

Preface: Nuclear Weapons and Critical Thinking

This seminar on “Nuclear Weapons, Risk and Hope” addresses two basic questions:

- How great is the risk that nuclear weapons will be used in anger?
- How great is the hope of ending that threat?

The following short story summarizes the answer to the first question, and lays a foundation for answering the second:



Imagine that a man wearing a TNT vest were to come into the room and, before you could escape, managed to tell you that he wasn't a suicide bomber and didn't have the button to set off the explosives. Rather, there were two buttons in very safe hands. One was in Washington with President Obama and the other in Moscow with President Medvedev, so there was nothing to worry about. You'd still get out of that room as fast as you can!

Just because we can't see the nuclear weapons controlled by those two buttons, why have we stayed here for over 50 years, complacently assuming that because Earth's explosive vest hasn't yet gone off, it never will? As if confronted by that man, we need to be plotting a rapid escape.

Thinking about sitting next to that man wearing the TNT vest brings the risk into clear focus, especially when it is remembered that buttons also are present in London, Paris, Beijing, New Delhi, Islamabad, Jerusalem, and Pyongyang – and terrorists are trying to get a button of their own.

This story also helps illuminate the hope: Right now, society complacently assumes that the risk posed by nuclear weapons evaporated with the end of the Cold War. If we can get society to recognize the suicidal vest in which we have clothed the Earth, there is real hope that people will start thinking about how to dismantle that infernal contraption.

In the Spring of 2010, I was invited to give one of Stanford's SLE Salons on the nuclear threat. (SLE is our [Structured Liberal Education](#) program, and its Salons are weekly guest lectures.) As I organized that talk, I realized that SLE's emphasis on critical thinking was a perfect way to

summarize the solution to the nuclear threat – reexamining the assumptions that underlie our world view and rooting out those found to be false.

Many people assume that the first step in eliminating the nuclear threat is to eliminate nuclear weapons. They then dismiss the possibility of a solution because nuclear disarmament seems impossible from our current vantage point – and probably is. This seminar will make a case for the hypothesis that the first step is critical thinking – an action which is very possible, and very desirable from other points of view, separate from reducing the nuclear threat.

One of the key societal assumptions that warrants reexamination is the belief that our current nuclear weapons strategy poses no real risk. That belief is reinforced by repeated statements about our nuclear deterrent (a euphemism for our nuclear weapons) being “safe, secure and reliable.” An [example](#) crossed my screen just today (11 SEPT 2012), as I wrote these notes. (Search on *safe* to find it.)

If people make the assumption that our current nuclear weapons strategy poses no real risk, it is not surprising that they do little to reduce the risk. If, on the other hand, critical reexamination of that assumption shows that relying on nuclear weapons is as risky as living in a town surrounded by thousands of nuclear power plants, those same people will be energized to produce change. By the end of this seminar, I will have presented data that explains why my research indicates that is the level of risk we face, and you will be able to decide whether or not you agree. For now, I hope the story of the man in the TNT vest raises at least reasonable doubt that our current strategy may be riskier than society believes.

This emphasis on rooting out false assumptions fits well with my mathematical training. It is well known in mathematics that starting from an incorrect assumption often leads to ridiculous conclusions. In fact, one method of mathematical proof is called a *reductio ad absurdum*, Latin for “a reduction to the absurd.” Whenever a line of reasoning produces a wrong conclusion, it is proof that a false assumption exists. These false assumptions often disguise themselves as “self-evident truths,” making it difficult (but rewarding) to root them out. A simple example of a *reductio ad absurdum* is the proof that the [square root of 2 is irrational](#).

The nuclear *reductio ad absurdum* can be stated as follows: Since the dawn of the nuclear age, the United States has spent vast sums of money and applied some of its best minds to improving our national security. Over that same span of time, our nation has been transformed from one that was inviolate into one that can be destroyed in under an hour. Something must be wrong!

If, as appears to be the case, some false assumptions may underlie our national security strategy, no amount of effort will fix the problem until they have been identified and corrected. We will investigate a number of possibly fallacious assumptions, but for now I will list several of the most critical:

- The United States is the world's sole remaining superpower.
- We have gone 67 years without a world war. Our current nuclear strategy works and should not be changed.
- Having thousands of nuclear weapons is essential to our security.
- Reducing our arsenal is dangerous.
- The United States is endowed with superior vision to other nations. Put in the words of President Clinton's Secretary of State, [Madeleine Albright](#): "If we have to use force, it is because we are America; we are the indispensable nation. We stand tall and we see further than other countries into the future, and we see the danger here to all of us."
- Any changes we make would be immaterial in light of Russia's resurgent nationalism, not to mention the nut jobs running North Korea and Iran.
- Only world leaders have the power to bring about the required changes. This is too big a problem for people like you and me to tackle.

If critical thinking is an important first step in defusing the nuclear threat, then there is much more hope for accomplishing that goal. If the first step had to be nuclear disarmament or even major reductions in the world's arsenals, reasonable arguments against those steps can be made – as, in fact, they have. But, if the first step is to rethink some of our assumptions, how can it be argued that is too dangerous?

Outline of this Handout

The remainder of this handout breaks each of the two basic questions (How great is the risk, and how great is the hope?) into several parts, resulting in the following, slightly longer list:

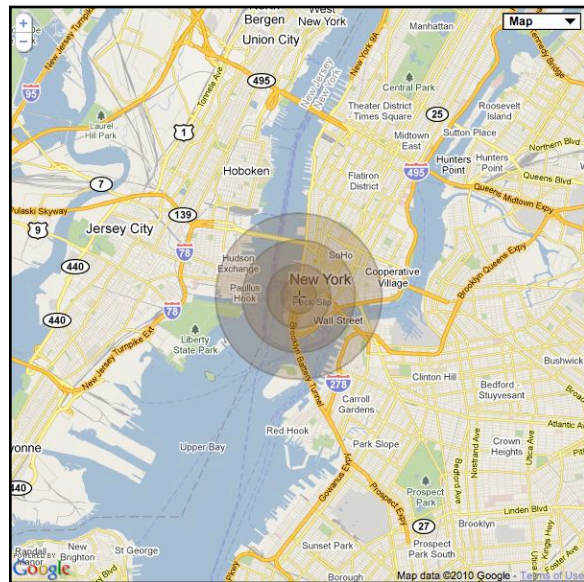
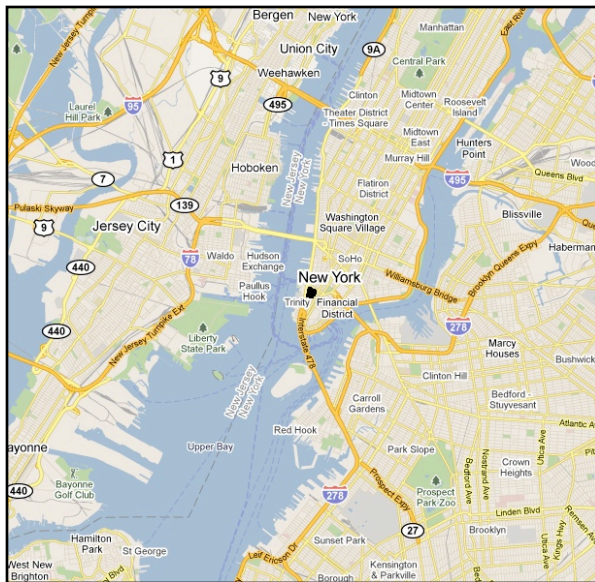
- How destructive are nuclear weapons?
- How likely is nuclear proliferation?
- How likely is nuclear terrorism?
- How likely is nuclear war?
- Which is the greater risk, nuclear war or nuclear terrorism?
- How much hope do we have?

- What role can I play?

Several of these questions will be answered in greater detail in later handouts, but at least summary answers for each of them are provided below.

How destructive are nuclear weapons?

Pound-for-pound, nuclear weapons can be a million times more powerful than TNT. To put this in context, the two maps shown below contrast the damage caused by the 9/11 terrorist attack on the World Trade Center (the small black area under the E of New York, near the tip of Manhattan, on the first map) with a 10 kiloton nuclear terrorist attack, centered at the same location. Terrorists probably would attack a more central location, wreaking even more havoc. More modern thermonuclear weapons (“H-bombs”) can be a thousand times more powerful than even that weapon. Even though the Cold War is supposed to be over, there are still approximately 20,000 nuclear weapons in the world’s arsenal, well over 90% of which are held by the United States and Russia.



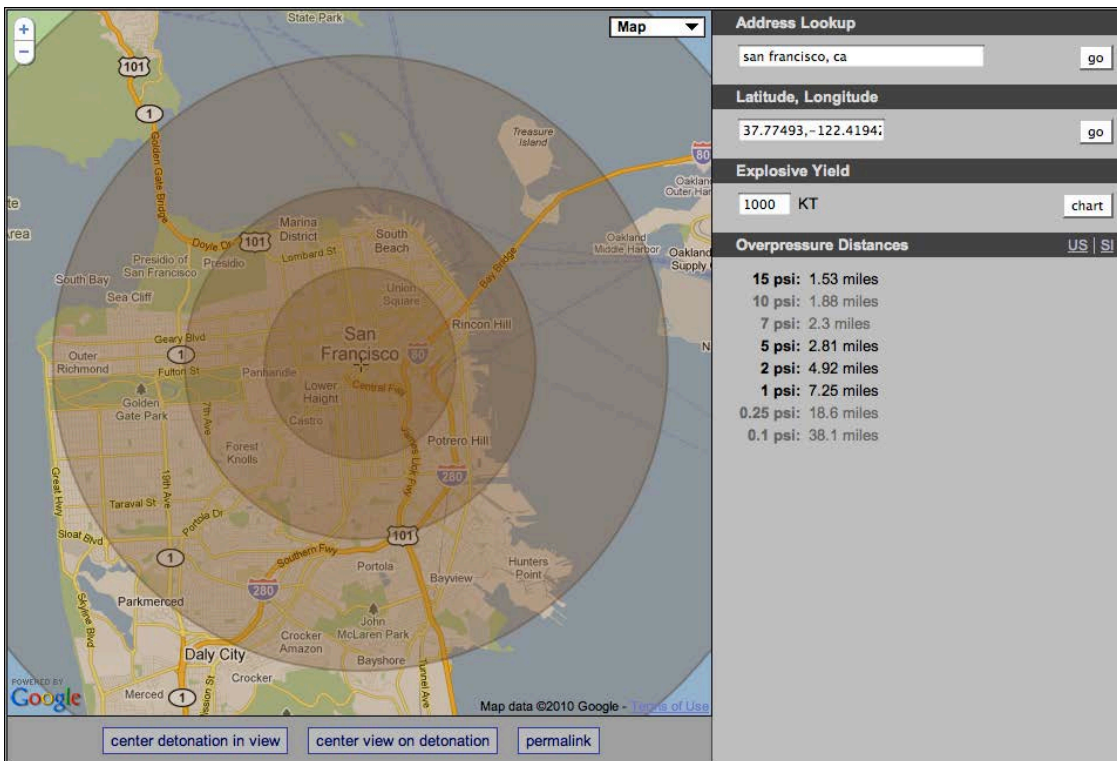
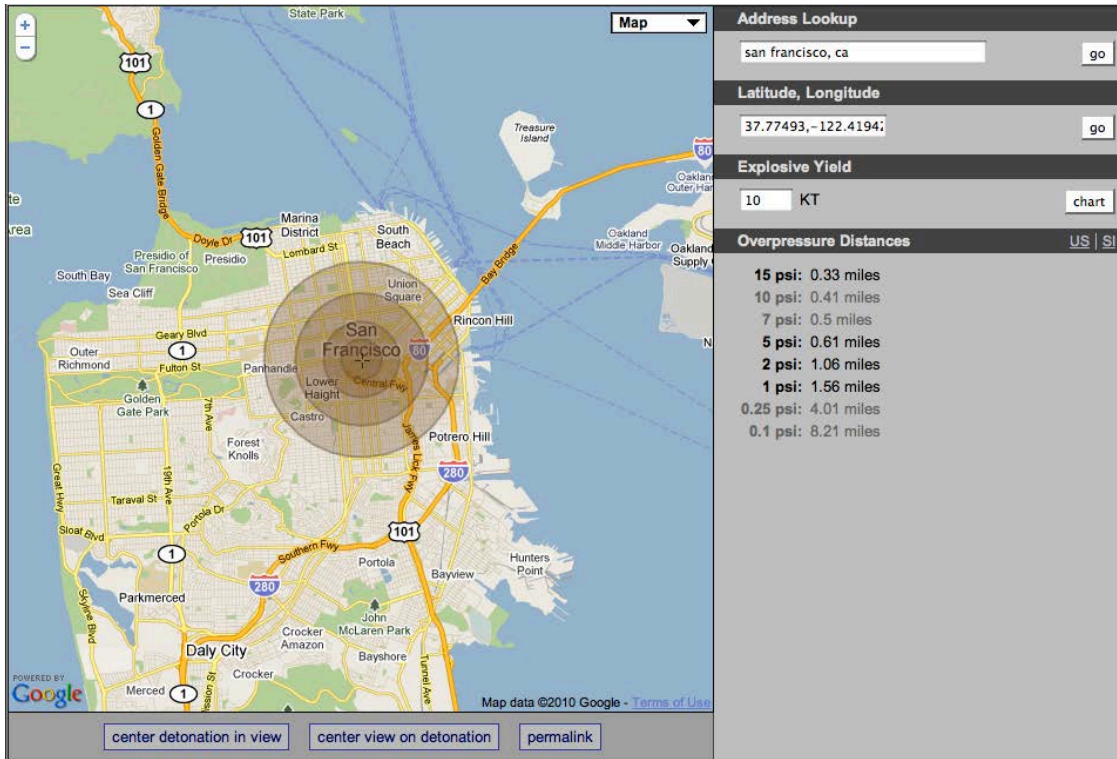
The weapon used on Hiroshima had a yield in the same ballpark as the nuclear terrorist attack depicted above. The next page has three pictures showing the physical and human devastation wreaked by that one, relatively primitive weapon. (Col. Paul Tibbetts, whose name appears on the first photo, piloted the plane that dropped the bomb. It was named the *Enola Gay* after his mother.)



While, the Hiroshima bomb was approximately 10 feet long and weighed several tons, over time we learned how to miniaturize warheads to the point that by the late 1950's they were "suitcase size," as shown in this picture of the Davy Crockett nuclear gun. The nuclear weapon is the small bulbous device with fins.



To make this somewhat more personal, the next page shows the blast circles for an attack centered on San Francisco's financial district. The first map is for a 10 kiloton weapon, the same as shown earlier for an attack on New York, and typical of what terrorists might mount. The second map is for a strategic warhead with a yield of 1 megaton, typical of what might be expected in a nuclear war. In both maps, the innermost circle shows 15 psi overpressure, causing complete destruction even of reinforced concrete structures, such as skyscrapers. The second circle shows 5 psi overpressure, causing complete destruction of ordinary houses. The third circle shows 2 psi overpressure, enough to cause severe damage to ordinary houses, and light to moderate damage to reinforced concrete structures. The fourth circle (which extends almost to the limits of the second map, so look carefully) shows 1 psi overpressure, which will cause light damage to all structures, and light to moderate damage to ordinary houses. To put "light damage" in context, only 0.25 psi overpressure (one-quarter that shown in the last blast circle) is required to shatter most glass surfaces, such as windows, some with enough force to cause serious injury.



All of the above was focused on a single nuclear detonation, as in a terrorist attack or an accidental launch of a single missile. If India and Pakistan were to use their approximately 150 weapons in a war, recent research has indicated the possibility of a “nuclear autumn,” in which the firestorms caused in those nations’ megacities would put massive amounts of smoke into the stratosphere, where it would remain for years. (Normal fires don’t reach that altitude and their smoke dissipates much more rapidly when rain washes their smoke from the air.) Computer modeling estimated a billion deaths worldwide due to starvation as agriculture collapsed due to the reduced sunlight reaching the earth. While this was a model and may have overlooked factors that would change the results, prudence dictates paying more attention to this threat and trying to reduce its risk.

With the United States and Russia each having on the order of 10,000 nuclear weapons in its arsenal (roughly 100 times what India or Pakistan has), a full-scale nuclear war is almost beyond imagination and conjures up images of mythic proportions. In a 1961 speech to a Joint Session of the Philippine Congress, General Douglas MacArthur, stated, “Global war has become a Frankenstein to destroy both sides. ... If you lose, you are annihilated. If you win, you stand only to lose. No longer does it possess even the chance of the winner of a duel. It contains now only the germs of double suicide.”

In 1986, former Secretary of Defense Robert McNamara expressed a similar view: “If deterrence fails and conflict develops, the present U.S. and NATO strategy carries with it a high risk that Western civilization will be destroyed.”¹ In January 2007, George Shultz, William Perry, Henry Kissinger and Sam Nunn [echoed those concerns](#) when they quoted President Reagan’s belief that nuclear weapons were “totally irrational, totally inhumane, good for nothing but killing, possibly destructive of life on earth and civilization.”

DoD and related studies, while couched in less emotional terms, still convey the horrendous toll that a full-scale nuclear war would exact: “The resulting deaths would be far beyond any precedent. Executive branch calculations show a range of U.S. deaths from 35 to 77 percent (i.e., from 79 million to 160 million dead) ... a change in targeting could kill somewhere between 20 million and 30 million additional people on each side ... These calculations reflect only deaths during the first 30 days. Additional millions would be injured, and many would eventually die from lack of adequate medical care ... millions of people might starve or freeze during the

¹ Robert S. McNamara, *Blundering Into Disaster*, Pantheon Books, New York, 1986, page 6.

following winter, but it is not possible to estimate how many. ... further millions ... might eventually die of latent radiation effects.”²

On page 9, that same 1979 OTA report also noted the possibility of serious ecological damage, a concern that assumed a new potentiality when the “TTAPS Report”³ noted that the ash and dust from so many nearly simultaneous nuclear explosions and their resultant firestorms might usher in a “nuclear winter” that could erase *homo sapiens* from the face of the earth, much as many scientists now believe the dinosaurs were wiped out by an “impact winter” caused by ash and dust from an asteroid impacting the Earth 65 million years ago. The TTAPS report produced a heated debate, and there is still no scientific consensus on whether a nuclear winter would follow a full-scale nuclear war. But let’s not do the experiment that would settle the debate!

In summary, a full-scale nuclear war would devastate civilization, and might even bring an end to human life. Therefore, referring to such a conflict as *nuclear war* is, in itself, an example of a societal assumption that warrants critical reexamination since *war* implies a winner and a loser.

How likely is nuclear proliferation?

The United States became the charter member of the “nuclear club” when it tested an atomic bomb at Alamogordo, New Mexico on July 16, 1945. It made its status as a superpower public the next month when it used nuclear weapons on Hiroshima and Nagasaki. To avoid living in the shadow of an all-powerful America, the Soviet Union accelerated its own nuclear program and conducted a successful nuclear weapons test in 1949. The United Kingdom and France, both eager to regain some of their former prestige and power, joined the nuclear club in 1952 and 1960 respectively.

China, feeling threatened by both the Soviet Union and the United States, conducted its first test in 1964. (China had fought the US during the Korean War, and had border disputes with the Soviets that erupted into armed conflict in March 1969.) India, remembering its 1962 border war with China, joined the club in 1974. Pakistani Prime Minister Zulfikar Ali Bhutto then declared

² Office of Technology Assessment, "The Effects of Nuclear War," May 1979, page 8. Available from NTIS, order #PB-296946. Also accessible [online](#).

³ Turco, R.P., Toon, A.B., Ackerman, T.P., Pollack, J.B., and Sagan, C., "Nuclear Winter: Global Atmospheric Consequences of Nuclear War," *Science*, vol. 222, 1983.

that, if need be, Pakistanis would “eat grass” in order to acquire their own bomb,⁴ and did so in the early 1980’s – though they delayed a public test until 1998 to forestall sanctions. North Korea, which feels threatened by both the US and China,⁵ conducted its first nuclear test in 2006.

While Israel has never publicly admitted possessing nuclear weapons, it is an open secret that it has approximately a hundred in its arsenal, creating pressure on its adversaries – notably Iran – to develop their own weapons.

Because nuclear weapons are the great equalizer, any nation that feels threatened by a stronger rival has a strong motivation to develop them. Viewed in this context, North Korea’s and Iran’s nuclear programs, while extremely dangerous and deplorable, are the logical outcome of threats made by their adversaries, including the United States. And each new nuclear power begets others which feel threatened by the new entrant. For example, if Iran becomes a nuclear power it would provide a strong incentive for other Middle Eastern nations, notably Saudi Arabia and Egypt, to follow suit.

In the current international climate, nuclear proliferation is almost certain. Paradoxically, our nation’s use of threats to deter others from obtaining nuclear weapons actually increases their motivation to do so. As one example, President Obama’s 2010 Nuclear Posture Review rules out the use of nuclear weapons against non-nuclear states with the notable [exception of Iran](#). If you were the leader of Iran, would this increase or decrease your motivation to pursue a nuclear weapons program?

There is also significant danger in the large number of nations that have commercial nuclear power reactors, and in the predicted renaissance of nuclear power to reduce emissions of greenhouse gases. That problem was presciently highlighted in [a 1987 essay](#) by Dr. Theodore Taylor⁶ that appeared in a book I co-edited with Anatoly Gromyko. Taylor wrote:

⁴ The United States originally pressured Pakistan not to pursue a nuclear weapons program. But, following the Soviet invasion of Afghanistan in 1979, America put non-proliferation concerns on hold because Pakistan played a key role in funneling supplies to the *mujahideen* (including Osama bin Laden and what became *al-Qaeda*). A [Congressional research report](#) provides more details in its section on “Alternating U.S. Policy Priorities Towards Pakistan.”

⁵ Most American media refer to China as North Korea’s ally. But, as we shall see later, the situation is much more complex.

⁶ Dr. Taylor was one of America’s most brilliant nuclear weapons designers, and is the subject of John McPhee’s book *The Curve of Binding Energy*. When I worked with Taylor in the 1980’s, he told me that he originally worked on nuclear weapons in the belief that they made war impossible. During Viet Nam, the fallacy of his belief system became evident and he told me that he decided to try and “undo with the second half of my life what I had done with the first half.”

Deterrence, the cornerstone of national security in present strategies, fails against nuclear terrorism simply because there are no well-defined targets against which to retaliate. ... Even where there is no current diversion of nuclear materials, the worldwide spread of plutonium produced in civilian nuclear power reactors has produced “latent proliferation” — the ability to produce nuclear weapons in short order — in every country with a nuclear power plant. Nuclear explosives can be made with less than 6 kilograms of plutonium, in size about enough to fill a coffee cup. The world’s present [1987] inventory of plutonium produced in civilian reactors is roughly 700,000 kilograms, greater than the total amount in the world’s nuclear arsenals. This plutonium is being produced in thirty-six countries. By the year 2000, there will be more than 3 million kilograms of plutonium in the world, enough for at least 500,000 nuclear weapons.

In summary, nuclear proliferation is a serious issue that deserves much greater attention than it receives. It would also be wise to apply critical thinking to some past decisions, in order to avoid repeating mistakes. For example, after the Soviets invaded Afghanistan in December 1979, President Carter made a conscious decision that nuclear nonproliferation was less important than aiding the Pakistani-based *mujahideen*, who were often referred to as “freedom fighters.” As a result, Pakistan today has a significant nuclear arsenal in a highly unstable country. In addition, many of those same *mujahideen* are now called terrorists as they fight us under the banner of the Taliban or al Qaeda.

How likely is nuclear terrorism?

- *If the existing nuclear countries cannot develop some restraints among themselves – in other words, if nothing fundamental changes, then I would expect that the use of nuclear weapons in some 10-year period is very possible.* Henry Kissinger in [Nuclear Tipping Point](#) video. Secretary of State and National Security Advisor to Presidents Nixon and Ford.
- *We need to organize ourselves so that if we lose a couple hundred thousand people, which is less than 0.1% of our population, it doesn’t destroy the country politically or economically. ... We need to have a way to survive such an attack, which I think is quite likely – maybe 20 percent per year probability, with American cities and European cities included.* Richard Garwin, former member of the President’s Science Advisory Committee (1962-65 and 1969-72), and described by Enrico Fermi as “the [only true genius](#) he had ever met.”
- Republican Senator Richard Lugar conducted [a survey](#) that asked 85 national security experts: “In your opinion, what is the probability of an attack involving a nuclear explosion occurring somewhere in the world in the next 10 years?” The average of their estimates was

30%, and a later question showed that most were thinking in terms of a nuclear terrorist attack. (See pages 14-15 of that document for the relevant data.)

Why are these experts so concerned?

Al-Qaeda has made no secret of its desire to obtain nuclear weapons and [kill millions of Americans](#). The main obstacle is obtaining nuclear fuel for the bomb, a task that is not as difficult as might first be imagined. As just one example, the apartheid regime in South Africa developed a small nuclear arsenal that it dismantled during the transition to majority rule. The highly enriched uranium (HEU) fuel from about a dozen bombs is stored in South Africa's Pelindaba nuclear facility, which was successfully attacked and entered by armed men in November 2007. Fortunately, the attackers did not obtain any HEU, but we should not complacently count on being so lucky next time – and all it takes is once. The 13 minute [video interview](#) with the survivors of that attack conveys the risk of nuclear terrorism more powerfully than anything else I've seen.

Matthew Bunn's MIT doctoral thesis, [Guardians at the Gates of Hell](#), provides a number of additional reasons for concern. For example:

Pages 36 and 44-45: terrorist teams [have been] carrying out reconnaissance at nuclear weapon storage sites and on nuclear weapons transport trains in Russia, whose locations and schedules are [supposed to be] state secrets; [There have also been] reports that the 41 heavily armed terrorists who seized hundreds of hostages at a theater in Moscow in October 2002 considered seizing the Kurchatov Institute, a site with enough highly enriched uranium (HEU) for dozens of nuclear weapons ... Aum Shinrikyo, the Japanese doomsday cult [responsible for the 1995 poison gas attack on the Tokyo subways which killed 12 and injured over 1,000] ... reportedly recruited staff members at the Kurchatov Institute.

How likely is nuclear war?

Post-Cold War, this threat is largely seen as a relic of the past, but that complacency is unwarranted. My paper “[Risk Analysis of Nuclear Deterrence](#),” indicates that, with current policies, the *time horizon*⁷ until we should expect a nuclear war is at most 1,000 years and could be on the order of 100 years. The corresponding risk of death for a child born today is at least 10%,⁸ and becomes worse than 50-50 if the time horizon is 100 years.

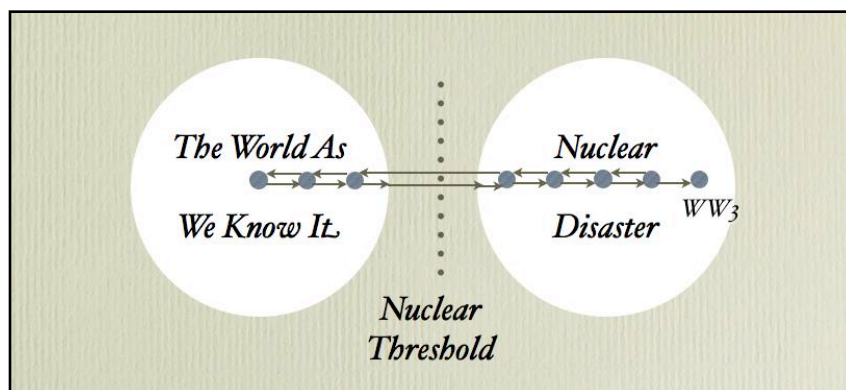
Viewed this way, the fact that we have gone 67 years without a world war is small comfort, especially when the near misses that occurred are factored in. The 1962 Cuban Missile Crisis is the best known such event, but there are many others, including a number that occurred after the Cold War ended. As just one example, in 1995 the Russian air defense system mistook a meteorological rocket launched from Norway for an American submarine launched ballistic missile, causing the Russian “nuclear football” – the brief case that contains the codes for authorizing a nuclear attack – to be opened in front of Boris Yeltsin. This was the first time such an event had occurred, and fortunately Yeltsin was sober enough to make the right decision.

Surviving such near misses has the dangerous tendency to breed complacency. Instead, we need to start seeing them as early warning signs that demand remedial action *before* a catastrophe occurs. An engineering discipline known as risk analysis does that by decomposing the process that leads to a catastrophic failure into a sequence of smaller steps and focusing attention on avoiding the precursors to disaster. Applied to nuclear war, that approach can be depicted as shown below.

This “state diagram” helps explain why people have difficulty envisioning the possibility of a nuclear disaster: There is no direct path across the nuclear threshold from the usual states (conditions of the world) that we occupy. Those who argue that there is nothing to worry about would be right if we never made enough mistakes to come close to the nuclear threshold. But, just as a sequence of miscalculations resulted in the Cuban Missile Crisis of 1962, our continued reliance on nuclear bluffs and Cold War-era nuclear strategies could again take us to the brink, and possibly beyond.

⁷ Talking of a *time horizon* until we expect a nuclear war, freezes the basic environment and asks how long we could expect civilization to survive under those conditions before a nuclear war occurred. That approach neglects the changes that would occur over an extended period of time, some of which (e.g., proliferation) would increase the risk (decrease the time horizon), and others of which would have the opposite effect. We really are trying to look at the probability of a nuclear war over each of the next few years, but it is easier to think in terms of a time horizon. If nuclear war has one chance in 1,000 of occurring each year, that corresponds to a 1,000 year time horizon.

⁸ The child has an expected life of 80 years. While $80/1,000 = 8\%$, that number suggests greater accuracy than is possible with such a rough approach, and so is rounded to 10%.



The large circle labeled *The World As We Know It* is a “super-state” consisting of all states short of a nuclear weapon being used in anger. The barrier labeled *Nuclear Threshold* separates that super-state from the one labeled *Nuclear Disaster*, and is crossed the first time a nuclear weapon is used in anger. The nuclear threshold can be crossed by a nuclear terrorist attack, a regional nuclear war (e.g., India-Pakistan), an accident, or a miscalculation. If the violence stops there, it is still possible to recover – much as the world healed after the horror of World War II. That possibility is depicted by the arrow returning to the world as we know it. But, once the nuclear threshold is crossed, previously unimaginable states become all too possible, including the state-of-no-return labeled WW3.⁹

Most of the time, we occupy one of the less dangerous states, far from the nuclear threshold. If we stayed there forever, society’s lack of concern about nuclear war would be understandable. This is indicated in the diagram by the lack of a discontinuous jump from the safer states to the nuclear threshold. Society tends to assume that because we cannot fall into the nuclear abyss from our current state, it is not a threat. What that societal assumption misses is the possibility of making a sequence of mistakes that takes us to the brink of the abyss, as happened during the Cuban Missile Crisis of 1962, and possibly beyond.

A lack of logical consistency in our nuclear strategy also makes nuclear war more probable than most people imagine. Known as *nuclear deterrence*, it is frequently argued that, since starting a nuclear war is suicide, no one in his right mind would do that. The threat of mutual suicide is seen as deterring bad behavior. For this reason, nuclear deterrence is often used synonymously with *Mutually Assured Destruction* or MAD. There are several problems with this argument that call for critical reexamination (critical thinking):

⁹ Although we do not know for sure that World War III would be a state of no return, prudence dictates making that assumption.

- Nuclear deterrence is logically inconsistent. It requires rational leaders to prevent mutual suicide, yet in a crisis involving two nuclear-armed powers, the one that behaves more irrationally wins – provided there is a winner and not two losers. Such behavior is even enshrined in a 1995 US Strategic Command report, [*Essentials of Post-Cold War Deterrence*](#), which argued that, “it hurts to portray ourselves as too fully rational and cool-headed.”
- Nuclear deterrence has many forms other than MAD, and nuclear threats are often used for much lesser objectives than protecting a nation’s homeland. The Soviet Union’s Cuban missiles were intended partly to prevent an American invasion of that island nation, and most nuclear threats – both Russian and American – also have been over relatively minor issues compared to the potential loss should the bluff be called.
- Mental illness, addiction and similar maladies can strike even world leaders, with Boris Yeltsin being the [most obvious example](#). But the problem is [more general](#) and affected at least John Kennedy, Richard Nixon and Tony Blair.
- Religious fervor can cause world leader to behave irrationally, with Iran’s President Mahmoud Ahmadinejad’s possible belief in an apocalyptic return of the “hidden imam” being a frequently cited example. We tend to be less aware that some American political leaders may harbor apocalyptic End Times beliefs that see war – possibly even nuclear war – as precursors to the Second Coming of Christ. The first 30 seconds of a [YouTube video](#) show former House Majority Leader Tom DeLay stating that his hopes for the Second Coming inspired some of his foreign policy positions. Later in the seminar, we shall explore evidence that such thinking even may have affected the decision to go to war in Iraq.

Which is the greater risk, nuclear war or nuclear terrorism?

Many people discount the risk of a nuclear war because the chance of a nuclear terrorist attack is so much higher. While the danger of a nuclear war occurring in any given time period is probably 10 to 100 times smaller than that of a nuclear terrorist incident, the consequences are hundreds or thousands of times greater, if indeed they can be quantified at all. For those reasons, it is important to reduce the threat of nuclear terrorism *and* the threat of nuclear war. Fortunately, as we shall see, both efforts require many of the same first steps, making a choice largely unnecessary.

While the threat of nuclear terrorism is often viewed as independent from that of nuclear war, there are at least two important areas of overlap. First, large arsenals assembled for fighting a

nuclear war make it more likely that terrorists will get their hands on one. While most Americans worry primarily about “loose nukes” in the former Soviet Union, we also need to pay greater attention to our own vulnerabilities. The US Air Force [lost six nuclear warheads](#) in August 2007, but later found them. A B-52, flew from Minot AFB in North Dakota to Barksdale AFB in Louisiana with twelve cruise missiles under its wings. Each missile was supposed to carry dummy warheads, but later it was discovered that six of the twelve warheads were real. Until that mistake was uncovered, those six nuclear weapons were inadequately protected from theft by terrorists and others intent on obtaining such a prize. Equally important are the lax procedures that allowed airmen to have access to nuclear weapons when they were supposed to be loading dummy warheads. This event shows how hard it is to keep track of the thousands of nuclear weapons in our arsenal, making the terrorists job easier.

Another connection between nuclear terrorism and nuclear war is the risk that a nuclear terrorist incident could act as the catalyst for starting a nuclear war. This idea was treated fictionally in Tom Clancy’s *The Sum of All Fears*, where a terrorist nuclear attack on Baltimore is mistaken for one perpetrated by Russia. This fictional account also has a factual basis as detailed by Stanford’s Dr. Pavel Podvig in a [2006 blog post](#) which describes how the 9/11 terrorist attack was mistaken for a Russian attack by at least one American F-16 pilot:

[Is it possible that] Russia would believe, if only for a brief moment, that the United States might attack it? Normally, the answer is no. After all, the cold war has been long over and there has been no shortage of declarations of partnership between Russia and the United States. However, we should not overestimate the ability of the militaries to change and to adjust their operational practices and plans to the new realities. The strategic weapon systems that they operate were built with cold-war missions in mind and it is only natural that they impose cold-war thinking on their operators.

Here are some examples. One of the fighter pilots who was scrambled into the air on September 11, 2001 was reported to testify that: “I reverted to the Russian threat – I’m thinking cruise missile threat from the sea. You know, you look down and see the Pentagon burning and I thought the bastards snuck one by us.”

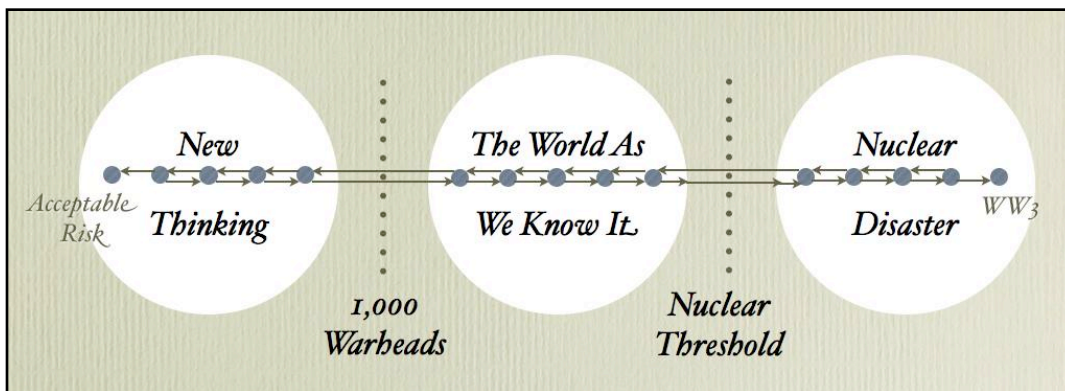
If on September 10, 2001 someone would suggest that a U.S. pilot would assume that Russia might attack the United States, that person would have been laughed out of the room. But this is exactly what happened. Two more “coincidences” of that day – NORAD was scheduled to conduct an exercise, known as Vigilant Guardian, “which postulated a bomber attack from the former Soviet Union” (look for Note 116 in the 9-11

Commission Report), while Russian strategic bombers were indeed conducting an exercise that involved flights in the direction of the United States. As far as we know, NORAD never began the exercise that day and the Russian military grounded the bombers as soon as they learned about the events in the United States, but the number of coincidences is quite alarming.

Not that there are any signs that the military on both sides have changed their plans and no longer practice attacking each other. Just recently Russia conducted a large-scale exercise of its strategic bombers, in which they got close enough to the United States to be intercepted by NORAD fighter planes. The United States also routinely conduct exercises that involve a nuclear exchange with Russia.

How much hope do we have?

While making the world safe from nuclear devastation will require changes that often seem inconceivable from our current vantage point, the same was true of past, fundamental transformations in human behavior. In 1800, ending slavery was seen as a fool’s errand, and women’s suffrage was even more difficult to envision, but both eventually were achieved through processes that started with small, seemingly inconsequential steps – individuals questioning the assumptions that were the foundation for the then-existing world view. That’s critical thinking! The state diagram used above to illuminate the negative possibility of a nuclear disaster can be extended as shown below to provide insight into the positive possibility.



Just as the failure process cannot occur in a discontinuous jump from our current state to World War III, neither can the nuclear threat be eliminated in one fell swoop. Rather, as with abolishing slavery, a number of intermediate goals must be achieved before the ultimate success becomes possible (or even conceivable to most). Several features of this new diagram are of particular importance:

- The ultimate goal is described as a state of *Acceptable Risk*. Some have argued that this state requires nuclear abolition, world peace, or the rule of law being extended to an international level. While I personally believe that some elements of all three eventually will be required, it is counter-productive to make that central to my current arguments. Those goals seem so naive and unachievable from our current vantage point that emphasizing them would hinder early progress. If they are part of the long-range goal, it is better to discover that farther out in the process, after early steps have brought them into clearer view. As we shall see, the level of risk needs to be reduced by a factor of at least a thousand before becoming acceptable, so the goal of reducing the nuclear threat to an acceptable level is much more ambitious and far-reaching than might first appear.
- A new, positive threshold is crossed when the world's total nuclear arsenal, including weapons in storage, is reduced by 95% from its current level of roughly 20,000 to 1,000. A thousand weapons is more than enough for the US and Russia to maintain their current strategy of nuclear deterrence (e.g., 300 each for those two nations, and 400 to be divided among the other nuclear-armed states), but will require a fundamental change in societal thinking – hence the name for the newly introduced *New Thinking* super-state. The connection between the solution and critical thinking is also emphasized by that naming convention.
- The name of the new super-state is related to Einstein's observation, uttered soon after the horror of Hiroshima and Nagasaki, that “the unleashed power of the atom has changed everything, save our modes of thinking, and we thus drift toward unparalleled catastrophe.” Einstein implicitly summarized both the problem (an obsolete mode of thinking about national security) and the solution (applying critical thinking to root out false assumptions, thereby allowing adoption of a new mode of thinking, consistent with the realities of the nuclear age).

There is a hopeful precedent because the changes in human thinking required to defuse the nuclear threat are no greater than those that brought about the end of slavery or those that gave women the vote. Added hope comes from recognizing an additional factor that should make this shift even easier: Nuclear weapons have the potential to end civilization, while neither slavery nor the subjugation of women posed an existential threat to those in power. The thinking that causes us to cling to nuclear weapons is sometimes seen as an immovable object. But, in that analogy, the survival drive would be an irresistible force. When those two meet, I am confident that survival will win out. But, for that to happen, society first must see that those are the stakes.

Hence, a critical first step in solving this problem is creating clearer societal understanding of the risk posed by our current nuclear strategies.

The hope that society might recognize that need is aided by a growing chorus of world leaders, who are sounding the alarm and calling for change. A [seminal 2007 article](#) by George Shultz, William Perry, Henry Kissinger and Sam Nunn called for a return to the vision of a world free from the nuclear threat. Because this goal was posed by Ronald Reagan and Mikhail Gorbachev during their 1986 summit at Reykjavik, this effort is sometimes called “a return to the vision of Reykjavik.” This effort is notable for its bipartisan nature: Shultz was President Reagan’s Secretary of State, Perry was President Clinton’s Secretary of Defense, Kissinger was President Nixon’s Secretary of State and National Security Advisor, and Nunn was the Democratic Chairman of the Senate Armed Services Committee. President Obama credits this group with laying the foundation for [his own](#) “commitment to seek the peace and security of a world without nuclear weapons,” and their initiative [has gained the support](#) of approximately $\frac{2}{3}$ of the living former Secretaries of State and Defense and National Security Advisors. This very hopeful sign provides strong evidence for reexamining the societal assumption that change is not possible, but has gone largely unnoticed by the public. Another, very hopeful sign that is often ignored by that conventional wisdom is the fact that the world’s nuclear arsenal has shrunk by a factor of four, from a peak of approximately 75,000 warheads to 20,000 today.

What role can I play?

Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has. Margaret Mead

There go the people. I must follow them, for I am their leader. Alexandre Ledru-Rollin

While support from world leaders facilitates the task of changing societal thinking, their efforts need greater grass roots support to succeed. The [difficulty in ratifying the New START Treaty](#) in December 2010 shows that too few people understand this issue. If more understood the stakes, they would demand change and our elected leaders either would get on board or cease to lead.

Changing the thinking of the entire nation currently is an impossible task that far exceeds the available resources. While the fraction of a population required to create a “tipping point” for a new idea or style depends on a number of factors, if we take it to be 5%, that is 15 million Americans. In the state diagrams used above, it would correspond to jumping many states out in the positive direction.

But, if we focus our efforts on a single dorm on the Stanford campus with 400 residents, under that same 5% assumption, it only takes 20 students to make the entire dorm “nuclear aware.” If we can reach a tipping point within that dorm, the topic becomes one of general concern. With all residents “nuclear aware,” the larger number of people involved would provide a foundation for Stanford becoming a larger “pocket of nuclear awareness.” That would provide even greater resources that eventually could transform the nation as a whole, at which point significant, concrete changes that currently are impossible could start to occur. We cannot jump over states in the diagram, but we can make large moves if we are patient and recognize that seemingly inconsequential steps today lay the foundation for much larger changes in the future.

Former Supreme Court Justice Sandra Day O’Connor (Stanford ‘50) wrote the letter shown on the following page, encouraging Stanford students to entertain “the audacious concept that their involvement could be the catalyst for realizing that immense and important goal.” She notes that, in entertaining that “nobler hypothesis . . . there is nothing to be lost and much – potentially the whole world – to be gained.” Former Secretary of State George Shultz and former Secretary of Defense William Perry also support this effort to make Stanford nuclear aware, as do Stanford’s President Emeritus Donald Kennedy, two of our Nobel Laureates (Prof. Kenneth Arrow in Economics and Prof. Martin Perl in Physics), and a former Dean of Engineering (Prof. William Kays).

Justice O’Connor’s letter mentions the critical role that the late [Professor Harry Rathbun](#) played in both of our lives. Born in 1894, he taught business law here for many years. His last lecture of every year was more eclectic and dealt with the meaning of life. It became so popular that it had to be moved to Memorial Auditorium, and filled even that venue. The current sequence of [Rathbun lectures](#) continues that tradition. Justice O’Connor gave the inaugural Rathbun lecture in 2008, followed by Secretary Shultz in 2009 and the Dalai Lama in 2010.



Supreme Court of the United States
Washington, D. C. 20543

March 2010

To Stanford's Student Body,

When I was an undergraduate at Stanford University, Professor Harry Rathbun repeatedly emphasized to me that a single caring individual could make a difference in this huge world, and might even help determine the course of events. I had not heard that before, but he put it forward so persuasively that many of us came to believe it might be true, and to take seriously the notion that we could make a difference. I can now say unequivocally that he was right.

Professor Martin Hellman, who also credits Professor Rathbun with having a major impact on his life, is currently attempting to complete "Harry's last project," whose goal was to end the threat posed by nuclear weapons. Given the Rathbun influence, it is fitting that this effort depends on Stanford students entertaining the audacious concept that their involvement could be the catalyst for realizing that immense and important goal.

Harry Rathbun died in 1987, so he cannot embolden today's students to consider that they might have that kind of impact on the world. I am pleased to encourage you, as Professor Harry Rathbun would have done, to entertain what he called "the nobler hypothesis" and take leadership roles in this effort to make society's actions consistent with the realities of the nuclear age. In doing that, there is nothing to be lost and much — potentially the whole world — to be gained.

Sincerely,

Sandra Day O'Connor

My own interactions with Harry (as he preferred to be called at that point in his life) started in 1981, when my wife and I became involved with a group that he and his wife Emilia had founded. While initially our interest was in improving our marriage, the same approach required there also applied to improving international relationships: learning to look beyond one's own frame of reference and trying to understand the other's point of view – another way to describe critical thinking. As the nuclear threat came into sharp focus during the 1980's the group shifted its focus to that issue. After I recognized the danger, I dropped my usual research on cryptography (codes and ciphers) and applied my efforts to help solve the nuclear dilemma. After 31 years, I am still at it. Short-term solutions do not appear to be in the cards!

It is fitting to mention Harry Rathbun's influence from another perspective as well. His earlier degrees were in Electrical Engineering, and he was fond of defining the scientific spirit as "a zealous search for the truth, with a ruthless disregard for commonly held beliefs when they are contradicted by the observed data." That is yet another way to define the critical thinking that is at the heart of resolving the nuclear dilemma.

Why nuclear weapons?

The risk posed by nuclear weapons is just one among many critical problems we face, so why do I put the bulk of my efforts into resolving just that one threat? Currently, there is significant momentum behind the movement to halt global warming, a modicum of concern about nuclear terrorism, and almost no public interest in the threat posed by nuclear war. It might therefore seem that we should direct our energy to global warming. But we cannot afford to neglect *any* issue with potentially catastrophic consequences, and especially existential threats to human survival. While addressing that many problems simultaneously may seem daunting, there is a fundamental underlying problem behind all three of those imperatives, as well as others just coming into view: the chasm between our physical power and our maturity level.

Science and engineering have given us physical powers that were traditionally thought of as god-like: causing massive floods, creating new life forms, and destroying the world. In contrast to our awesome physical power, humanity's maturity level is far from god-like. At best, our species is in its adolescent phase. Humanity is like a 16-year-old with a new driver's license who somehow gets his hands on a 500 hp Ferrari. We will either grow up fast or kill ourselves.

Because it would complicate the basic message concerning the nuclear threat, this overarching view is best left out of most discussions at this point in time. But, once society has recognized the highly unacceptable risk of our current approach to nuclear weapons, it is reasonable to hope

the question will be raised: “How did we get into such a mess, and where else might we be neglecting catastrophic threats?” If we do that, efforts to avert global warming, severe environmental degradation, nuclear terrorism, nuclear war, bioterrorism, and other catastrophes would be seen as part of the same underlying effort. They would reinforce one another, rather than compete for resources.

I believe that the problem can be seen most clearly with the nuclear threat, so I put most of my effort into working on this topic, and later hope to connect it to the others. But, I have deep respect for, and often join, people who focus on other critical issues facing humanity.

Critical Thinking

While we are just getting started on applying critical thinking to resolving the nuclear threat, we have already seen evidence that the following assumptions, held by significant segments of society, warrant critical reexamination:

Nuclear war: If, in the words of General MacArthur, “Global war has become a Frankenstein to destroy both sides,” then just the use of that term invokes a fallacious assumption since war has a winner and a loser. In spite of that problem, I will often follow convention in these notes and use the term *nuclear war*. However, please keep this caveat in mind.

The United States can only counter nuclear proliferation with sanctions and threats. Some evidence already has been presented that this assumption may not be completely true, and much more will follow in later handouts, particularly on North Korea.

Nuclear war is no longer a significant threat. The 1995 Norwegian meteorological rocket launch that caused the Russian “nuclear football” to be opened in front of Yeltsin is just one of many dangerous, post-Cold War incidents that we shall study.

Change is impossible. The approximately 75% reduction in the world’s nuclear arsenals shows that change is possible, as does the Shultz, Perry, Kissinger, Nunn initiative. The question is not whether change is possible, but whether it will occur rapidly enough to avoid a catastrophe.

I cannot play a role in solving such a major problem. Only world leaders have the required power. Change does not occur in one fell swoop and starts with individuals. Leaders must follow the crowd, or they cease to be leaders.