. they are aware.

Over the years, numerous studies involving many species have yielded exquisite evidence of the thinking and consciousness of other animals, animals whose morphology is very different from ours.

we are not alone.

We are not the only ones with this ability.

And what I hope, and one of my greatest dreams, is to give them the respect and protection they deserve as we become more aware of others and their relationship to the rest of the animal kingdom.

That's the wish I'm throwing at you here, and I hope you can really join in on this idea.

Now, I would like to return to the story of dolphins. Because dolphins are animals that I feel have worked closely and personally with for over 30 years.

And these are real personalities.

They are not human, but they are personalities in every sense of the word.

And there is nothing more alien than dolphins.

They are very different in body type from us.

they are fundamentally different. They come from radically different environments.

In fact, we are separated by 95 million years of divergent evolution.

Look at this body

And in every sense of the joke here, these are bonafide non-terrestrials.

We wondered how we could interact with these animals.

We developed an underwater keyboard in the 1980s.

This was a custom touch screen keyboard.

What I wanted to do was give the dolphins choice and control.

They have big brains and are very social animals. I wondered if I could give them choice and control to type symbols on this keyboard. Incidentally, this keyboard was connected to an Apple II computer with a Hewlett-Packard fiber optic cable.

It seems prehistoric now, but this was the age of our technology.

So the dolphins could press keys and symbols, and listen to computer-generated whistles to get objects and activities.

Here is a small video.

This is Delphi and Pan. When Delphi presses a key, he hears a computer-generated whistle and gets the ball. So they can actually ask for what they want.

What's remarkable is that they researched this keyboard themselves. There was no intervention from our side.

They studied keyboards. they played with it.

They understood how it works.

And they immediately started mimicking the sounds they were hearing on the keyboard.

they imitated themselves.

But beyond that, they began to learn associations between symbols, sounds and objects.

What we saw was self-organizing learning. Now I imagine what I can do with new technology.

With the technology that exists today, how can we create interfaces that are new windows into the animal mind?

As I was thinking about this, I got a call from Peter one day.

Peter Gabriel: I make my living in noise.

In good weather, it's the music. I'd like to talk a little bit about the most amazing music-making experience I've ever had.

I'm a farm boy I grew up surrounded by animals, so I looked into these eyes and wondered what was going on there.

So when, as an adult, I started reading about the amazing breakthroughs of Penny Patterson and Coco, Sue Savage Rambeau and Kanji, Pambanisha, Eileen Pepperberg, Alex the Parrot, and others, I was so excited.

What was also surprising to me was that they seemed much more adept at understanding our language than we were at understanding theirs.

I work with a lot of musicians around the world, and often we don't have a common language at all, but sitting in front of our instruments suddenly gave us a way to communicate and express our emotions.

So I started making phone calls, which eventually led to Sue Savage Rambeau, and she invited me over.

When I went down, bonobos had access to percussion instruments and musical toys, but they never used keyboards.

At first they did what toddlers do, just banging their fists, but I asked Panvanisha through Sue if she could challenge him with just one finger.

Sue Savage-Rambo: Can you play the grooming song for me?

I want to hear a song about grooming.

Play a really quiet grooming song.

PG: So the groom was the subject of this piece?

(music) So I'm jamming right behind, yeah this is what we started.

Sue encourages her to continue.

(Music) She found a sound she liked, found an octave.

She had never sat at a keyboard before.

Nice triplets.

SSR: Well done. It was so good.

PG: She hit well.

(Applause.) So that night we started dreaming, and we thought, perhaps the most amazing tool humanity has created is the Internet, and what if we could somehow find new interfaces, visual and auditory interfaces, that would make accessible to these amazing intelligent beings with whom we share the earth?

And Sue Savage Rambeau was so excited about it that he called his friend Steve Woodruff and started hustling with all sorts of people who were work related or inspirational. That led us to Diana, which led us to Neil.

Neil Gershenfeld: Thank you, Peter. PG: Thank you.

(Applause) NG: So Peter came up to me.

I lost it when I saw that clip.

He approached me with a vision of doing these things not for humans, but for animals.

And I was struck by the history of the Internet.

This is what the internet was like when it was born, and you could call it the internet of middle-aged white men, mostly middle-aged white men.

Vint Cerf: (laughter) (laughter) NG: Talk as one.

And when I first came to TED where I met Peter, I showed him this.

This was a $1 web server and was groundbreaking for its time.

And with the increased possibility of creating a web server for $1, it became known as the Internet of Things. This is literally an industry that now has a huge impact on healthcare and energy efficiency.

And we were happy with ourselves.

And when Peter showed it to me, I realized we had missed something, it's the rest of the planet.

That's why we launched this interspecies internet project.

Well, we started talking to TED about how to bring dolphins and apes and elephants to TED, and it turns out that's not going to work.

So we take you to them.

If you would like to switch over to the audio from this computer, we are video conferencing with cognitive animals and would like each to introduce themselves briefly.

So it would be great if we could do this too.

So the first place we plan to meet is Waco's Cameron Park Zoo, which has orangutans.

I live outside during the day. It's already night there.

So could you please move on?

Terry Cox: Hi, I'm Terry Cox from the Cameron Park Zoo in Waco, Texas. I have two bornean orangutans, Kerajan and Mei.

During the day, they have a beautiful and large outdoor habitat, and at night they enter this habitat, a night dwelling, where they can sleep in a safe, air-conditioned environment.

We're participating in the Apps for Apes program's orangutan outreach, using iPads to inspire and enrich animals while also raising awareness for these endangered animals.

And because they share 97 percent of our DNA and are incredibly intelligent, it's exciting to think of all the opportunities we have to enrich their lives and open up their worlds through technology and the internet.

We are really excited about the possibilities of the heterogeneous internet. I am enjoying the conference very much.

NG: That's amazing. Last night when we were rehearsing, he enjoyed watching the elephants.

The next user group is the National Aquarium dolphins.

Please proceed.

Allison Ginsberg: Good evening.

Hi, my name is Alison Ginsburg. We live at the National Aquarium in Baltimore.

Joining me are 3 of the 8 Atlantic bottlenose dolphins. Chesapeake, 20, the first dolphin born here; her 4-year-old daughter, Bailey; and her half-sister, 11-year-old Maya.

Today, here at the National Aquarium, we are committed to excellence in animal management, research and conservation.

The dolphins are very interested in what happens here tonight.

They aren't used to having cameras here at 8pm.

In addition, we are also passionate about various types of research.

As Diana said, our animals participate in various research studies.

NG: It's for you.

ok, that's great, thank you.

And the third user group is in Thailand, Think Elephants. Come on, Josh.

Josh Plotnik: Hello, my name is Josh Plotnik. I belong to Think Elephants International and I am in Thailand's Golden Triangle with elephants from the Golden Triangle Asian Elephant Foundation.

While we have 26 elephants here and our research focuses on the evolution of intelligence by elephants, our foundation Think Elephants is focused on bringing elephants into classrooms around the world virtually like this to show people just how amazing these animals are.

So we can bring our cameras very close to the elephants, put food in their mouths, show people what's going on inside their mouths, and show the world how amazing these animals really are.

NG: Okay, that's great. Thanks Josh.

And again, we've had a great relationship between them since we started rehearsing.

So at that point, if we could go back to the computer on the other side, we started thinking about how we would integrate the rest of the biomass on earth into the internet, and consulted the best person I could think of: Vint Cerf, one of the founders of the internet, who gave it to us. Vint?

VC: Thank you, Neil.

(Applause) A long time ago, in a galaxy — oops, wrong script.

Forty years ago, Bob Kahn and I designed the Internet.

Thirty years ago we turned it on.

Just last year we enabled our production internet.

I have been using the experimental version for the last 30 years.

The production version uses IP version 6.

There are 3.4 times 10 to 38 possible exits.

This is a number that only Congress can measure.

But it leads to what happens next.

When Bob and I did this design, we thought we were building a system of interconnecting computers.

What we quickly discovered is that this is a system for bringing people together.

And what you've seen tonight shows that this network shouldn't be limited to one species, but that these other intelligent and sentient species should also be part of the system.

By the way, this is the current system.

This is what the Internet looks like to a computer trying to figure out where traffic should go.

It is generated by a program that looks at your internet connectivity and how all the different networks are connected.

About 400,000 networks are interconnected and independently operated by 400,000 different governing bodies. The only reason this works is that they all use the same standard TCP/IP protocol.

Well, you see where this is going.

The Internet of Things indicates that many computer-enabled appliances and devices will also become part of this system. The appliances you use around the house, the appliances you use in the office, the appliances you carry around yourself or in your car.

That is the future of the Internet of Things.

Now, the important thing about what these people are doing is that they are beginning to learn how to communicate with species that share a common sensory environment, not with us.

We are beginning to explore what it means to communicate with something other than just another person.

Well, we know what happens next.

All kinds of sentient beings can be interconnected through this system and I can't wait to see these experiments unfold.

What happens after that?

Well, let's see.

There are machines that need to talk to machines and machines that we need to talk to, so over time we have to learn how to communicate with computers, and not with keyboards and mice, but in the way we are used to, using voice and gestures and all the natural human language we are accustomed to.

So we need something like C3PO to be the translator between ourselves and the other machines we live with.

There is currently a project underway called the Interplanetary Internet.

It operates between Earth and Mars.

It operates on the International Space Station.

This is part of a spacecraft rendezvous with two planets in orbit around the Sun.

The interplanetary system is underway, but we have one last project. The Defense Advanced Research Projects Agency, which funded the original ARPANET, funded the Internet, and funded interplanetary architecture, is now funding a project to design a spacecraft to reach the nearest stars in 100 years.

What that means is that what we learn from our interactions with other species ultimately tells us how we interact with aliens from other worlds.

I can't wait.

(Applause) June Cohen: So, first of all, thank you. And I'd like to admit that the four people who were able to talk to us for four full days were actually able to stay for four minutes each. And thank you for that.

There are a lot of questions, but there are probably some practical things your audience might want to know.

You present this idea at TED — PG: Today.

JC: Today. This is my first time talking about it.

Tell us a little bit about where you're going to take this idea.

what's next?

PG: We want as many people here as possible to help us come up with smart interfaces that make all this possible.

NG: Mechanically, we have things like 501(c)(3) and web infrastructure, but they're not ready for practical use yet. So please expand it and contact us if you need information about it.

The idea is that this will be a wrapper around all these efforts to globally link great individual efforts in much the same way that the Internet acts as a network of networks, which is Vint's core contribution.

JC: Well, do you still have the web address you're looking for?

NG: Coming soon. JC: Very soon. I will get back to you about it.

Let me be quick but clear.

Some of you may have seen the video you showed and thought it was just a webcam.

What's special?

Can you talk a little bit about how you want to get over it?

NG: So this is a scalable video infrastructure, many-to-many instead of few-to-few, so it can scale to symmetrical video-sharing and content-sharing between these sites around the globe.

So much of the backend signal processing is done many-to-many instead of one-to-many.

JC: Well, on a practical level, what technologies are you looking at first?

You mentioned that the keyboard is a very important part in this regard.

DR: We are trying to develop an interactive touch screen for dolphins.

It's kind of a continuation of some of our previous work and we just received our first seed money for it today, so this is our first project.

JC: Even before the talk. DR: Right.

JC: Wow. wonderful.

Yes, thank you for your participation.

I am very happy to have you on stage.

Doctor: Thank you. VC: Thank you.

(applause)

Have you ever had a moment in your life that was so painful and confusing that you wanted to learn as much as possible to make sense of it all?

When I was 13, a close family friend, like my uncle, died of pancreatic cancer.

When this disease happened so close to home, I felt I needed to learn more.

So I went online to find the answer.

I surfed the internet and found different statistics about pancreatic cancer. That's where I got the shock.

More than 85% of all pancreatic cancers are diagnosed late and have a survival rate of less than 2%.

Why is pancreatic cancer so difficult to detect?

reason?

Today's "modern" medicine is 60-year-old technology.

He is older than my father.

(Laughter) But also this test is very expensive, $800 per test. Also, the test is grossly inaccurate, missing 30% of all pancreatic cancers.

A doctor would have to have an amazing suspicion that you have cancer in order to do this test.

After learning this, I thought there must be a better way.

So I set a scientific standard for what a sensor should look like to effectively diagnose pancreatic cancer.

Sensors should be cheap, fast, simple, sensitive, selective and minimally invasive.

There's a reason this test hasn't been updated in over 60 years.

That's because when we look for pancreatic cancer, we're looking at the bloodstream, which is already rich in tons of protein, and we're looking for tiny differences in these tiny amounts of protein.

Only one protein.

It's nearly impossible.

But my teenage optimism didn't deter -- (Laughter) (Applause) I went online to my two teenage best friends, Google and Wikipedia.

I got all of my homework from these two sources.

(Laughter) And what I found was an article listing a database of over 8,000 different proteins found in pancreatic cancer.

So I decided to make it a new mission to look at all these proteins and see which proteins act as biomarkers for pancreatic cancer.

And to make it a little simpler for myself, I decided to plan a scientific standard. Here it is.

Essentially, the protein first needs to be detected at high levels in the blood stream at an early stage in all pancreatic cancers, but only in cancers.

So I chipped away at this enormous amount of work, and finally, on the 4,000th try, I almost lost my mind and found the protein.

And the name of the protein I tracked down was called mesothelin. This is a common and common type of protein. Unless, of course, you have pancreatic, ovarian, or lung cancer, in which case you will find very high levels in your bloodstream.

Importantly, however, it is detected in the early stages of the disease, when the chances of survival are nearly 100%.

So, having found a reliable protein to detect, we shifted our focus to actually detecting that protein: pancreatic cancer.

Well, my breakthrough happened in a very unlikely place, perhaps the most unlikely place for innovation: my high school biology class, which absolutely stifles innovation.

(Laughter) (Applause) And I had a sneak peek in this article about something called a carbon nanotube, which is just a long, thin pipe of carbon about the size of an atom and 1/50,000 the diameter of a human hair.

And despite its very small size, it has these amazing properties.

They are like material science superheroes.

And while I was secretly reading this article under my desk in biology class, we were supposed to be looking at another class of wonderful molecules called antibodies.

These are very good because they only react with one specific protein, but they are not as interesting as carbon nanotubes.

And then, when I was sitting in class, I suddenly had an idea. You can combine the carbon nanotubes I was reading about with the antibodies I was thinking about.

Essentially, by weaving bundles of these antibodies into a network of carbon nanotubes, we can construct a network that reacts with only one protein, but in addition, the properties of these nanotubes change their electrical properties based on the amount of protein present.

However, there are pitfalls.

These carbon nanotube networks are very fragile.

And they are so delicate that they need to be supported.

So I decided to use paper.

Making a cancer sensor out of paper is as easy as making my favorite chocolate chip cookie.

(Laughter) You can start with water, pour in the nanotubes, add the antibody, mix, take the paper, soak it, let it dry, and you can detect cancer.

(Applause.) Then, suddenly, I had an idea that would taint my brilliant plan.

You can't do cancer research on your kitchen countertop.

My mother wouldn't really like it.

So I decided to go to the lab instead.

So I entered a budget, material list, schedule, procedures, and emailed it to 200 different professors at Johns Hopkins University and the National Institutes of Health—everyone who had anything to do with pancreatic cancer.

I sat waiting for a flood of positive emails saying, "You're a genius! You're going to save us all!"

And -- (laughter) And then reality became reality, and in the space of a month, 199 out of 200 emails were rejected.

One professor went over all my procedures. I'm not quite sure where he's been so far, but he thoroughly went through every step and said why it equals the worst mistake I could make.

Apparently, my professors didn't appreciate my research as much as I did.

However, there are also bright spots.