

Program Information:

Title: Six Easy Steps to Avert the Collapse of Civilization

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ALEXANDER ROSE: Good evening everybody, please take your seats. As some of you know we start these talks off with a long short, a short film that exemplifies long term thinking. This long short is one of the shortest at sixty seconds and probably covers the longest time span at several million years.

STEWART BRAND: And for the next four and a half billion years. Good evening I'm Stewart Brand from the Long Now Foundation. As for tonight's speaker how many here have read Sum Tales of the Afterlife, how many have given copies to their friends. That happens a lot and it's going to happen more.

DAVID EAGLEMAN: Okay so this is you and you live in a fantastic, terrific society and you would probably think that there's no way that anything's ever going to happen in this society. You can't even imagine how something like this would fold and collapse. It's very difficult to imagine, but note that you would feel exactly the same way if this were you and you lived in the Roman Empire. You would have thought exactly that same thing and if you lived in ancient Greece it's impossible to imagine that your whole society would fold and collapse. Similarly if you were living in ancient Egypt or in the Mali Empire in Africa it would be very difficult to imagine these things. But in fact an astounding number of civilizations have come before us and they have collapsed and centuries of progress and development and invention have caved in on themselves and what this has left is nothing but archeological ruins and scattered genetics. So some of these civilizations here have declined slowly and others have suddenly toppled and scholars are still trying to figure out why, and there's an entire academic discipline that's devoted towards figuring out why societies collapse? Now one of the main reasons to figure out why societies collapse is to figure out how to avoid that happening to us. So when you sift through the evidence about the different societies and how they fell, you find that there are things in common. Things in common that cause them to collapse and these include things like disease, natural disaster, political corruption, economic meltdown and resource depletion. So the civilizations that survive are those that have either been lucky or the ones that have developed new technologies to circumvent these challenges. What I'm going to argue tonight is that we are a very lucky civilization because we have sort of accidentally invented a technology that I think obviates many of the threats that have caused previous civilizations to collapse. This is a con-activity map of the Internet. What I'm going to do tonight is present a case of this rapid electronic network system, it provides six very important steps that we would want to avoid collapse. So I think we're at a water shed moment in our history and this may just be the thing that saves our future. For each step I'm going to explain why it matters historically and what still remains for us to do to keep ourselves safe. Step number one for avoiding the collapse of civilization is try not to cough on one another. This is a virus and disease epidemics caused by microbes like

this, viruses and also bacteria; these are the things that precipitated the fall of the Roman Empire and of the golden age of Athens and of most of the empires of the Native Americans. It's sort of surprising that when you look at the largest threat to the survival of civilization that something so small, and in fact it's so invisibly small that viruses and bacteria weren't understood until very recently in history and yet despite their small size these have caused more death and destruction than all the famines and wars put together. Take as an example small pox which was the most destructive disease in history. It's killed hundreds of millions of people between ancient times and 1977 when it was finally eradicated. The Romans lost up to a third of their population in parts of their empire and about a millennium later what happened is that the crusaders came back from pillaging distant land and they brought an epidemic of small pox to Europe. Europeans then went over to the new world, they brought small pox to the new world and in doing so it devastated the Incas and the Mayans and other natives there. Some of you may know in 1707 small pox wiped out a third of Iceland. Similarly the black plague, *Yersinia Pestis*, this wiped out a third of Europe starting in 1347 and then it kept coming back to haunt Europe century after century. Yellow fever so badly decimated Napoleon's army's in Haiti that Napoleon gave up the idea of having a Western French empire just because of yellow fever. Because of his 22,000 crack soldiers he had sent to Haiti, 21,000 of them died so that's why Napoleon sold the Louisiana Territory to the United States because he said I just don't want to be running this show confronting diseases that I no longer understand. So he sold it for roughly five cents per acre which in a bloodless manner doubled the size of the United States. It goes on and on, there are these viruses and bacteria that have really navigated the course of history in major ways. What I'm going to suggest is that the Internet is really our key to survival here and this is for three reasons. First what the Internet gives us is the ability to work remotely and when you can work from home telepresently, what this allows you to do is inhibit viral transmission by reducing face to face contact, the human to human contact. So here's the idea, the next time that there's a really killer virus coming our way, if businesses are prepared in advance, what they can do is really leverage telepresence to keep supply chains running with the maximum number of employees working from home. Now this isn't going to keep everybody off the street but it's going to vastly reduce the density and it turns out that when it comes to epidemics that's all you need to do. You just need to get things below a tipping point so the reason viruses have this sort of tipping point is because viruses have a limited lifetime and a certain probability of infecting somebody. If you have very low host density then the virus dies before it can get to a new host. But as soon as you get enough people together then it can find new hosts and you go from some sort of equilibrium state into an epidemic, it really blows up. In fact you can see this sort of thing happening every Christmas holiday season with people shopping in the malls, because they all bunch together and then you cross over this population tipping point and then everyone gets the flu and cold. Now here's the problem, in the past societies have reacted to epidemics by bunching together so for example in medieval Europe when the black plague hit and other plagues like it, war and religious factions who spent all of their time killing each other would show solidarity in the face of all this death by marching together in the streets together to show that the Catholics and

the Protestants could be friends in the face of the plague. Well that was the real misstep in terms of density. It turns out that the Native Americans in a show of good will, they would gather in the tents of people who were infected with small pox, everyone would gather together and again unfortunately that was a gesture that was sort of ill fated. This is exactly the fear that all major medical centers have the next time we have a new strain hitting us, whether it's the Asian flu or Swine flu or something, the big fear that medical centers have is that everybody with a cough is going to come flocking into the medical center to get checked out. This is really dangerous. I think this is the second great opportunity afforded to us by the net besides telepresence is telemedicine whereby with increasingly sophisticated technologies we don't have to have patients coming in and bunching up together but instead we can have diagnosis from a distance. The telepresence and the telemedicine are very useful because they keep the population density below a tipping point. I think there's a third benefit that we get from the Internet which is we can optimally direct resources when there is an outbreak. You may know that the Center for Disease Control tracks the flu by tracking what happens at the local hospitals. Now the thing is that it takes two weeks for the CDC to put together their report. It lags the actual flu outbreak by two weeks, so Google came up with a better idea. What they do is they track where people are searching for terms related to the flu so if their searching for information on symptoms or medicines or something it turns out that over the course of the nation that serves as an excellent proxy for where there is a flu outbreak. While the CDC's report lags by two weeks, Google's lags by only a day. This gives us a very rapid way to know dynamically exactly where the flu is and where the outbreaks are happening. Unlike previous generations that were brought down by disease, especially because they didn't know how to react in terms of density and sparseness, we can now do better because of the Internet. If we're well prepared when the next epidemic arrives we can fluidly shift into a self quarantine telepresence society in which the microbes fail by dent of host sparseness. There is a lot of talk of course about the ills of social isolation and everybody sitting on facebook, but whatever those ills are it [Inaudible] a lot worse for the microbes than it does for us. Although we're well into the step there's work to be done if we want to save our civilization. Businesses really need to work on developing their disaster plans and their work from home epidemic plans. I wrote a paper on this in the Journal Nature about five years ago and I've been watching what businesses are doing. I've been monitoring how this has been going. Some businesses are doing it, most aren't still. It's really important to try to get businesses to do this and it's extremely easy to test, to work out the kinks, to have everybody to work from home. The second thing is in society we really need to keep developing telemedicine and similar ideas like that. So that's step one where the Internet already gets us a long way down that road of not coughing on each other. The second way that I propose the Internet is going to avert the collapse of civilization is with this. You don't want to lose things so in a battle between Julius Caesar and Tony the eighth, Julius Caesar got backed into a sort of funny military move and what he ended up doing was burning his own ships at the dock. Now military historians talk about whether it was a good idea or not but the thing was he accidentally lit the docks on fire and that burned down the library at Alexandria. Now the reason that was such a

tragedy is because the library at Alexandria had for a very long time been collecting the manuscripts of every single person who passed through the port. So if you were going through Alexandria you had to give up your manuscripts for careful copying by the scribes and then they would give it back to you. So what the library housed was all of the knowledge at that time. This was the repository. The problem was it was the single repository and when it got torched; it's now just a memory. The thing is that all the knowledge collected over that period of time was lost entirely in a single fire. It turns out that the learning and discovery of the Mayans met the same fate in the bonfires of the Spaniards. Of the thousands of books that the Mayans had written, that cataloged all of their learning and discovery and so on, we only have four of them. Only four survived in the modern times. Now can you imagine somebody trying to understand our civilization by reading let's say the Bible and Frankenstein and Harry Potter and Twilight. That's the situation we're in where we're trying to understand the Mayans. All of their knowledge is gone it was burned. The Minoan civilization was a flourishing civilization between 2700 BC and 1450 BC. It was on the island of Crete, they had all kinds of trade and discovery. Here's one of their Frescos, this is known as the Phaistos Disc from the Minoans. Does anyone know what those symbols mean? Nobody does, join the club, yeah exactly, because it was completely lost. In fact they weren't even called the Minoans, that's not what they called themselves. That's a name that a British archeologist gave them because we don't know what they called themselves. So everything they had and knew was lost to us. So knowledge is hard won by societies and civilizations but it's very easily lost and it proves impossible to estimate the number of museums and archives and libraries and houses of learning that fell under the swords of invaders or under the wrecking balls of natural disasters. So the problem is history is characterized by the sort of amnesia where you have civilizations that flourish if you can imagine little fires on the surface of the globe there where there's a fire that happens for a while and then it gets doused out for whatever reason and everything they learned is now forgotten. The thing is that this impacts survival; this isn't just some sort of historical interest thing. So take as an example inoculation. Many people know that in Europe inoculation was introduced by Lady Montegut, and the idea is that you introduce a little bit of the virus to somebody and that confers immunity to a bigger dose of the virus. For example with small pox, this is where it was used. But inoculation isn't just a good idea it's a great idea because it really reduces the death rate. But what's not so widely known outside of western circles is that Lady Montegut didn't invent this, in fact the Audubon Empire where she first saw it, they didn't even invent it. It turns out that this inoculation had been in practice in China and India and Africa for centuries unbeknownst to the Europeans. For example in China inoculation was underway since the tenth century and by the time of the Ming Dynasty in the 1500's it was widely practiced, everybody was doing it. But the Europeans had to sort of re-stumble on this on their own much later. Does this matter? Well you bet it matters because millions of people died in the meantime while this was going on while some people had the knowledge of inoculation and others didn't. Now Edward Jenner in 1796 improved on inoculation instead of injecting somebody with small pox you used cow pox instead which makes them less sick but it also confers the immunity. Well that was a great idea that Jenner had except we now know that six people

in Germany and England had the same idea and they had shown the success of that idea but nobody knew. What happened is the little fires got lit but they didn't spread so everybody had to independently rediscover this. Now as I mentioned it really matters if these things have to get rediscovered or if they can catch on and spread because at the same time that all this was going on with Lady Montegut and then later with Dr. Jenner, Native Americans were dying of small pox. The knowledge existed in other places on the planet but they didn't exist as these whole empires were falling here. Okay what happens is if you can imagine these little fires going on, I should mention two more examples actually. This is stunning but did you guys know that basic plumbing ceased to exist for a millennium after the collapse of the Roman Empire. People forgot how to do plumbing, they had to rediscover that a thousand years later. One more example in the year 1900 three different botanists independently discovered the rules of genetic inheritance which Gregor Mendel had quietly published forty years earlier. It was independently rediscovered three times in the same year. If you can imagine these little fires, you've got inoculation that goes away and you've got basic plumbing and you've got the rules of genetic inheritance and what you really want is for an idea to get discovered once and then to really catch fire. That's what you want to happen and that's what the Internet is good for because it's distributed and when you distribute ideas it can latch on everywhere and get spread around and in fact this was one of the original motivations for the Internet was to have distributed storage. The big idea is when you distribute things bits of knowledge and transformed ideas can latch on immediately. The news spreads everywhere quickly and redundantly and it makes it very difficult to erase. So fires like the library of Alexandria and floods and so on have a very difficult time erasing such a knowledge set. So for example in my field as a neuroscientist I everyday use Pop Med which is the central collection of all of the bio medical research. So anything that's discovered anywhere on the earth is going to end up in here very quickly and I can find it with a few clicks. There's a company called JSTOR which some of you may use, they scan these old archives of all these old journals from the 1600 and 1700's. Journals that nobody goes down to the library and actually dusts off anymore, now it's fully text searchable, you can find things that were once lost to history, they've been exhumed now and they're all right there at your fingertips. And of course with something like Google books you have the worlds writing is all there and it's clickable and discoverable and readable. So the idea is if the Mayans had had Pop Med they could have just looked up inoculation, right, and unlike the library of Alexandria you can't torch Google books, that's really here to stay. That's the idea. Now as an example of the modern appreciation of storing knowledge in a redundant indestructible manner, everyone recognizes Michelangelo's David. Well this is not actually Michelangelo's David, this is Michelangelo's David and it's being scanned with a 3D laser scanner, it's from a group Stanford and University of Washington. What they did was they scanned the entire statue and what you're seeing on the right is a reproduction of it made of a billion polygons at a quarter of a millimeter resolution. This is the largest scanned object in the world right now and the idea is that if the museum were to be suddenly destroyed in an earthquake, this statue would not be lost. It's totally reproducible now; this is what's known as the digital Michelangelo project. You can download this onto a CD under jump drive it's stored all over the

world and what this means is, by the way, this just got completed a few months ago, so previous to that if this hadn't been done and there was an earthquake it would just be utterly lost. There would be no more statue there. Now this is just a piece of art of course but I'm using this as an example of the way that we can create things now and make them immune against destruction. Where this becomes really important is with the intellectual discoveries that might be happening anywhere on the earth and that might become really important for our future. We won't be losing those ideas anymore and we can draw on them when we need them and we're not wasting time with parallel rediscovery as has happened so many times in history. This allows us to optimally solve problems including problems that we don't even know are problems yet. Okay, so step two is distribute, don't reinvent. Now the fast spread of these ideas obviously injects noise into the data base but it also very importantly prevents the loss of discovery. In this way societies can optimally ratchet up and we can use the latest bricks of knowledge in our fortification against existential threats. I think we're doing a good job here, there's a lot more that we're going to develop here, for example, aside from doing digital statues I don't see why we couldn't do full digital cities and combine for example Flickr and Microsoft Photosynth passively and reconstruct very fine three dimensional detail of everything that's out there and have that for the future. Right now that's a lot of data but in four years it won't be. I've been thinking about ways to improve information science so that you could not only make sure that none of the information is not lost but you could develop algorithms some day that could actually go and read all the papers in Pop Med and analyze them and start constructing new hypothesis and experiments and that ratchets things up even faster. So there is a lot of room to grow here but I think we're well on our way on this step for saving civilization. Okay, step number three. Tell each other about things faster. What you're seeing in the top left here is an image from Pompeii which was destroyed when Mount Vesuvius blew and covered the city in ash. What you're seeing in the lower right is a Fresco from the Minoan's civilization that I mentioned before which was destroyed by a tsunami. Here we see the Harappa civilization which is in between India and Pakistan on the coast which disappeared entirely and Meghito which is in modern day Israel, both of these seem to have fallen to earthquakes. So in all these cases natural disaster suddenly made a civilization disappear. When I really started thinking about the relationship between natural disaster and the Internet is when I was watching what was happening with the California wildfires starting several years ago. So what happened was Californians were glued to their television sets trying to figure out if their neighborhoods were in danger. Here's a picture from San Diego and you can see the fire way in the distance. What people wanted to know was am I in trouble? So they turn on the news station let's say CNN and they got disappointed because what happened was CNN was spending all their time covering celebrity mansions and they were looking at whether these mansions in Hollywood and Malibu were going to be in danger and somehow these houses were taking up air time in proportion to their square footage. So if you want to know if your neighborhood is in danger that's not useful to you. So what happened is you could see this several years ago happening something tipped, something changed and what happens is everybody turns off the TV and they went to their computer, they start taking Geotag cell phone pics, they started twittering, they started

updating their facebook pages and what happened is the news started spreading very fast. The news started spreading in a very accurate way faster than the front of the fire and faster than CNN could cover it because essentially what you had were all these home journalists. You had journalists embedded on every block in every home and people were taking information and putting this out there. What happened was this decentralization and this massive networking really sped up the information in a way that old news networking just couldn't compete with anymore. So that got me thinking about what happens when you do and you don't have this kind of networking in the face of a natural disaster? Take what happened in December of 2004 when there was an earthquake underneath the ocean and that caused a massive tsunami that hit all of the lip of the Indian Ocean and caused a devastating tsunami in Southeast Asia. It all happened without warning, nobody saw this coming. People saw the water receding and they thought it was interesting, they went out there and everybody knows about the thousands of people that died. Contrast this with what happened in the Pacific Ocean just four weeks ago, February 27th. What happened was the Pacific Ocean has a tsunami warning system because in 1964 there was a giant earthquake in Alaska which triggered a tsunami and after that happened scientists went and built this specific tsunami warning system, essentially it's a bunch of buoy's that are sprinkled out over the entire ocean and they track what's happening in real time and they're connected to an informational way of getting the word out. So what happened on February 27th, just four weeks ago, was that there was an underwater earthquake and the system picked up these shock waves and sent out the word. What happened is within hours the beaches in Hawaii were completely evacuated, there was nobody there everyone went up to the high grounds people were sort of festive about it and got a picnic or whatever, but they were up in the high grounds, nobody was on the beaches. The U.S. Navy took their ships from Pearl Harbor and steamed them out so they wouldn't be caught in near shore damage. It turns out what happened is the big wave never came, it was sort of a false alarm but it was a tremendously successful test of the system. Because had the wave come nobody would have been hurt because there was great warning that happened there. So the Indian Ocean lacks a system like that and so I think what we have is this fantastic contrast just in the last few years of what happens when you do and you don't have the sort of network communication where you can get the word out very quickly. And if you can imagine that if the Minoan civilization had had a tsunami warning system then they'd still be here with us and they would be sitting in the audience next to you. Okay, I want to give another example of how having fast information like this impact existential threats so imagine that the Pompeian's had had electronic communication when Mount Vesuvius blew and this was in the year 79 and the volcanic eruption actually happened in two phases. What happened the first day is over the course of about twenty hours there was this huge plume of pumice that rained over the course of the day about nine feet on Pompeii, but that's not what killed people. Actually what kills people often with these volcanic eruptions is what happened the next day, it's called pyroclastic flow. What pyroclastic flow is, is you've got this hot rock and gas and dust that's screaming down the side of the volcano at a hundred miles per hour and this is a thousand degrees in temperature, right so this is what kills you. It turns out that this is what eventually hit Pompeii and it hit all the people that were still there and this is what killed them and what

destroyed the city. By my calculation here's Vesuvius right here and here's Pompeii, by my calculation it would have been very easy with a networking system for the Pompeian's to march ten kilometers to the southeast in about two hours and it would have all been saved had they just known that this was coming, right? The idea is they were stymied by the lack of information and they were completely killed and then they were forgotten for centuries. Something that strikes me as very interesting is that Pompeii was rediscovered in the 1700's. Can you imagine now with our network system forgetting a city but it was forgotten where it was, who they were, it was forgotten until the 1700's. Okay so what I've been telling you about is early warning systems with tsunamis with volcanoes, but you might be thinking what about something fast like an earthquake, is that going to help anybody? Well maybe not, but certainly where the net has been proving very useful lately is with aggregating information for the public for crisis response. Just like the information was spread about the California wildfires, quickly this has all been sort of formalized. This is a site called Ushahidi.com and this was originally built in 2008 to monitor violence that was happening in the elections in Kenya. What you're seeing here is a real time map of areas of trouble in Haiti and what this is, is people can contribute with text messaging or e-mail or web submission exactly where trouble is. Different sorts of trouble too, emergencies, menaces, public health problems, all this stuff and in the immediate aftermath of the Haitian earthquake, this was a real go to site. Because everybody on the ground with a mobile phone can text and say hey here at this location something is happening and everybody gets to see this. It aggregates it and this optimizes disaster response. I also want to mention a very interesting twist on this. The fact that people we know will inevitably now a days twitter and text and update statuses from wherever there is a disaster, actually gives us another way to read information if things go really badly. We should be able to assess spots of really big damage because of the absence of information. So what I mean is imagine there is a really big hail storm somewhere where there is going to be a lot of twittering about that but now imagine that a giant meteor slams into the United States somewhere, it's the absence of any twittering from that spot that's going to carry the bad news at the speed of electricity. That's how we're going to know something really bad happened there. So the idea with step number three here with advanced communication networks, humans grow closer to omniscience and omnipresence and they can spread news of a disaster faster than the disasters wave front. And with the right circumstances that head start can provide the extra hours that saves us. We still have a long way to go with monitoring these sorts of disasters. Scientists right now are working on putting the same sort of monitoring system that's in the Pacific Ocean in the Indian Ocean so that we won't have a recapitulation of what happened in 2004 and it's a very good step and we'll continue to have better and more accurate disaster recovery sites. One of the things that has to be absolutely certain is that these sites don't go down right when we need them most. Okay, step number four, how to avert the collapse of civilization is you have to minimize tyranny. Political censorship has been a familiar specter in the last century with state approved news outlets in Rumania, China, Cuba, Iraq and lots of other countries. The official newspapers of the Soviet Union, what you're seeing here, you're seeing Pravda, had a complete lock on the news and foreign newspapers were only allowed in if they were published by communist parties

in other countries and approved by the Soviets. It wasn't just the newspapers, the Soviets had a firm lock on all the copying machines so that you couldn't even have self published books and disseminate flyers and that sort of thing. And of course the Soviets were very fond of editing photographs to remove people who had fallen out of favor with the party, so you see these sorts of things where people are just gone. This is Photoshop before Photoshop was cool. They were fond of doing this sort of thing, this is an unusual fact but even the weather reports were doctored so in Cheska Romania for example it turns out that certain weather extremes translate to time off from work and so those temperatures were never reached, ever. It turns out that Stalin did the same thing because if the weather report suggested that the sun was not going to shine on the day of celebration of the labor movement then it was doctored. In all of these cases what the censorship did was it hobbled cultural progress and it directly fomented revolutionary reactions and the reason is that censorship never seems to work that well with the population because people never really fall for doctored messages that easily. The parties always think that they're going to get away with it but in fact the population is usually smarter. So it doesn't do a regime much good, but the point I want to make is that censorship can be much more dangerous than just books and photos and weather. Tyranny can actually bring down a nation so on the far left here is Trofim Lysenko, he was a Soviet Agronomist who became extremely powerful in the USSR because he was favored by Stalin. So Lysenko had these theories about how to grow wheat and it turns out that we now know those theories were scientifically fraudulent but it didn't matter because he was favored by Stalin he got more and more power and by the late 1940's he was completely in control of Soviet agriculture about the way that everybody had to grow their wheat. The problem is with the centralized command is that the Soviet Union covered thirteen time zones and had an incredible variety of soils and climates and a lot of local common sense by local farmers and as a result this central rule setting that happened, it was called Lysenkoism, the central rule setting for how to grow agriculture was absolutely disastrous for the wheat crops in the Soviet Union. The local farmers knew better how to care for their crops but they were disallowed this freedom. What happened is that scientists who disagreed with Lysenko and it turns out that they were correct, they were disbarred from their position and several of them, at least four of them, were executed based on the fact that they were disagreeing with his genetic theories. Well historians traced part of the downfall of the USSR to this catastrophe that happened with their agriculture. It hobbled the economy and it crippled the proletariat belief in the new system and so the lesson for history is that having a centralized tyranny rarely works as well as having local information and nested feed back loops. Well the Internet allows us in a very natural way; it democratizes the flow of information by giving the open access to everybody. To the newspapers to the world, to the photographs to the world, to the blogs. Now obviously some postings that you find on the Internet they're full of doctoring and dishonesty and others strive for independence and impartiality, but in the end everything is available on the net for the end user to sift through and to give reason and consideration to. As a result of this, related to this, the Internet can allow for massive speedy democratic responses to things. So I'm just going to use this as an example because this happened just four months ago. On December 30th the Canadian Prime

Minister Stephen Harper announced that he was going to shut down Parliament until March 30th presumably so he could continue to work on a stimulus package. But a lot of people knew that the reason he was doing it was because he was about to get a vote of no confidence that would force an election and maybe force him out of office. So what he does is he just shuts down Parliament and he did it on December 30th so that everybody would be busy with the holiday season and in fact a lot of people were busy and sort of didn't notice. Well one student noticed and he started a facebook group which very quickly got 214,000 members and through this they were able to organize rallies all across Canada. Many of these rallies had 3,000 people at them and he was able to do this with such rapidity and effectiveness in a way that would not have been possible before the advent of the Internet. Of course we see this all the time now, we're seeing this all over the world. And so the idea is that governments can be kept in check this way with a sort of speed that wasn't possible before. Here's another way that governments can be kept in check by publicly aggregating and displaying information about vote tampering. This is a growing trend in many countries, this has been used in the voting, the national elections in the last few years by Nigeria, Kenya, Afghanistan and among several others. So the idea is that citizens using their cell phones can report disturbances or defamations or vote tampering or they can even just report incidents where things went well. What this has the effect of doing is keeping the election fair and free as possible, in fact I mentioned earlier the crisis mapping tool Ushahidi, it was developed in Kenya for the 2008 elections when a lot of violence was going on. What this does is it publicly shines a light on the election and this is just one way to keep governments a little bit more transparent than they might otherwise volunteer to be on their own. Now obviously the benefit of the Internet in shining lights on governments and minimizing tyranny is in danger in many places around the globe as most of you know, I'm sure. In 2006 Google agreed that they would sensor traffic in China because it was obviously very appealing to tap into a market of four hundred million people. As many of you know if you search for Tiananmen Square protest most places in the world on Google this is what you get. If you're inside China and you search for Tiananmen Square protest this is what you get. So what happened very recently of course is that Google changed their mind on this topic and recently started putting into practice ways of circumventing the great fire wall of China. In doing so they are taking a real risk about giving up this giant chunk of market, but I think it's a very admirable thing to do if you care about mitigating tyranny. It puts the Chinese authorities in a very difficult position which is interesting because the government there is weary of agitating local Google users who tend to be very highly educated and vocal. So I bring this up to emphasize this point that minimizing tyranny with the Internet is not automatic, it's not straight forward, it's going to require constant vigilance. In fact, here's another example of that: This is a map of the Internet and information flow around the world and how free it is and you can see that the red areas are sort of the usual suspects where there is really serious danger in terms of the openness of the information flow, but what some of you might not know is that the government of Australia in 2008 decided to try to pass mandatory ISP filtering on all the web sites and in 2009 it was leaked that they had a list, the black list of all the sites they were going to filter out. Now this hasn't actually been put into

practice in Australia but it is a subject of real political discussion and the government that's in power wants to do it and this is something for us to really be aware of. Because again while the Internet can reduce the control of a government there is constant vigilance that is required. So I mentioned these difficulties, even in the face of these difficulties, it remains likely that future attempts at censorship are eventually going to be defeated by the new technology of the Internet or at least the Internet will help with this. Among other things as citizens our next steps are first of all to demand transparency in government at every point that we can, this is already under way with sites like recovery.gov and we should financially encourage companies who stand up against censorship. There are several companies now that are considering pulling out of China. Now it's complicated, some of them have various reasons, some of their servers have been hacked and they're mad about that. They have various reasons for wanting to do that, but I think the [Inaudible] is on us as a population to give positive feedback to those companies. Google's stock has fallen 6% since they started having this trouble with China and that's a shame. Thinking a little further into the future, eventually people are going to get very good at having home brewed satellite uplink systems which means that you can circumvent government firewalls all together. I think all these steps are going to be very important in terms of minimizing tyranny and the Internet is one of the technologies that can really help us get there. Step five: If you want to save civilization is to get more brains involved in solving problems. We all know about crowd sourcing and the idea here is that you solve problems by massive participation and what you do is you get lots of people together and their essentially the nodes of the super computer. There's been a lot of scholarly writing and popular writing about the wisdom of crowds and the fantastic properties you get out of crowd sourcing. For example on the site Foldit, protein folding is an extremely intensive computational problem and the idea here is that you turn it into a game and you have end users work on the game and see how they can fold it and see who can get the minimum energy configuration and then you can win prizes and so on. So what you're doing is you're distributing this very hard problem to lots and lots of people. It's a great idea for crowd sourcing. CSTART is a new organization that's just begun and their idea is to do open source knowledge gathering to get to the moon. So we don't have to depend on governments anymore we're going to get to the moon by ourselves by everybody sort of pitching in the same way you can do open source movements to develop really good software. So that's the idea with crowd sourcing, but what I want to point out is that crowd sourcing really, the way it's going now, involves less than 1% of the world population who are actually involved in this sort of thing. I want to suggest an important way to go beyond crowd sourcing. Eighty years ago Virginia Woolf and her essay *A Room of One's Own*, she pointed out that half of the planet's writing talent had been squandered by the simple fact that women at that time didn't have the same opportunity as men to become writers. She imagined in this book what would happen if William Shakespeare had had a sister named Judith Shakespeare who was equally as talented. What would have happened? And her answer is we would never have heard of Judith Shakespeare because she simply wouldn't have had the opportunity. That's a real waste of human capital. Human capital is a term that originally was defined by Adam Smith and it refers to the skills of the labor force. It turns out that it's now becoming clear that

the development of human capital depends on open access to education and opportunities. Many economists have been really emphasizing lately the importance of cultivating human capital because the investment translates directly into economic output. In a world where we know that historical collapse is so tightly tied to economic meltdown civilizations would be well advised to leverage all the brain power that they have. The problem is most of the world doesn't have the opportunity to get the education that's afforded to a small minority. For every Einstein, or Yo-Yo Ma, or Barak Obama who have the opportunity for education there are uncountable others who just never get the chance. This vast under tapping of our civilizations potential steals security from our future. The Internet addresses this problem with a kind of natural ease by opening the gates of education in a way that's never been possible before. So a motivated teen anywhere on the planet can start walking through the world's webs of knowledge, starting with Wikipedia and then going to MIT's open course ware and getting an Ivy League education. Many universities launch this sort of thing, Rice University has a site called connections which is essentially Wikified text books from children to professionals and it's been very successful. So for the intrepid learner anywhere on the globe, if they can get a hold of the Internet, there are tens of thousands of courses on line, there are lectures, there are lecture notes, there are homework problems, there are quizzes, interactive web demo's and so on. And beyond the courses the world's scientific knowledge is now at the fingertips of everyone. So hunting down a scientific paper when I had first started graduate school you had to walk over to the library. Now everything is at your fingertips and the National Institute of Health has demanded that all the papers that are published on their dime, in other words, any scientist who has an NH Grant, now has to upload the published manuscript to Pop Med central. So the idea is that for the tax payers the fruits of their labors should be right there at their fingertips. If they're the ones contributing to the research they should be able to access that. The same with Archive.org, you've got all the physics papers available so all the world's knowledge is available right there to anyone who can get a hold of the Internet. If you're ever going to be a medical patient of course now's the right time to do it, until recently physicians had a lot of asymmetric knowledge over the patients, but with the proliferation of medical web portals and sites where patients get together and share information, the patients are better educated and that ends up being better for everyone. Okay, I know what you're thinking, you're thinking you know it's not actually trivial for kids in impoverished countries to get a hold of the Internet and much of the world does not have access still. Nonetheless, even the mere feasibility that completely redefines the playing field and people are working on getting computers into the hands of children all over. Many of you are familiar with the One lap top per child program, which builds very cheap computers and allows children to have these so that they can have this self empowered learning. There was a lot of development that went into One Lap top Per Child to make these computers very inexpensive and Negroponte, the guy who's been leading this charge, just announced that they're working on a new model of the computer which will be based on the tablet model and the advantage here is that it's a lot cheaper and more robust to build because the former model has nine hundred moving parts including the keyboard and the hinge and so on whereas the tablet model has none of that. So you can

do it for cheaper and it's more robust and you can get this into the hands of even more children. So this is a program that's underway and it's been tremendously successful. I talked a few steps ago about the retention of knowledge and the speed of spreading knowledge, but what I'm really talking about here is the creation of knowledge and I'd like to be able to come up with a better word than crowd sourcing which as I mentioned just uses less than 1% of the population working on these problems. Since there will be problems in the future that we haven't even thought of, in the face of that what we want to do is maximize our problem solving machinery and so what I think we want to do as we democratize education is move from crowd sourcing really to something like society sourcing where we're getting 10%, 50% of the population involved in really solving problems. It goes without saying that vast numbers of people on the planet will not take the opportunity to give themselves an Ivy League education, but for the first time in history it's widely available. So the Internet has sort of naturally accomplished a human resource capitalization that would make Judith Shakespeare proud. We're finally in a position to actualize the brains available in a worldwide population. There are a lot of steps that we need to do next. We need to keep increasing sites and application for crowd sourcing, contribute to open course where support open access publishing in all areas financially incentivize that and improve information science. I can go into that a little bit more. Finally the last step if you want to avert the collapse of civilization is try not to run out of energy. It turns out that carrying capacity is one of the main concerns on the mind of scientists and politicians and thinkers. It's the fugacity of the natural energy resources that we have is really the concern because when societies exceed their , in other words how much energy is available to support them, that's when all is lost. That's when they start fighting for the resources that are there and everything goes down the tubes. So this characterizes many different types of collapses that have come before us, so in Jared Diamond's book Collapse, he points out that a common reason for societal failure is environmental damage for example: deforestation, or soil erosion. In his book Ancient Maya, Arthur Demarest points out that the same thing that draught and a loss of soil fertility precipitated the fall of the Mayan even before the small pox arrived. It turns out that just recently people have come up with evidence for the exceedance of carrying capacity among the Minoan's, a civilization that I mentioned before that got wiped out by a tsunami. It turns out that archeological recovery shows evidence for deforestation around that part of Crete, meaning that if a tsunami didn't get them, carrying capacity issues might have. Well happily the Internet again addresses this sort of problem with very natural ease. I was recently just giving a talk at the NIH in [Inaudible] and I was absolutely amazed by these atavistic filing cabinets that lined the hallways and the rooms and they filled everything with this unnecessary gravity and no one accesses these anymore because all of the important papers of course have shifted into electrons at this point. So what remains in the hallways are these fossil like evidence of a recent age in which you measured information content, not by gigabytes but by cubic meters? The inefficiency of these giant filing systems has characterized everything, businesses and scientists until very recently. I'm going to suggest that the technological shift from bigger to smaller is more than convenient, it's absolutely critical to the future. Take for example our mail service, since the

introduction of e-mail our postal system which has now been demoted to the moniker of snail mail, has been hemorrhaging financially and they have been raising their stamp prices continually to try to keep up. Why, because everybody is sending their documents electronically, whether it's real estate contracts or book manuscripts or whatever it is everybody is sending this electronically. It's very difficult to estimate the billions of pounds of carbon dioxide saved by not having to ferry batches of paper everywhere for simple transactions. We can be sure that this makes a contribution to air quality. Similarly we've diminished the need to drive long distances to browse and purchase products and this has allowed many brick and mortar stores to shift a lot of their operation online. If you're shopping for a perfect set of cutlery or dishes or a shirt or something you might have previously driven around to several stores to look for this, to look over the stock, and now it's replaced with some minutes of web surfing, you find exactly what you want at the best price and you click to get a single delivery. Now I know what you're thinking, you're thinking well what makes you think that the delivery trucks are any better for the environment than if you drove around. Well there's a couple things, it turns out that one thing you might worry about is all the packaging that involves in delivery but of course all the companies that are moving towards more eco friendly packaging, they call it eco friendly packaging, but of course they're saving themselves money. The only reason that they ever had big packaging was to prevent shop lifting. You have to put things in big display packages so people can't stick it in their pocket and walk out. Well now you don't have to do that and companies increasingly they're all advertising how they're saving more and more and more on their packaging. So now things are very tight. Okay, but obviously we still have to worry about the trucks driving around, but the good news is everybody's trying to save money and energy and so it turns out that companies like UPS who deliver these things have developed these super optimization algorithms where they can figure out how to make deliveries in the most optimal way possible and some of you may know that UPS trucks don't even make left turns anymore. Why because left turns are terrible. You sit there, you idle, you waste a lot of time and gas, so UPS they never make left turns anymore, their super optimized and as a result they've saved millions of miles off their delivery route, they've saved millions of gallons of gas and they've reduced CO2 by a lot. In many cases it turns out it actually is much more efficient to have these things delivered to you and to your neighbors rather than you driving all over town in your inefficient, sitting alone in your car, left turning method. And then finally it's the case--so I'm a scientist and I see this all the time, people in businesses and other people see this in your own ways all the time, but we're having more and more meetings on line. A few months ago I was invited by the Journal of Nature to give a talk in second life and I was able to use power point slides and people dropped in from all around the world to hear the talk and it was a fantastic experience for me because there was not a drop of jet fuel burned for all the people to come and hear the talk. It was seamless and it was absolutely environmentally friendly. Now there are of course real costs for the forest of computers that under pin the Internet, but these costs are far less than the trees and the coal beds and the oil deposits that would be spent down for the same amount of information flow. A lot of people are working on ways to produce electricity more cheaply and quickly, but there aren't any such plans for trees and

coal and oil. So to summarize this many authors have pointed out that societal collapse can typically be cast in terms of energy. When energy expenditure begins to outweigh energy return, that's when collapse ensues. So next time you're annoyed by the accumulation of e-mails in your e-mail box just think about how grateful you are that it's not all packages and papers like it was in the old days. Okay, so what to do next, well I think it would really be useful for companies to commit to server farms around sustainable energy. Governments can incentivize us with tax breaks and you know I don't see in the future why we can't have phone apps where you're minimizing your own routes doing no left turns and figuring out how to go places and this is just in the near future. I think in the far future we're going to have even better ways involving crowd sourcing and other methods of really getting better energy efficiency. In Jared Diamond's book Collapse, he points out that societies often fall because of malfunctions in long distance trading for needed resources. And I think through the modern lens we can suggest that maybe the most important trade works nowadays, the trade networks nowadays are carrying zeros and ones. They're informational, they're in other words instead of sort of the silk route it's the fiber optic trading route. And what I've argued is that the Internet can in a very natural easy way defy six problems that play traditional roles in societal collapse, and these are the problems. Now of course I'm sure some people are scribbling down questions, now saying you know it's more complex than that and that's exactly right. There are a lot of things that the Internet will only address tangentially. There are many scholars who address why civilizations collapse, some point out that, very general things they don't change their fixed design for solving problems or they find problems they cannot solve. These are two famous ideas about why societies collapse. They are very general. I actually think that even though it's sort of tangential here the Internet with the crowd sourcing, the marketization of education and so on, the speed of information, I think it might actually be able to touch on these. There are others that it probably won't be able to touch on directly. Two men invented in 1948 listed many prerequisites for a civilization's survival, I've picked out some here that I think the net doesn't directly address. Basic nutritional needs, construction of a good legal system, maintenance of order with good executive and judicial branches, and having meaningful diplomacy abroad. These are all things that maybe the net doesn't directly address. And then I'm sure somebody scribbled this down on a piece of paper already, there is a really big problem with everything I've been saying which is what happens when the net goes down? We are completely married to this, I mean it's already the case that we're in this situation, but I'm arguing that it will save civilization and here's the real Achilles heel to the argument here. I think there are at least two ways that the net will go down, one of course is major electricity outages and I think what's going to need to happen is people are going to need to think very hard about back-up plans not only for the server farms but the routers, the end users people having waves at their own homes to run this and it might not, you might not want to just have it solar because there might be something like a nuclear winter where there is no sun, you maybe want wind, I mean there are a lot of really bad scenarios you can imagine where the net would go down and you're completely depending on it and you want some way that the whole society has a back-up plan here. I have a suspicion that the nets going to go down a few times

before people get really good about having home back-up plans and everybody along the way has a good method for this. Then of course there's going to be network attacks and we're already seeing some of this. The Internet in Iran went down recently and I haven't been able to find out exactly the follow up of what happened, but at the time they were saying it looked like cables were cut, these undersea cables and I think the juries still out about exactly what happened, if it was purposeful or not. What's clear is that in warfare of the future we're not going to be talking about just having rugged soldiers in camos and machine guns, we're going to be talking about young people in their work out clothes slamming energy drinks and fighting national wars this way with cyber warfare. This is really, as we get more and more married and interact with the Internet. That's going to be the future of warfare. I just want to wrap up with making one statement. Given how married we are to the Internet and given that this is the thing that might save us in various ways I think we should probably have something like an equivalent of the seed vault. This is the seed vault in Svalbard which holds five hundred different types of plant seeds and the idea is that if there's some global catastrophe you've got a back-up of everything here and you can actually reconstitute the crops of the world by pulling them out of this seed bank in Svalbard. So we need to have some sort of Internet seed bank, and I'm not talking about the Internet archive or just having a copy of what's happening on the Internet, I'm talking about things burned in the physical media that teach you how to generate electricity, how to build a computer and how to reconstitute the net. Because we might have back-up of all the data on the net, but someday if things get really disastrous we want to be able to actually rebuild the net. So that's all I'm going to say and I'm happy to take questions now. Thank you so much.