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**PROFESSOR:** I've prepared some slides, of course, but I don't know, please interrupt at any time and ask questions, OK? I've sort of got a big panorama of things to talk about. It's basically impossible to cover everything, OK?

I mean, basically I advertise this talk as an outlook for the future, and of course, that's too broad. So I've picked a few things which are of special interest to me, and what they are are the possible pathways to nuclear war. Now, as you know, what I talk about often is in comparing the danger to the planet, and of course, its population, of climate change and nuclear war.

So climate change is just-- I think the probability is pretty close to 100%. I don't know how to quantify it, but it's fairly certain that we are into an era of global warming and its consequences. And this is a slow, steady thing in terms of probability of occurrence with all its ramifications.

Nuclear war is much easier to avoid, but if it happens-- and of course, every day the probability is very low. That's what I call the probability structure. So the probability of a nuclear war any specific day is low. The cumulative probability is higher, of course. And if that event occurs, it's catastrophic.

So what happens is the destruction just starts in. The destruction, of course, is local in the place where the weapon blows up. The destruction, it depends how many bombs go off and how much soot goes into the air, but we could have global consequences if there are enough of them. A so-called nuclear winter.

So having said that, I just want to talk about-- and this is the fear, of course. And that's what keeps some of us worrying about this problem and working on it. So basically I want to talk about the possible pathways to nuclear war. I'll talk a little bit

about proliferation and the Non-Proliferation Treaty. I'll say just a few words about the possibility of nuclear weapons abolition. I'll talk a wee bit about Obama's record and the outlook. That's a pretty ambitious agenda.

There are endless debates about the utility of nuclear weapons. Some people are at least pro having them. Not using them, but having them, because, of course, they were pro in the one case that they were used, and of course, we used them on Hiroshima and Nagasaki. One group of people says that actually saved lives because the war ended more quicker that way. I think that's highly debatable, but it's a point of view which is held.

So it actually saved casualties and it prevented World War III. These are some of the arguments. I'm not trying to give all of them, but these are arguments that you can find in the literature. And you can find books, and this just goes back and forth.

And of course, the counter argument was that the use of atomic weapons in Japan was not necessary. What was really necessary was to agree that the Emperor could stay on, and that turned out to be the key that people argue. And certainly almost everyone agrees that the use of the second bomb in Nagasaki was something that should not have been done. I think there's much more agreement to that.

There are books that this use was actually the first step of the Cold War. Of course, many Japanese civilians were killed, several hundred thousand, and two cities were destroyed. On the other hand, we destroyed almost all the major cities in Japan by conventional weapons.

And of course, Japan did not have an unblemished record in Korea and China and so forth. I'm not going to go into that, but the moral dimensions of World War II are pretty horrible. I'll stop there. The inhibition about killing civilians pretty much disappeared in World War I and was just totally ignored in World War II, I would say.

And in the post-war era, the argument is that you didn't need nuclear weapons to prevent a war between the United States and the Soviet Union. I pretty much think that's the case myself.

So here are the questions. There have been no nuclear wars since the first two weapons were used. Of course, there have been many explosions, but they were tests. So was that deterrence?

There's a theory about nuclear taboo because they're morally so awful. I'm a bit skeptical, but it's a theory that's out there by an important Yale sociologist. Is it luck, other reasons, and so forth.

So many of us-- well, I'll give you some of my conclusions at the end, but the crucial question is does the possession of nuclear weapons make a country more secure? You heard this in the case of Ukraine when the Russians took the Crimean, when they basically have their stealth invasion of the Ukraine, which is going on as we speak. Would a Ukrainian nuclear weapon deter them?

And when the Soviet Union broke up in the end of 1991, there was a lot of discussion about what would happen to all the nuclear weapons. They were mostly in Russia, Ukraine, and Kazakhstan. And we managed to persuade the Ukrainians-- they were the toughest-- and the Kazakhs to give all those weapons to Russia.

But in fact, one of the things-- and there's a lot of history here-- but one of the best articles that I've read, and I think it's obviously true, states that in fact the Ukraine and Kazakhstan never really owned those weapons. They were really owned by the Soviet Union. The Ukrainian army was not prepared to take them in any way. They really didn't have an army. They hardly have an army now, 20 years later or something.

So there's no realistic way that the Ukrainians had a nuclear weapon that could be used. They had possession of nuclear weapons, but not the actual ability to use them. So it's a very funny thing. It's a very special case, and it's a very funny thing.

But that argument is heard. I would say more important, or at least as important, is is the present situation stable? This is a key question. Many people doubt it that our good fortune in not having any nuclear exchanges since 1945 is purely deterrence. if there isn't an element of luck or other issues involved.

And each specific case is different. So it's hard to generalize. I mean, one of the issues, one of the differences between physics and arms control, is how the lack in arms control is the lack, really, of science. How much more difficult the situation is to evaluate.

And of course, now with relationships between the United States and Russian, in fact, the whole west and Russia at a low point, probably a few decade old low point, the future of arms control seems bleak at this moment, I have to say. It's hard to maintain optimism. And finally there's this perennial question about abolishing nuclear weapons, which is certainly more and more remote as time goes on. But I think as academics we should think about it, because these are very important issues.

So we should think long-range is what I'm saying. It's not going to happen quickly, obviously. If at all. But is it desirable? There are two separate questions. Is it desirable and is it going to happen.

So immediately after the development of the atomic bomb, there were intense discussions inside of the Manhattan Project before the public knew about it. And there was this famous Franck Report, and the conclusions of the Franck Report are here. Use the bomb for a demonstration, not on cities. Share the secret.

The secret-- not necessary the details of how to make it. I don't think anyone ever proposed that. What's meant here is share the secret of its existence before its use. That's what they're talking about.

Because the use without notice, particularly without notice to the Soviet Union, would ensure the start of a war, a Cold War, and a nuclear arms race. And that's exactly what the scientists predicted. These were very sophisticated people. Franck was a Nobel Laureate from Germany who escaped from Hitler.

And there were many other things that happened. The scientists banded together. They formed the Bulletin of the Atomic Scientists, the Federation of Atomic Scientists, which still goes on although it's not as strong as it was. And they

developed this Acheson-Lilienthal plan, in which Oppenheimer played a major role. And it ended up as the Baruch plan, which was not really what was proposed, and it was turned down immediately by the Soviet Union for various reasons. I can go into them, but I won't.

So the era of possible arms control in 1945, 1946, collapsed in the beginning of the Cold War period. And what the scientists feared the most happened. And the other thing is-- and you hear this from the people who first developed the bomb and then worked as actively as they could against it, and many of them were at MIT. Some of the names you know very well. Victor Weisskopf. There was Hans Bethe from Cornell. And there was just a whole group of people, very prominent scientists.

And Hans Bethe-- both Viki Weisskopf and Hans Bethe told me personally, but they said it many times in public, that when we realized in about 1946 that there was no agreement was going to happen, we asked ourselves, what is the worst thing that could happen? And they said, we would build a hundred weapons. 100. And the Russians would build 100 weapons. And then we would face each other down with 100 weapons. That was the worst these sophisticated, bright men could imagine in 1946.

So what did people expect? First, the atomic scientists, they thought that the nuclear weapon was so horrible it would change the behavior of mankind. And politicians like Churchill and Roosevelt believed that this powerful weapon would allow England and the United States, with their monopoly, to be able to say the way the world evolved. So both sides were wrong. Typical.

So the influence that it had has been reasonably small. We never got the Russians to agree to almost anything we wanted them to do. For example, they took over Eastern Europe. We hated that. They did it. Et cetera.

You know, it just goes on and on. The Communists took China. We hated that. The list of things-- I just mentioned a few major ones. So that's what I mean by its coercive influence.

Its possession became a status symbol almost right away. But there is some deterrence in it. Deterrence isn't completely useless. Deterrence and abhorrence, a combination of the two of them I think, works to some extent. So there's been a non-use.

Now, I want you to look at this graph. This is the buildup of nuclear weapons between us and the Soviet Union. And you notice this scale? 5,000, 10,000. 100 is down here.

The Soviet Union blew up their first bomb four years after we did, as predicted. Not only was it predicted that they would get the bomb, but that it would take them three to five years. That was the number that was given by the atomic scientists. And it was hotly disputed in Washington, but so what.

And again, we built up to astronomical numbers. Tens of thousands of weapons. And finally we have a slow decline through nuclear arms control agreements and through terrifying events, like the Cuban Missile Crisis.

And the spirit of that build up is, I think, exemplified in this great cartoon, which you can read for yourself, from the middle of the Cold War. And I think this says the story.

**AUDIENCE:** Is that the only reason?

**PROFESSOR:** Fear.

**AUDIENCE:** Fear is the only reason?

**PROFESSOR:** Fear. Well, I mean, they developed all kinds of fancy strategies, but at the heart of it was fear. Just plain fear of a devastating first strike. And then you had to build up counterforce capabilities, be able to absorb the first strike, and able to destroy the enemy after the first strike.

But the astronomical number was mad. And it was called MAD, Mutual Assured Destruction. It was literally called MAD. Those of us looking from the outside-- but we weren't really on the outside, because we would have been the victims-- thought

it was mad.

But you know, logic is in a certain sense, irrelevant in this situation. I mean, there's such a grip of fear on both sides. And it's really true. I sat through the Cuban Missile Crisis personally with a dedicated Russian Communist who had actually come to work in my laboratory. It was a very interesting experience. He thought it was all the fault of the United States. Most of the people thought it was the fault of the Soviet Union. Most of the people here.

But I thought they were both at fault. You know, I thought-- not that they were equally nice people, but that they were just operating from too much fear. So they overdid it.

You know, this business of a hundred weapons. I often ask students in class how many weapons are enough, and nobody knows how to answer that question. But then I say, well, how many cities are you willing to give up? You now, in the case of the Russians, is it Moscow? Leningrad? That's two cities.

And there's a famous exchange between Jerome Wiesner, who was ex-president of MIT, and also a science adviser the Kennedy, with Gorbachev where he asked them exactly this question. And Gorbachev was just amazed. So well, there you go.

So I think it's fear and distrust, of course. Fear and distrust, they go together. And that's very important.

I just want to point out that one of our nuclear submarines-- this is the maximum loading, by the way. They're loaded a little less now, but it doesn't matter. I don't change this slide. But basically they have 100 and 300 kiloton warheads. So in order of magnitude, larger than the Hiroshima weapon on Nagasaki.

And each submarine has a maximum loading, it should say, of 96 warheads. They're independently targeted. You can destroy 96 targets. After firing, it takes 10 or 15 minutes to reach Russia. So you could-- it's kind of staggering. So the total explosive power is three times that of World War II. One submarine. It's incredible.

This is the present global inventory, more or less. You can see-- this is the number that counts. These are the strategic warheads, and you can see there the order of 1,500, which is this new START Treaty limit. We're just about at that limit anyway. And that all the other countries have typically a few hundred at the most.

This is all guesswork as to the numbers. It's not known. I think 10 for North Korea is probably a factor of two to three high, but it gives an order of magnitude. This is guesswork, frankly, because these are all secret. So people do the best they can. This is a table from Hans Kristensen and the Federation of American Scientists who keeps track of these things as well as he can.

**AUDIENCE:** How can they make these guesses?

**PROFESSOR:** Oh, they look at the literature and they look at budgets and they look at satellite pictures. They do their best. I think they have the right order of magnitude, but nobody claims they know the exact number.

I mean, if you talk to Hans Kristensen, who's very good, and who knows what he's doing, he's very smart and competent. He'll tell you this is educated guesswork. But it's more or less-- it's enough. You know, I mean, 90 or a hundred weapons. It's all-- a hundred weapons is overkill.

**AUDIENCE:** But is it usually the case where the countries would want to make that number look higher or lower than that?

**PROFESSOR:** They want it to be higher so that--

**AUDIENCE:** [INAUDIBLE].

**PROFESSOR:** Right? Except for Israel, which doesn't want to admit it has any, but they want it known anyway. So it's a complex game. But for most of the other countries, they say it's for deterrence. So it's better to let your adversary know what you've got.

China is also very coy about their numbers, because they have relatively few numbers, and they want to keep this-- positions secret and all of that. So they don't want to have-- and they don't keep their missiles on alert either. China's a very



interesting country with respect to nuclear weapons. And perhaps exceptional.

So the pathways to nuclear escalation and war, as I've stressed, is fear. Fear, to me, is the biggest factor. I'm sure people will argue with me. Every point I'm making at some level as controversial, by the way. I'm not trying to hide it, but it's just I can't give you every nuance. You know, it's one hour. People write books about each subject. So, you know, have to oversimplify it.

But anyway, I consider the two possible pathways to War. One is an accidental launch between the United States and Russia. And the other is escalation from conventional war in India and Pakistan.

Now, somewhat less likely is North Korea's use of a weapon, but I suspect they won't, because I think that they are constrained by other military reasons on the Korean peninsula. So North Korea wants to rattle the sword, so to speak, but they, I think, really want it for both deterrence and, as far as I can tell, for the survivability of the regime. Which is a whole other-- but that comes into all these things. That's why each case is special. North Korea's a very special case. It's a very odd government, and so forth.

Now, we had-- Vipin Narang talked about escalation from conventional war, and he talked about the deployment. One of the things he talks about, which I think is very sound, is that this whole issue when you talk about deterrence, it isn't just numbers. There's a whole other dimension, at least. And one is the deployment posture. And Pakistan has a very aggressive deployment posture, because they feel inferior in conventional weapons to India. And they feel threatened by India in many ways.

And they've already been partitioned by India when the country broke up into the eastern and western part, Bangladesh and India. So there's a historic enmity between the two, which needs to be-- and I want to-- it needs to be fixed. And I have to say, personally, that I was very disappointed with Obama's visit to India in many respects. You know, I look at the nuclear issue, and that's one of my lenses. It isn't my sole lens, but it's an important focus for me.

And what I see is Obama talks about the climate, which is excellent, then he gets on this very poor policy of selling nuclear energy, nuclear reactors, to India and not exempting India from the restrictions that used to be in place before the Bush administration of exempting India from the restrictions we've placed on them because they violated the Non-Proliferation Treaty and tested weapons. Now of course, Pakistan did so, also.

But the point is that we just aggravate the Indian-Pakistan tension. As far as I can tell, and I just read *The New York Times*, you know, and listen to the BBC, as far as I can tell, the subject of treating Pakistan, of defusing the tension with Pakistan, did not arise. As far as I can. At least these there was no public mention of it. And I was very disappointed.

And Obama's also trying to draw-- India is more concerned with China than with Pakistan. This is a sort of three-way dance, if you want to put it that way. And so it's more complicated than a bipolar interaction. It's a three-way game where China frightens India, India frightens Pakistan. China ends up helping Pakistan with nuclear issues and nuclear weapons issues. They originally gave Pakistan the design for the bomb.

So this is something that if India wants to solve this issue of Pakistan's aggressive deployment, they either have to do it by force, which won't work, because India has been deterred. Or they have to do it through diplomacy, and it always ends up with this message. You can use force, which won't work, or you can use diplomacy, which has a chance. Which is difficult, but has a chance. Those are the two ways to solve the problem.

So how could a war start by accident between US and Russia? Well, basically the most likely path is a malfunctioning of the Early Warning system. So here's a chilling quote from Vice President Cheney, when he was Vice President. I'll just let you read it for a minute.

The famous football he's talking about. Or black box. And this is carried around wherever the President of the United States goes. There's somebody a few doors

down, 24/7, who can say, Mr. President, we're under fire. Here's the button.

Now, it actually isn't a physical button, but that doesn't matter. That's irrelevant. It's the equivalent of a physical button. It's a virtual button.

So this is chilling. And you ask, what about the Constitution? What about consulting? What about anything? No, because of the 10-minute, the 30-minute launch time and the 10-minute warning time.

So we have roughly a thousand missiles, and so does Russia, on hair trigger alert. They're ready to be fired at minutes' notice. The number's probably closer to 900, but so what.

I mentioned the delivery times and decision times. So the probability of an error is not negligible. It is true, this is a complex physical, emotional system. It's a human system with fear. I keep emphasizing this, because there is fear, a very basic fear.

And each side-- what hawks don't realize is that on each side is vulnerable to the other's system. You cannot stop the attack. All you can do is retaliate. In other words, it's deter or revenge. Those are the two modes of operation. This is chilling, but that is the world we've been living in for 50 years. Literally. People don't think about it, but it's pretty awful.

Now, the fact is that the Russian system is less robust. So we are actually more vulnerable than they are, except that we'll fire if they do. And of course, why does it go on? Each side does it because the other side does it. It's sort of nutty.

This is not logic. This is not normal logic. This is a tight circle.

And so the latest that has surfaced in the last few years is cyber attack. So you ask how this can happen. Well, a cyber attack. Just imagine, somebody hacks into the system, somebody who really wants the United States and Russia to destroy each other, hacks into the Early Warning system of either side. Just imagine that. That's a nightmare.

So the irony, as I mentioned, is that the safety of each side depends on the other

side not launching. And then of course, there's the political question, why do we persist? Obama promised to do something about it when he came to office, but he has given it up. He's clearly given it up without explanation. But it was one of his promises. Yeah?

**AUDIENCE:** You would think even with the tensions that exist that we would both be better off if this system were up.

**PROFESSOR:** Of course. The more tension there is, the more scary this is. It's less scary when there's no tension, obviously. It's fear, again. And all the things that go with fear.

**AUDIENCE:** And distrust.

**PROFESSOR:** Fear-- yeah. I'm going taking them almost as synonymous. Distrust because the other side has the capability to destroy you. And a second strike capability, in the language of Cold War-- you know, you ask why it happens with all this strategic doctrine, but a second strike capability and launch on warning are physically identical with a first strike posture.

So you cannot tell. I mean, the other side tells you, we love you. But it's like having a guest over for dinner when the guest comes with a loaded Uzi. Not just a pistol, but a high-powered weapon, and says, oh, yes. We're pals. I'm here for dinner.

You know, what kind of pals are these? Right? I mean, it's a little nutty. But maybe who am I to judge?

So I want to talk a little bit about the Non-Proliferation Treaty, because I think it's-- one of the things that's very important in this world is that nuclear weapons don't spread to other countries. And the cornerstone of that is the Non-Proliferation Treaty. And, honestly, I think in the nuclear weapons states, particularly in the United States and Russia, the NPT is not taken as seriously as it should be. And I think it's very important.

The NPT is taken seriously for half of what it does. Namely, it says that people should not acquire nuclear weapons. But it is not taken seriously, because it

obligates the five nuclear powers, established nuclear powers, to give up their nuclear weapons.

And this is really the heart of abolition of nuclear weapons, because it's built-in. It's Article VI of the Non-Proliferation Treaty. It obligates us to do it. And so there's a tremendous tension. I'll come back to this in a minute. But the tension is between the countries who gave up aspirations for nuclear weapons saying to the nuclear weapons powers, OK, you are obligated to do it. But the nuclear weapons countries say, we're doing it very gradually and responsibly.

And now-- I'll talk more about this-- the non-nuclear weapons states want, really, a timetable. So there's a lot of tension over this. And I'll come to this in a minute.

So the cornerstones, as I mentioned, Article VI nonproliferation, disarmament. And I write disarmament and in black, although they're all extremely important. I do this for a US audience.

But the last point is that there's a five-year review. Every five years there's a review. The next one will be this May, and there are going to be fireworks. So I'll talk about that.

So how effective is the NPT? So there are four states outside the treaty, Israel, India, Pakistan, North Korea. There was this AQ Khan Network from Pakistan, which was shut down. It's never been absolutely clear how much the Pakistani state was involved or if this was a private venture.

Scott Kemp talked interestingly about how the actual material that was sold by the AQ Khan Network actually setback countries like Iran and their development of centrifuges. Because what was sold was a technology which was obsolete and inefficient. So it's very ironic.

So a few countries have given up their bombs-- oh, excuse me. And many countries have given up nuclear weapons programs. I've listed some of them. There are many nuclear-capable countries that don't have weapons.

Japan is one of them, of course. Not surprisingly. Canada. Our friends in Canada. But even South Korea, that feels very threatened by North Korea, has no bomb. But they are quite capable.

And the main point I want to make is that fewer countries have nuclear weapons that were predicted in the early '60s. Like, famously, Kennedy, JFK, said aloud that in a few years, 15 to 25 countries would have nuclear weapons. And he was reflecting what the US intelligence agencies told him. He wasn't making this up. It wasn't just a speech. He was reflecting what he was told.

And right now, the political norm is to renounce nuclear weapons and press the ones that have it to disarm. And that is a big plus and one that needs encouragement.

There are problems with the NPT, of course. Life isn't perfect. North Korea, in my view, is the most serious problem. Well, Pakistan-- I haven't even written it down here, but Pakistan and India are bigger problems because of the possible pathways to war. I already said that. I didn't want to repeat it. That's why it's not on the slide.

But the whole issue with Iran. There's no question that Iran's enrichment capabilities exceed what they can do for power. In other words, they are very well-suited for making weapons and not for power, because they don't produce enough enriched uranium for power needs. But they do produce enough for weapons. And that's been clear since the beginning of the program, despite what is said. And so there's been a tremendous tension there.

I just want to talk a little bit about the ongoing negotiations. They're making a lot of news now. It's very important, because we have an interim agreement, and this is the time, six months-- it's really four months on the political level and six months on the technical level, to reach a final agreement. That's what was set up.

I mean, the first one was supposed to be six months. It was extended. Well, excuse me. The first phase agreement was for six months, and then it's been extended-- it's not on here-- but it's been extended for six more months. So the deadline for the

political agreement is in March, and then in June, I think, is the deadline, the official deadline. People are skeptical, but I don't know.

There are some technical issues. The Iraq reactor can produce plutonium. But there are a simple solutions to that. There are simple technical fixes, and Iran has agreed to them, as I understand it. So that the amount of plutonium production from the Iraq reactor will be small.

In the interim agreement there's not supposed to be any additional sanctions. That's very important in terms of the US Congress, because bills have circulated demanding new sanctions. But they're probably in abeyance, fortunately.

There are really four parties involved, the two official parties and then the hardliners on both sides. So this is a complex negotiation. Within each side it's complex. I can't go into all of it. And I think people know what's going on better here on the American side.

But the real issue, as far as I can see it, in terms of Iran, what Iran wants is to have, I think, the Ayatollah said something like 15,000 centrifuges. The West, the most hardline people in the West say zero. Netanyahu, for example. Zero is the only acceptable number of centrifuges. And that's why he's campaigning so hard against it, because he knows that there will be no deal with zero centrifuges. So he already knows in advance that what he wants is not possible.

**AUDIENCE:** How many do they need to really power a nuclear power plant in the future?

**PROFESSOR:** Well, they need probably 20,000 advanced ones. Advanced ones, not what they have, the so-called P1s. Ones that work really well. I don't know off the top of my head, but to supply-- what is it? Bushehr? Is that the right pronunciation?-- the Bushehr reactor. Which they don't need, by the way, because Russia's going to supply the fuel. But they don't quite trust Russia, of course, for reasonable reasons, I think.

But anyway, this whole business is so murky, in my personal opinion. It's hard to tell facts from motive, in my opinion. I don't think I can do it, honestly. I'll talk with you

privately if you want, but I don't think I can really evaluate it in a way that I would consider satisfactory. I can speculate. That's what I can do.

But the point is-- you know, there's an old saying that the ideal solution gets in the way of the good solution. The good solution, in my opinion, is pretty much to continue the interim agreement that we have. Why is that good? Because what people are not talking about in the United States is the best thing about the whole negotiation.

Namely, that Iran keeps saying they don't want to develop nuclear weapons. And there's a fatwa. That's excellent. Second, Iran says that they want to be part of the NPT. They are enduring-- and I'm going to use that word, enduring-- the most rigorous inspection regime that the IAEA, that's the international agency that inspects, the International Atomic Energy Agency-- they are enduring the most rigorous inspections that any country ever endured.

Those are two excellent things. There are people on the ground all the time. People say, well, they can break out. Yes, they can break out if they want to. They will only agree to all of this if it's in their self-interest. Nobody can expect anything more of them or us.

So I think what we've got is the best possible solution that's feasible. And if they kick inspectors out and decide to go for a bomb, because it's close to impossible for them to do a bomb without kicking the inspectors out, and--

**AUDIENCE:** Even if they have hidden sites?

**PROFESSOR:** Well, they would have to then develop so many thousand more centrifuges and have that material and no news could leak out and all of that stuff. There are opposition groups. We found out about some of the sites-- I forget which one. The one that's underground. I forgot the name of it-- through dissenters in Iran. It always can happen.

The Soviet Union found out about the Manhattan Project in a most remarkable way. I want to talk about that for a minute, because that's really important. In 1940, a



Soviet nuclear physicist, a very good one named Flyorov, realized that all the publications about fission in the United States, England, and France had stopped. And he went to Stalin and said, the West is developing an atomic bomb, based on what was not appearing in the literature.

This is remarkable. And it's a fact. Of course, the Soviet Union had spies, and they found out about the Manhattan Project through the spies. But Flyorov, just reading the physical review-- this is a remarkable story which should not be ignored.

So I think we'd find out. Maybe slowly, but, you know. And if they really want the weapon as a deterrent, they've got to show us that they have it, like North Korea's done. There are all kinds of steps, and one weapon isn't good enough. I mean, I wrote an op ed with Jim Walsh that this whole break out time thing is too short. You know, the calculations, because it assumes one weapon. So I have an op ed in Reuters about this.

So there are all kinds of arguments. I mean, you could argue forever. I mean, I don't expect people who are what I would call hardliners to adjust agree with me because I've published an op ed. But I'm just saying-- it's not so simple, is what I'm saying. There are arguments. You have to decide which is right, because these are very complicated issues.

So anyway, we have our Menendez-Kirk bill, which is in the Senate. It seems to be in abeyance for a couple of months. There's a grace period. People are working hard against it, so it's a very political thing in both countries. I know it.

So I sort of wound together the discussion of two things, Iran and the NPT. So I want to come back to the NPT, because I embedded the Iranian discussion in the NPT discussion. Because it came up naturally, that's why.

But so to come back to it, the next thing that's going to happen, and I'm just quoting here, Stormy weather predicted for the NPT review in May at the UN. So I'm actually quoting an article from Daryl Kimball of the Arms Control Association. I didn't have time to make all the points, but in 2005 we had a disastrous NPT review. That was

under George Bush, and the nonaligned countries, Egypt and Sweden and Denmark and Ireland and a whole bunch of countries were very angry. Particularly at the United States and George Bush. It was a disastrous conference.

2010, Barack Obama had delivered his speech that he wanted to eliminate nuclear weapons. The United States was very welcome, and it was a productive conference. And they had 22 interrelated disarmament steps. I'm not even going to try to repeat them.

The two major ones were that the nuclear weapons countries should give a timetable for going to zero. A timetable. And the second thing is that they should convene a conference in the Middle East looking towards a nuclear-free zone in the Middle East. That's very delicate, because getting Israel to come, getting Iran and Israel to the table at the same time is difficult. The whole thing is difficult, and not just Iran.

**AUDIENCE:** But the concept was originally started by Iran and, I think Egypt, but Israel was a party to it at one point, too.

**PROFESSOR:** They were?

**AUDIENCE:** They were interested. They were considering.

**PROFESSOR:** In my personal humble opinion, Israel's interests are best served by a nuclear-free zone in the Middle East. If you ask me. I carry zero weight in Netanyahu's cabinet. Believe me. I probably carry-- no, that's an exaggeration of my influence. Zero weight is better than what I have.

So anyway, I'm not even going to go through any of those, but the follow through on these steps have been disappointing. They've basically been nonexistent. There's been basically no follow through on the 22 points. And so that's one of the reasons everyone who knows anything about this is predicting that it's stormy weather ahead, especially for the nuclear weapons states. So you can look forward to some interesting news in May.

I'm kind of running out of time, so basically Obama raised a lot of hopes with his Prague speech in 2009 talking about the possibility of a nuclear-free world. Of course, he hedged right away, it won't be reached quickly. And the US, as long as the weapons exist, we're going to have our little toys, too.

But anyway, it was still the most forthright statement since 1945. I mean, so it was a breath of fresh air. And he won the Nobel Peace Prize. Probably prematurely, but who am I to quibble?

So there are many arguments against nuclear weapons abolition. I'm just going to pick one. Because it eliminates deterrence, and to me that's the biggest argument against it. And it cannot be achieved. That's a different kind of argument, but in my opinion that's even stronger. I wouldn't say cannot, but my personal statement is it's unlikely.

But that doesn't mean it's not desirable. And that doesn't mean that academics, in particular, shouldn't talk about it. That's one of the things that I have in mind, and we should have a long-range view, academics. That's one of our luxuries. We can try to look ahead.

And so there are really two questions. One, is it desirable in view of all of the difficulties with it conceptually? And then, is it achievable if it is desirable? You should only ask the second question if the answer to the first is yes, it's desirable.

And I can't go through all the arguments, but deterrence is a very interesting question. I think I'm going to convene a little working group on it. I've been thinking about it a lot for the last few years, and I'm ready to do some more serious research in this arena.

But the point is that it's never worked in the sense of coercing others to do what you want, which is the way it's often used in US diplomatic circles. I don't know about Russia, but it's certainly used in the US. And another problem with it, as we heard about India and Pakistan, is it enables brinkmanship, low-level brinkmanship. In other words it introduces instabilities, is what I'm saying. Deterrence isn't what it's

cracked out to be, because by having the weapons, you also introduce instabilities in the system, especially if you have aggressive basing mechanisms.

This is very important. And Pakistan certainly is an example of that. They have deterred India, but with a very aggressive basing mode and threatening verbally. So, yes, they've deterred, but is it stable? How will it last?

They have delegated command and control of these local tactical weapons to field commanders. Suppose you get a rogue field commander who wants to create mischief. Like you had somebody from Pakistan goes to Mumbai, and shoots everyone in the hotel and so forth. Or when they entered the Indian parliament a few years before that.

So these are actions which don't introduce love or stability between countries. Putting it mildly. And of course, deterrence requires rationality, which is in short supply. My view.

Accidental use, which we've talked about. And of course, it won't work against terrorists. They want-- a real terrorist who's a suicide bombardier wants death and destruction. So, boy, that's a bad mixture.

And I think one of the points that people should not forget is deterrence requires a small number of weapons.

**AUDIENCE:** How many is small?

**PROFESSOR:** Well, I would say a hundred is overkill. So it's less than a hundred in my view. I've been giving a number, and I'll keep giving it. I have zero weight in Washington or Moscow, but that's what I think.

So should we try to abolish nuclear weapons? Really is it a good idea? And so the answer is, there's no risk-free world. What you have to do, when you look at the arguments against abolition, and I've done my best to look at what I consider the serious ones, papers typically criticize going to zero because it's risky. But the question is what they never do is talk about the relative risks.

In other words, minimizing risks. How do you minimize the risk? You're never going to eliminate risks. It's impossible. So the right question is not to eliminate risks, you have to ask the right question. Every scientist knows that. The right question here is minimization of risk. That's the right question. How do you minimize risk? Do you stay on the present course or do you try to do something more creative? And this is one of the creative things.

And so the other thing is that abolition in by itself is an important goal. And if we want the NPT to be healthy, we better be serious about it. And those are the fireworks that I'm talking about. And the nuclear weapons states had better take this into account. If you want to look long-range, how patient are the NPT states going to be? It's very important.

So, yeah, Obama has a mixed record. He's inspired great hopes. He's done the new START Treaty. He's improved nuclear security. He tried to engage Russia for of the steps.

Actually, that's a dated slide. Those efforts and now dead. The Russians effectively said no, by the way. So this is bigger than Obama. You know, Putin can veto negotiations easily, as you know.

The nuclear posture review. In my view, this is very important. This is our deployment strategy was only slightly modified from earlier years. We still have too many warnings on hair trigger alert.

With respect to North Korea, he talks about strategic patience, which is head in the sand, as far as I'm concerned. I'm very critical of the North Korean lack of engagement. There I'm very critical of Obama.

**AUDIENCE:** They're asking us right now, aren't they?

**PROFESSOR:** Yes. They're asking again, and we're ignoring them. And I think it's dumb.

And the last thing, again, this has a lot to do with Congress, is they're modernizing nuclear weapons. Which, again, in the NPT review is going to come up for

tremendous criticism, and it should. And in this day and age of budgetary restraints, it should be criticized. And in terms of strategic stability, it should be criticized.

So there are two buzz words. One is "modernization," and the other is "maintenance." So if you have nuclear weapons, you have to maintain that they're usable and safe-- that's maintenance-- without testing. That's important. And the other is to modernize the weapons, make them more accurate, and so forth. And that really should not be done. And the two get fused together, and it's very hard to tell the detail because it's all classified. It's the typical trick of large bureaucracies.

So anyway, I find some reason for optimism. The CTBO, I want to talk about that, and I just want to say a few words. That is the-- what is it? The-- I forgot what it stands for. It's the worldwide monitoring system for tests. It's basically an international thing. It's technically fabulous. I mean, I am really impressed.

They have seismic detectors. They look for radioactivity in the air. And they look for-- there's one more thing. I'm sorry, I'm blanking. But anyway, they detected a half kiloton blast in North Korea. An unannounced half kiloton three stations triangulated. They can tell it from earthquakes and conventional explosions.

What happens, just briefly, is it's the rise time in the seismic signal. See, from a chemical-type explosion, it's slower. And the instruments have a fast enough response time so you could see the initial overpressure. It's quite wonderful. And in several, I think two out of the three of the North Korean tests, all unannounced, they detected radioactivity in the air. I think one of the xenon isotopes from the explosion, which is long-lived.

And so finally, and I outlined this, public opinion does count. So that's one of the things I take some comfort from. There are many arms control organizations. I'm on the board of the Council for a Liveable World. The Arms Control Association is a wonderful organization in terms of giving out information. And their journal is quite excellent. And Peace Action is a grassroots. It's all to the good.

I think I've given the answers. Is the present situation stable? And my answer is with

luck. And I gave my answer about abolition of nuclear weapons.

So anyway, there's plenty to do, and why don't I just stop. You can look at it. I'm sure this is only a partial list of all that can be done. Some of it can't be done without Russia, but some can.

For example, we could reduce, more rapidly, to the level that Russia has of launchers and the new START Treaty. Russia, for example, just as an example, Russia is below the limits imposed by the START Treaty. Those limits go into effect when? In something like six or eight years or something? I forget. Do you remember? When they go into effect? But we could accelerate those numbers.

You know, like typical arms control treaties they go into effect almost the day they expire. So it's always too slow for arms control people. You know, it's always welcome, but always too slow. But you take what you can get.

But again, I want to just repeat one thing. The new START Treaty, the big success of the new START Treaty, in my view, which was not stressed by the newspapers or the commentators, is the fact that the inspections are going on. And the inspections, in my view, are much more critical than the numbers. There's such overkill whether it's 1,000 or 1,500 weapons.

I mean, again, this 100 number is overkill. So to me, it's almost irrelevant except symbolically whether you have a thousand or 1,500. Below a thousand, you get into issues with how many does China have, and so forth. I showed you. So a thousand is roughly the critical point in which all the nuclear weapons states have to negotiate with each other, not just the US and Russia. Of course, Russia's critical there.

OK, I'm going to stop. And of course, there's been a lot of questions, but I'm happy for more discussion or whatever. Yeah?

**AUDIENCE:**

You argued that it's typical to abolish all the nuclear weapons because it is used as deterrence. If it's true, isn't there another way of deterrence that would replace the nuclear weapons? What is your opinion?

**PROFESSOR:** Well, first of all, we already have it, and it's conventional smart warfare. I haven't talked about it. The United States calls it Global Strike, which we're developing. And that's a whole other dimension. It's not the nuclear arms race, but it was too much for me to get into that.

But, yes, you're asking a very good question. And our conventional military powers are incredible. And we can do now, in many respects, with conventional weapons what we could have done only with nuclear weapons 20 years ago. Or even 10 years ago.

And this Global Strike, which is a way to strike across the world with precision, with conventional weapons, with missiles, with cruise missiles, and so forth, is incredible. And it's all sophisticated command and control stuff plus guidance. Yeah?

**AUDIENCE:** So in your opinion that could replace the nuclear [INAUDIBLE] in the future?

**PROFESSOR:** Well, replace it in the sense that you don't have nuclear weapons. But then other people are just as scared as before. So it's also an aggressive military posture. And maybe, in the day and age when we're really trying to replace that, then we can no longer distinguish between conventional arms control and nuclear arms control. They will become merged, I think, as an intellectual subject as well as a practical matter.

But I'm looking ahead probably at least 10 years. But in my view, that day will come. So you're really asking a great question.

**AUDIENCE:** Disturbing.

**PROFESSOR:** Yes. Disturbing. The peace action will have plenty of work to do for plenty of time. I'm afraid. What can I say? I'm not happy about that, but it's a fact.

**AUDIENCE:** I'm curious about one thing. Do you know who in India or Pakistan presses that actual button?

**PROFESSOR:** No, I do not.



**AUDIENCE:** The reason I'm asking is is it delegated to some [? war-grade ?] people or some--

**PROFESSOR:** OK. In India-- look, here's what I know. I don't know more than I do know. What I think is true in India is that the armed forces are under civilian control. But in Pakistan, that is not true. So Pakistan is not what you would call a unitary state. OK There is no single command authority. I mean, there is officially, but de facto we know that the Pakistani military is at least equal to the civilian branch.

But this ISI, whatever it is, the security thing, it seems to be quasi-independent. I'm not sure. So you can see.

But what I'm afraid of is with this aggressive-- I said it before, but I'll just repeat it-- is this aggressive first strike military nucleus posture of Pakistan is leading to delegation of authority to low-levels where there's a great danger of a rogue commander. So I see Pakistan as the place with the most danger of a rogue commander. And I think I'm not the only one who thinks this, by the way.

**AUDIENCE:** Again, how many weapons do we think that Pakistan has?

**PROFESSOR:** Roughly between 100 and 200. It's more than 100 now.

**AUDIENCE:** And they're making more all the time.

**PROFESSOR:** They're making more all the time. They're making them as fast as they can, as far as we can tell.

**AUDIENCE:** The same in India, also?

**PROFESSOR:** No. India seems to be more relaxed about it. Both in terms of their aggressive policy-- they say they won't fire first. India has a much more reasonable stated policy of use. They're much more laid back. They say they won't use them first. They say the Pakistanis are just going much, much too far.

But on the Indian side, the problem that I see is they're not trying for the political solution. In other words, their deployment posture is more sensible, but they're focused on China. But they are not-- India-- my big criticism of India is they are not

solving the problem. I'm going to come back to that.

**AUDIENCE:** They're not initiating any kind of--

**PROFESSOR:** Right. They're being much too slow in trying to heal problems like Kashmir and other irritant points in the relationship. I mean, they're not going to disappear overnight, but they could do things. And I can point to some literature, but I'm not a real expert, by the way.

The United States is not being evenhanded, and that's a mistake. That's a basic American mistake. So, you know, I've been critical since the beginning. I'm not the only one on this basis.

I think the predictable is happening. They're just spurring Pakistan into a more frenzied state of nuclear weapons development. It's unfortunate. But we're doing something we don't want to see happen. We deplore it on one hand, and then we encourage it indirectly on the other. So it's a contradictory policy. It's unfortunate.

They should know better, but there they're letting commercial interests override this. This is a tug of war. The United States says many interests.

**AUDIENCE:** Are you saying the commercial interest with respect to power plant sales?

**PROFESSOR:** Right.

**AUDIENCE:** It's sort of interesting in that this got started what? In 2005 or 06?

**PROFESSOR:** Under Bush somehow.

**AUDIENCE:** Yeah.

**PROFESSOR:** Right.

**AUDIENCE:** And in the meantime, of course, all the American companies are now owned by Japanese or French companies. So what we're doing--

**PROFESSOR:** Well, we also make military hardware sales to India, which is increasing. That was--

oh, that was one of the other things from the Obama visit, the sale of conventional military equipment to India is going up for the first time in a long time. So that was a big success, I guess.

**AUDIENCE:** So that was a part of the recent trip?

**PROFESSOR:** Yes. Yes. I forgot to mention that. You reminded me. Thank you. Thank you for coming.