Assignment before next class

Read this handout. Make sure you have finished reading handouts #1 and #2. Because this handout spliced together material from several places, there may be some overlap or rough spots. In the future, I hope to find time to edit the material to flow better, but for now ask your indulgence. If you notice any problems, I'd appreciate hearing from you so I can correct them.

How risky are 99.9% safe maneuvers?

Mushroom clouds are a turn-off, so let's approach the question of nuclear risk somewhat obliquely by first considering the much more attractive picture shown below.[1]

Figure 3.1: A glider executing a high speed low pass.

The glider looks like it's suspended above the runway, but in reality it's screaming toward the photographer at 150 mph in a maneuver known as a high speed low pass. The pilot starts about 1000 feet above and a mile from the runway. He then dives to convert altitude into speed, levels off just a few feet above the ground, and skims the runway. At the end of the runway, he does a steep climb to reconvert some of that speed into altitude so he can turn and land.

Given that the glider has no engine, you might wonder how the pilot can be sure he'll gain enough altitude in the climb to safely turn and land. The laws of physics tell us exactly how altitude is traded for speed and vice versa. While there is a loss due to the air resistance of the glider, that is a known quantity that the pilot takes it into account.

But it's important to read the fine print in the guarantee that the laws of physics seem to provide. It only applies if the air is stationary. If there's a slight wind the difference is negligible, but if the

[1] Photo courtesy of Bret Willat, Sky Sailing, Warner Springs, CA

air movement is unusually strong all bets are off – which is what happened to a friend of mine who had safely executed the maneuver many times before. The last time he did it, he hit an unusually strong, continuous downdraft. The laws of physics still applied, but the model of stationary air was no longer applicable and he had no way of knowing his predicament until he approached the runway with much less speed than needed for a safe landing. Between luck and excellent piloting, he managed to land without damaging himself or his glider. He learned a lesson and no longer does high speed low passes.

While most experienced glider pilots sometimes do low passes (and some race finishes require them), I've opted not to because I regard them as a 99.9% safe maneuver – which is not as safe as it sounds. A 99.9% safe maneuver is one you can execute safely 999 times out of a thousand, but one time in a thousand it can kill you.

Even though they are clearly equivalent, one chance in a thousand of dying sounds a lot riskier than 99.9% safe. The perspective gets worse when it's recognized that the fatality rate is one in a thousand every time you execute the maneuver. A pilot who does a 99.9% safe maneuver 100 times, stands roughly a 10% chance (100/1000) of being killed. Worse, the fear that he feels the first few times dissipates as he gains confidence in his skill. But that confidence is really complacency, which pilots agree is our worst enemy. A graphic portrayal of both the lure and the danger of such maneuvers is available in a short YouTube video.[2]

Many people point to the absence of a world war since the dawn of the nuclear era as proof that these weapons are necessary to ensure the peace. But that argument leads to the question, "Is relying on nuclear weapons a 99.9% safe strategy?"

Is nuclear deterrence 99.9% safe?

When I talk about nuclear risk, people often ask me, "What is the probability of a nuclear war?" But, formulating the question that way introduces a very dangerous error that can be seen by briefly reconsidering the risk of high speed low passes. The fatality rate of a glider pilot who

---

[2] Of course, a high speed low pass isn't exactly 99.9% safe, and I am using that number symbolically since the same arguments apply to maneuvers that are 99% or 99.99% safe. I should note that the glider that crashed in the video was not doing a high speed low pass, but was struggling to make it back to the airfield at the end of the contest. However, stretching a final glide beyond the usual safety margins is also a 99.9% safe maneuver. If the pilot had been acting prudently, he would have opted to land in a farmer's field a few miles earlier, while he still had enough altitude to plan a safe landing approach. His ground crew then would have come with a trailer, disassembled the glider, and towed it back to the airfield – after thanking the farmer and paying for any crop damage. The pressure of trying to complete the contest may have pushed the pilot to take chances that he clearly should not have. Although the glider broke in two, the pilot walked away from this accident. If you want to know more about 99.9% safe soaring maneuvers, see my 2007 soaring safety talk. If you'd like to see what a soaring trip looks like, check out one of my favorite flights. Video footage courtesy of Drew Associates, The Sun Ship Game. Editing courtesy of Basrai & Basrai Media, Mountain View, CA.

does that maneuver depends on how many low passes he expects to do over the course of his flying career. If each high speed low pass has a fatality rate of one chance in a thousand, a pilot who will do 100 high speed low passes has roughly a 10% chance of dying (100/1000), while a pilot who does only ten has 1% total risk (10/1000). In the same way, the correct question concerning the risk of a nuclear war (and similarly for nuclear terrorism) is, "What is the probability of a nuclear war each year?" If there is a 0.1% chance of a nuclear war occurring each year, then in 100 years the risk is roughly 10%, while over 10 years the risk is roughly 1%.

As noted in handout #1, most people find it easier to think in terms of what I call the *time horizon* for an event. If nuclear war has 0.1% chance of occurring each year (one chance in a thousand), then it has a 1,000 year time horizon. Because the risk of a nuclear war varies with time, this is not the same as saying we expect to survive 1,000 years, even though, to simplify, I sometimes may say something like that.

Before studying ways that risk analysis can help us estimate the time horizon for a nuclear war, it helps to consider what various values for that parameter would imply. A 1,000 year time horizon at first sounds safe because none of us will be around that long. But, just as a 99.9% safe soaring maneuver entails a 10% fatality rate if repeated 100 times, a child born today would have almost a 10% chance of not living out his or her expected life of 78 years. Under those assumptions, the risk is closer to 78/1000 or 7.8%, but when roughly estimating a number, scientists and engineers often use an *order of magnitude estimate*, in which the estimate is rounded to the nearest power of 10 (1, 10, 100, etc.) to avoid giving an impression of greater accuracy than is warranted. In that approach, a 7.8% estimate becomes 10%. The table below puts the risk for various time horizons for a full-scale nuclear war into perspective, assuming that it would end civilization.

Time Horizon (years)	Pr(child dies)	# of nuclear plants	Skydiving
10	Almost 100%	100,000	30 times per day
100	50%	10,000	3 times per day
1,000	10%	1,000	Twice a week
10,000	1%	100	Once a month
100,000	0.1%	10	Once a year

Figure 3.2: Equivalent levels of risk for different time horizons for a full-scale nuclear war

The second column is the probability that a child born today would die in a nuclear war; the third column is the number of nuclear power plants that would have to surround your home town to produce an equivalent level of risk; and the last column is how often you would have to skydive

from an airplane to bear the same risk. Of course, it is not just one person's life that is at stake. For example, in the skydiving analogy, the whole world is in the harness with you.

The second column is found using probability theory, with the smaller numbers being equal to the annual probability of the event times the number of years, and using 100 years as the order of magnitude life expectancy. For example, a time horizon of 10,000 years corresponds to one chance in 10,000 each year, so over 100 years the risk is roughly 100/10,000 or 1%.[3]

The third column uses the fact that a modern nuclear power plant is designed so that the probability of its suffering a catastrophic failure in any year is at most one chance in a million. Ten thousand such plants surrounding a town would add up to one chance in 100 per year, which corresponds to a 100 year time horizon. Hence the 10,000 entry in the 100 year time horizon row.

While Chernobyl might seem inconsistent with that million year design goal, it is not considered a modern design because it did not have a containment vessel. The accident at Three Mile Island was not catastrophic because its containment vessel did what it was supposed to – contain the radioactivity that was released by the accident. As a result, Three Mile Island produced no immediate fatalities. (There is disagreement as to whether there are any long-term fatalities.) In contrast, Chernobyl killed over 50 people immediately, and the total death toll is estimated to be at least in the thousands, and potentially nearly a million.

The last column is based on skydiving having a fatality rate of 1-in-100,000 per jump. Skydiving 3 times a day, or roughly 1,000 times a year, therefore would have a 1-in-100 or 1% annualized fatality rate, the same as for nuclear war having a 100 year time horizon.

A table similar to the one shown above can be constructed for a nuclear terrorist event, but the entries would depend on where you lived and the assumed severity of the event. Someone living on a remote ranch in Arizona would bear almost no risk, while someone living in New York City would bear a significant fraction of the overall risk. For a New Yorker, assuming New York has a 10% chance of being the target, and assuming 10% of the city's population is killed in such an attack, the numbers in the table would be reduced by a factor of 100. This helps explain why, even though most research about the danger of a nuclear disaster focuses on nuclear terrorism to the exclusion of nuclear war, I believe it is necessary to consider both possibilities. Nuclear war has a lower probability each year, but a much higher cost – potentially infinite.

---

[3] Optional: The smaller time horizons (higher risk assumptions) clearly cannot use such an approximation. For example, the "small probability" approximation when the time horizon is 100 years is 100% (100/100), whereas the more exact value is (1 – 0.99100) or about 63%.

How risky is nuclear optimism?

In September 2009, Newsweek carried a cover story, Why Obama Should Learn to Love the Bomb, that quoted Columbia University Professor Kenneth Waltz: "We now have 64 years of experience since Hiroshima. It's striking and against all historical precedent that for that substantial period, there has not been any war among nuclear states." Waltz is a leading advocate of a school of thought known as *nuclear optimism*, which argues that fears of nuclear war are greatly exaggerated. Elsewhere, Waltz has claimed: "The probability of major war among states having nuclear weapons approaches zero."[4] Waltz is not alone. In a July 2009 interview, former Secretary of Defense and Director of Central Intelligence James Schlesinger claimed, "We will need a strong deterrent ... that is measured at least in decades – in my judgment, in fact, more or less in perpetuity." While not directly stating that the risk of a failure is near zero, requiring deterrence to work "more or less in perpetuity" either implies that or sees the destruction of civilization as acceptable. In September 2009, after President Barack Obama was awarded the Nobel Peace Prize for his efforts to rekindle the vision of a world free of nuclear weapons, Time magazine had an online essay arguing that the Nobel Committee should have awarded the prize to the atomic bomb instead. The headline read, "Want Peace? Give a Nuke the Nobel."

Last year's BP oil spill demonstrates why nuclear optimism would require much more evidence than the absence of world war in the last 65 years. In November 2009, BP's vice president for exploration in the Gulf of Mexico, David Rainey, touted offshore drilling's safety record in these words: "I think we also need to remember that OCS (Outer Continental Shelf) development has been going on for the last 50 years, and it has been going on in a way that is both safe and protective of the environment." Five months later, BP's Deepwater Horizon drilling rig exploded, killing 11 workers, creating an environmental catastrophe, and proving that 50 years of success was inadequate evidence for complacency.

Similar, misguided thinking was responsible for the loss of the Space Shuttle Challenger when gaskets – called O-rings – on a booster rocket burned through, directing a blowtorch-like flame against a fuel tank and causing it to explode. Engineers who had designed the booster rocket tried to halt the launch because of partial O-ring failures on previous launches in cold weather. Lawrence Mulloy, manager of NASA's booster rocket program, cited past successes to justify ignoring those concerns, "What you are proposing to do is to generate a new Launch Commit Criteria on the eve of launch, after we have successfully flown with the existing Launch Commit Criteria 24 previous times." Here too, we learned the hard way that a long string of successes is inadequate evidence for assuming continued favorable outcomes.

---

[4] Kenneth N Waltz, "Nuclear Myths and Political Realities," *American Political Science Review* 84: 731-745, 1990. See page 740 for this quote.

The Gulf of Mexico will eventually recover from the BP oil spill, and the Challenger disaster was not the end of the world. The same cannot be said for mistakenly extrapolating 65 years without a nuclear exchange into the indefinite future. Where nuclear weapons are concerned, we cannot afford to wait for disaster to strike before realizing that complacency was unwarranted.

A temperamental nuclear coin

Fortunately, quantitative risk analysis or QRA[5] can illuminate the danger by gleaning more information from the available data than might first appear possible. Start by thinking of each year since 1945 as a coin toss with a heavily weighted coin, so that tails shows much more frequently than heads. Tails means that a nuclear war did not occur that year, while heads corresponds to a nuclear catastrophe, so nuclear optimism's evidence corresponds to noting that the last 65 years produced 65 tails in a row. Risk analysis reclaims valuable information by looking not only at the gross outcome of each toss (whether it showed heads or tails), but also at the nuances of how the coin behaved during the toss. If all 65 tosses immediately landed tails without any hesitation, that would be evidence that the coin was more strongly weighted in favor of tails, and provide additional evidence in favor of nuclear optimism. Conversely, if any of the tosses teetered on edge, leaning first one way and then the other, before finally showing tails, nuclear optimism would be on shaky ground.

In 1962, the nuclear coin clearly teetered on edge, with President John F. Kennedy later estimating the odds of war during the Cuban Missile Crisis at somewhere between "one-in-three and even."[6] Other nuclear near misses are less well known and had smaller chances of ending in a nuclear disaster. But, when the survival of civilization is at stake, even a partial hesitation before the nuclear coin lands tails should be of grave concern:

- During the 1961 Berlin crisis, Soviet and American tanks faced off at Checkpoint Charlie in a contest of wills so serious that President Kennedy briefly considered a nuclear first strike option against the Soviet Union.
- In 1973, when Israel encircled the Egyptian Third Army, the Soviets threatened to intervene, leading to implied nuclear threats.[7]
- The 1983 Able Archer incident was, in the words of Secretary of Defense Robert Gates, "one of the potentially most dangerous episodes of the Cold War." This incident occurred

---

[5] Quantitative risk analysis is also known as probabilistic risk analysis, abbreviated PRA.

[6] Sorenson Theodore C (1965) *Kennedy*. New York: Harper and Row, page 705.

[7] Ury William L (1985) *Beyond the Hotline: How We Can Prevent the Crisis that Might Bring on a Nuclear War*. Boston: Houghton Mifflin Company, pages 19-20.

at an extremely tense time, just two months after a Korean airliner had been shot down after it strayed into Soviet airspace, and less than eight months after President Ronald Reagan's "Star Wars" speech. With talk of fighting and winning a nuclear war emanating from Washington, Gates notes that Soviet leader Yuri Andropov developed a "seeming fixation on the possibility that the United States was planning a nuclear strike against the Soviet Union." The Soviets reasoned that the West would mask preparations for such an attack as a military exercise. Able Archer was just such an exercise, simulating the coordinated release of all NATO nuclear weapons.[8]

- Certain events during the 1993 Russian coup attempt that were not recognized by the general public led a number of American intelligence officers at the North American Aerospace Defense Command (NORAD) headquarters to call their families and tell them to leave Washington out of fear that the Russians might launch a nuclear attack.[9] (We will study this in more detail in a later handout.)

- In 1995, Russian air defense mistook a meteorological rocket launched from Norway for an American submarine-launched ballistic missile, causing the Russian "nuclear football" – a device that contains the codes for authorizing a nuclear attack – to be opened in front of President Boris Yeltsin. This was the first time such an event had occurred, and fortunately Yeltsin was sober enough to make the right decision.[10]

- Confusion and panic during the 9/11 attacks led an airborne F-16 pilot to mistakenly believe that the US was under attack by Russians instead of terrorists. In a dangerous coincidence, the Russian Air Force had scheduled an exercise that day, in which strategic bombers were to be flown toward the United States. Fortunately, the Russians learned of the terrorist attack in time to ground their bombers.

- The August 2008 Russian invasion of Georgia would have produced a major crisis if President George W. Bush had followed through on his earlier promises to Georgia: "The path of freedom you have chosen is not easy but you will not travel it alone. Americans respect your courageous choice for liberty. And as you build a free and democratic Georgia, the American people will stand with you." The danger is compounded because most Americans are unaware that Georgia fired the first shots and Russia is not solely to blame. Ongoing tensions could well produce a rematch, and Sarah Palin, reflecting the mood of many Americans, has said that the United States should be ready to go to war with Russia should that occur.

---

[8] Gates Robert M (1996) *From the Shadows*. New York: Simon & Schuster, pages 270-273.

[9] Peter Vincent Pry, *War Scare*, Praeger, Westport, CT, 1999, pages x and 129-169.

[10] Peter Vincent Pry, *War Scare*, Praeger, Westport, CT, 1999, pages x and 183-238.

The majority of the above incidents occurred post-Cold War, challenging the widespread belief that the nuclear threat ended with the fall of the Berlin Wall. Further, nuclear proliferation and terrorism have added dangerous, new dimensions to the threat:

- India and Pakistan combined have approximately 150 nuclear weapons. These nations fought wars in 1947, 1965, 1971, and 1999. India suffered a major attack by Pakistani-based terrorists as recently as November 2008.

- Pakistan is subject to chaos and corruption. In October 2009, internal terrorists attacked Pakistan's Army General Headquarters, killing nine soldiers and two civilians. A. Q. Khan, sometimes called "the father of the Islamic bomb," ran a virtual nuclear supermarket and is believed to have sold Pakistani nuclear know-how to North Korea, Iran, and Libya.

- If terrorists were to obtain 50 kg of highly enriched uranium (HEU), it would be a small step from there to a usable nuclear weapon.[11] The worldwide civilian inventory of HEU is estimated at 50,000 kg. HEU is used in over 100 research reactors world wide, many of which are not adequately guarded.

- South Africa stores the HEU from its dismantled nuclear arsenal at its Pelindaba facility. In November 2007, two armed teams, probably with internal collusion, circumvented a 10,000 volt fence and other security measures. They were inside the supposedly secure facility for almost an hour, but fortunately, were scared off before obtaining any HEU.

- In the recent film, *Nuclear Tipping Point*, former secretary of state Henry Kissinger states that "if the existing nuclear countries cannot develop some restraints among themselves – in other words, if nothing fundamental changes – then I would expect the use of nuclear weapons in some 10-year period is very possible." [This film is available free of charge.]

- Richard Garwin, a former member of the President's Science Advisory Committee (1962-65 and 1969-72) holds an even more pessimistic view. In Congressional hearings he testified: "We need to organize ourselves so that if we lose a couple hundred thousand people, which is less than a tenth percent 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."

---

[11] Unlike more complex plutonium-based implosion weapons, those using HEU's simple gun assembly are unlikely to require testing prior to use. As noted earlier, the HEU bomb dropped on Hiroshima was never tested before hand.

These incidents show that the nuclear coin has teetered on edge far too often, yet society's lack of concern and resultant inaction demonstrate that nuclear optimism is a widespread illusion. A prerequisite for defusing the nuclear threat is to make society aware of the risk that it bears *before* catastrophe strikes.

Risk analysis

By fostering a culture of risk awareness, quantitative risk analysis has improved safety and illuminated previously unforeseen failure mechanisms in areas as diverse as nuclear power reactors, space systems, and chemical munitions disposal. Quantitative risk analysis also has been applied to the risk of nuclear proliferation[12] and nuclear terrorism, and both Los Alamos and Lawrence Livermore National Laboratories have performed such analysis for various aspects of the country's nuclear programs. It is therefore surprising that the applicability of quantitative risk analysis to estimating and reducing the failure rate of nuclear deterrence has only recently been recognized, and its serious employment is yet to be accomplished.

As depicted in Figure 3.3's now-familiar state diagram, quantitative risk analysis decomposes a catastrophic failure of nuclear deterrence into a sequence of smaller, partial failures. The large circle labeled *The World As We Know It* is a super-state that includes all possible states (conditions) of the world prior to a nuclear weapon being used in anger. Each such state is depicted by a small circle or dot, and the arrows indicate possible moves from one state to another as international tensions rise and fall. In reality, there are many more states than could be depicted in the figure.

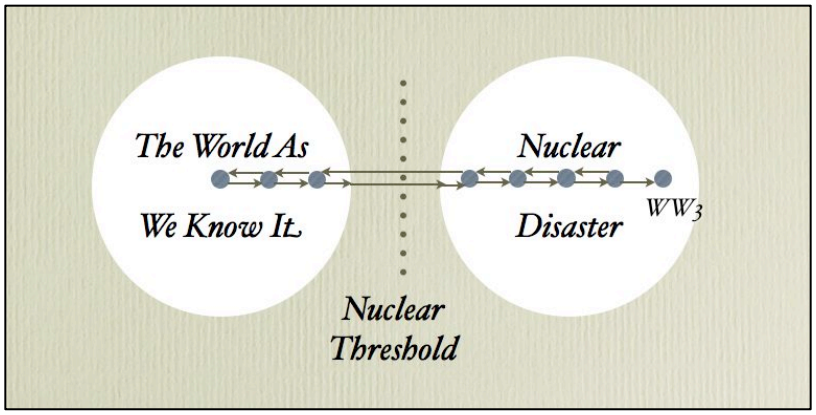

Figure 3.3: QRA decomposes a catastrophic failure into a sequence of partial failures

During the Cuban Missile Crisis of 1962 the world was in a state that had high potential for crossing the *Nuclear Threshold*, while today we are in one of the much safer states, near the

[12] Caswell David J (2010) *Analysis Of National Strategies For Combating The Proliferation Of Nuclear Weapons*. Ph.D. thesis, Stanford University, Stanford, California.

middle of the super-state. The other super-state, labeled *Nuclear Disaster*, includes all possible states after the nuclear threshold has been crossed. That occurs the first time a nuclear weapon is used in anger, for example in a terrorist attack, in a regional nuclear war (e.g., India-Pakistan), or by an accidental missile launch. As devastating as the use of a single nuclear weapon would be, in time the world would recover, as indicated by the arrow re-crossing the *Nuclear Threshold* in the positive direction. The state labeled *WW3* represents a full-scale nuclear exchange and is assumed to be a state of no return, as indicated by the lack of a return arrow to any other state in the diagram.

Figure 3.3's 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 that we occupy. Nuclear optimists 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.

Quantitative risk analysis allows improved estimates of the catastrophic failure rate because existing data on partial failures can be used in the analysis. For example, in nuclear power plant design, reliable data exists for the failure rates and repair times of many components. Utilizing this information allows better estimates of how frequently the plant will be in a vulnerable state. Applying the same approach to a failure of nuclear deterrence, we have significant information on the frequency of nuclear threats, international crises and other events that put the world at greater risk. Utilizing that data allows better estimates of the risk of nuclear deterrence failing.

While other definitions for a failure of nuclear deterrence are possible, this article uses a full-scale nuclear exchange, depicted as *WW3* in the above figure. At the other extreme, deterrence could be defined to fail the first time the nuclear threshold is crossed (e.g., in a nuclear terrorist incident). The definition used here has the advantage of providing a system-level perspective and incorporating all lesser failure modes. By definition, a full-scale nuclear war can occur only after a first nuclear weapon has been used in anger. Thus, estimating the catastrophic failure rate also requires estimating the failure rates of nuclear terrorism and other events that could cross the nuclear threshold. If, instead, and as much current work suggests, we were to focus solely on the risks of nuclear terrorism and nuclear proliferation, then our analysis could overlook an unacceptable threat.

While estimates of the risk inherent in nuclear deterrence can be only approximate, they still can be extremely useful. For example, as noted earlier, even if they were to indicate that civilization can be expected to survive another 1,000 years, then a child born today with a 78-year life expectancy would have almost a 10 percent chance of not living out his or her natural life due to our reliance on nuclear weapons – a highly unacceptable level of risk.

To simplify the analysis to the point that a lone researcher could undertake the task, when I performed the only currently existing quantitative risk analysis of nuclear deterrence, I lower bounded the risk, meaning I purposely underestimated it. Even so, I found the risk to be at least 200 times greater than living near a nuclear power plant. My preliminary risk analysis produced a statement, endorsed by a number of prominent individuals, that urgently called on the international scientific community to undertake in-depth risk analyses of nuclear deterrence and, if the results so indicate, to raise an alarm alerting society to the unacceptable risk it faces, as well as initiating a second phase effort to identify potential solutions. Efforts to initiate such in-depth analyses have not yet borne fruit, and I am currently working to create support for such a study by the National Academies (the umbrella organization for the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine).

Anatomy of a near miss: The 1962 Cuban Missile Crisis

Figure 3.3's state diagram decomposes a catastrophic failure of nuclear deterrence (i.e., World War III) into a sequence of smaller mistakes or failures. Neglecting Hiroshima and Nagasaki, we have never crossed the nuclear threshold, but we have visited states that were dangerously close to it. Studying these nuclear near misses can help us identify mistakes that allowed them to happen, and that we should endeavor to avoid in the future. This section dissects the 1962 Cuban Missile Crisis and identifies six key mistakes that took us to the brink of the nuclear abyss. The next section then spotlights modern day analogs that took us within half a step of repeating 1962's errors. Because those current events did not produce a full-blown crisis, most people are not even aware that they occurred.

The Cuban Missile Crisis surprised President Kennedy, his advisors, and most Americans because we viewed events solely from an American perspective and missed warning signs visible from the Russian perspective.[13] Fortunately, that view has been recorded by Fyodr Burlatsky, one of Khrushchev's speechwriters and close advisors, as well as a man who was in the forefront of the Soviet reform movement. While all perspectives are limited, Burlatsky's deserves our attention as a valuable window into a world we need to better understand:

> In my view the Berlin crisis [of 1961] was an overture to the Cuban Missile Crisis and in a way prompted Khrushchev to deploy Soviet missiles in Cuba. … In his eyes [America insisting on getting its way on certain issues] was not only an example of Americans' traditional strongarm policy, but also an underestimation of Soviet might. … Khrushchev was

[13] Even the names used here and in Russia are indicative of our very different perspectives. Our calling it the Cuban Missile Crisis focuses on Khrushchev's putting Soviet missiles on Cuba, and tends to see that action as the sole cause of the crisis. The Russians usually call it the Caribbean crisis, because they see it in a larger context, including the Bay of Pigs invasion the year before and the US deploying similar missiles in Turkey.

> infuriated by the Americans' … continuing to behave as if the Soviet Union was still trailing far behind [in nuclear weapons]. … They failed to realize that the Soviet Union had accumulated huge stocks for a devastating retaliatory strike and that the whole concept of American superiority had largely lost its meaning. … Khrushchev thought that some powerful demonstration of Soviet might was needed. ... Berlin was the first trial of strength, but it failed to produce the desired result, [showing America that the Soviet Union was its equal] . [Burlatsky 1988, page 164][14]
>
> [In 1959 Fidel Castro came to power and the U.S.] was hostile towards the Cuban revolutionaries' victory from the very start. … At that time Castro was neither a Communist nor a Marxist. It was the Americans themselves who pushed him in the direction of the Soviet Union. He needed economic and political support and help with weapons, and he found all three in Moscow. [Burlatsky 1988, page 169]
>
> In April 1961 the Americans supported a raid by Cuban emigrees … The Bay of Pigs defeat strained anti-Cuban feelings in America to the limit. Calls were made in Congress and in the press for a direct invasion of Cuba. … In August 1962 an agreement was signed [between Moscow and Havana] on arms deliveries to Cuba. Cuba was preparing for self-defense in the event of a new invasion. [Burlatsky 1988, page 170]
>
> The idea of deploying the missiles came from Khrushchev himself. … Khrushchev and [Soviet Defense Minister] R. Malinovsky … were strolling along the Black Sea coast. Malinovsky pointed out to sea and said that on the other shore in Turkey there was an American nuclear missile base [which had recently been deployed]. In a matter of six or seven minutes missiles launched from that base could devastate major centres in the Ukraine and southern Russia. … Khrushchev asked Malinovsky why the Soviet Union should not have the right to do the same as America. Why, for example, should it not deploy missiles in Cuba? [Burlatsky 1988, page 171]

In spite of the similarity between the Cuban and Turkish missiles, Khrushchev realized that America would find his deployment unacceptable and therefore did so secretly, disguising the missiles and expecting to confront the U.S. with a *fait accompli*. Once the missiles were operational, America could not attack them or Cuba without inviting a horrific nuclear retaliation.

Our Turkish missiles had a similar purpose. Stationing nuclear weapons on an ally's soil provides a "nuclear trip wire." An opponent is deterred from threatening that nation out of fear for the consequences. But that begs the question, addressed here, of how much risk is involved in

---

[14] All references to Burlatsky are to: Fedor Burlatsky, *Khrushchev and the first Russian Spring*, Scribners, New York, 1988.

devising such a contraption. As the name so presciently implies, it is possible for the opponent to accidentally trip and spring the trap, except this trap destroys both trapper and trapped.

Just as Kennedy did not think through likely Soviet responses to our Turkish missiles, Khrushchev did not envision what would happen if he was caught before completing his missile deployment – which is exactly what happened. With respect to the Cuban Missile Crisis, the states of Figure 3.3 that brought us to the brink of nuclear war can now be identified as:

1. conflict between America and Castro's Cuba;
2. Russia demanding to be treated as a military equal and being denied that status;
3. the Berlin Crisis;
4. the Bay of Pigs invasion;
5. the American deployment of ballistic missiles in Turkey; and
6. Khrushchev's deployment of ballistic missiles in Cuba.

The actors involved in each step did not perceive their behavior as overly risky. But compounded and viewed from their opponent's perspective, those steps brought the world to the brink of nuclear disaster. During the crisis, there were additional, fortunately unvisited states that would have made World War III even more likely. As will be discussed in more detail in a later section of this handout, the strong pressure noted by Burlatsky to correct the Bay of Pigs fiasco and remove Castro with a powerful American invasion force intensified after Khrushchev's Cuban missiles were discovered. But those arguing in favor of invasion were ignorant of the fact, not learned in the West until many years later, that the Russians had battlefield nuclear weapons on Cuba designed to be used against just such an American invasion.[15]

Anatomy of another near miss: The 2008 Cuban Bomber Crisis

The sequence of six steps listed above that resulted in the Cuban Missile Crisis is a concrete example of state transitions that took us from a relatively safe state within Figure 3.3's *The World As We Know It* to a state just this side of the *Nuclear Threshold.* Contrary to conventional wisdom, which sees both the Cold War and the nuclear threat as ghosts of the past, this section shows that in the summer of 2008, we came perilously close to repeating that sequence of mistakes. Because the 2008 Cuban Bomber Crisis stopped just short of becoming a full-blown

---

[15] Coleman argues that the possibility of Soviet tactical nukes was considered by some, but my reading of the history indicates that those arguing for an invasion either largely or completely ignored that information. Later material presented here will help you decide.

crisis, most people are unaware of it. But, as shown below, we came within what might be called "half a step" of once again staring at the nuclear abyss and wondering how we got there. This section lists the six steps that led to the 1962 crisis and then provides examples of recent mistakes that fit the same pattern, leading up to July 2008's Cuban bombers:

Step #1: conflict between America and Castro's Cuba

Cuba still is an emotional land mine for Americans. When word reached General Norton Schwartz, now Air Force Chief of Staff, that the Russians might deploy nuclear capable bombers in Cuba, he said that would cross "a red line."

Step #2: Russia demanding to be treated as a military equal and being denied that status

The same is true today. Even though Russia has thousands of nuclear weapons (as does the U.S.), we see ourselves as the world's sole remaining superpower, leading even Mikhail Gorbachev to say in a 2008 interview, "there is just one thing that Russia will not accept … the position of a kid brother, the position of a person who does what someone tells it to do."[16] Repeated American statements that we defeated Russia in the Cold War add fuel to that fire since the Russians feel they were equal participants in ending that conflict. An additional irritant is the way D-Day ceremonies repeatedly give the impression that the West won World War II, overlooking the immense Soviet contribution in the victory over Nazism.

Step #3: The Berlin Crisis

Several hotspots (e.g., Chechnya, Georgia, Estonia, Cuba and Venezuela) test Russian-American relations in ways that are similar to Berlin forty years ago.

Step #4: The Bay of Pigs invasion

The 2008 Georgian war is almost a mirror image of the 1961 Bay of Pigs invasion. In 1961, Kennedy was humiliated and therefore looking for ways to regain his manhood, both with the Soviets and the American electorate. In 2008, Georgia's President Mikheil Saakashvili was whipped by the Russians after his attempt to regain South Ossetia and Abkhazia by force. Probably pushed by the same motivations that drove Kennedy, Saakashvili has taken actions that could result in a rematch. The danger is increased because most Americans mistakenly believe that Russia's invasion of Georgia was totally unprovoked. In consequence, possible presidential candidate Sarah Palin has said that we should be prepared to go to war with Russia should it invade Georgia again, and many Americans, including President Obama, still support NATO membership for Georgia.

---

[16] Nicholas Tatsis, "A Brave New World: President Mikhail Gorbachev on the nuclear age and Russia's future," *Harvard Political Review*, January 13, 2008. I could not find a link to this interview all by itself. The link given in "2008 interview" will take you to a collection of articles, where you can search on *Tatsis* to find the beginning of this article.

Step #5: The American deployment of ballistic missiles in Turkey

The missile defense system President George W. Bush planned for Eastern Europe, with American missiles in Poland, bears an ominous similarity to the Turkish missiles. While these new missiles are seen as defensive and a non-issue in America, the Russians see them as offensive and part of an American military encirclement. In October 2007, Putin warned, "Similar actions by the Soviet Union, when it put rockets in Cuba, precipitated the Cuban Missile Crisis." Two months later Gorbachev questioned America's stated goal of countering a possible Iranian missile threat, "What kind of Iran threat do you see? This is a system that is being created against Russia." Russia's fears are exacerbated by Poland's seeing the system as providing protection for it against Russia.

While President Obama's September 2009 decision to emphasize options that are less threatening to the Russians has partly defused the danger, basing part of the system in Romania leaves the issue far from resolved. Also, looking beyond the next few years, it is possible that a future American president could reactivate the original plan in a manner that would add to the danger.

Step #6: Khrushchev's deployment of ballistic missiles in Cuba

While there is not yet a modern day analog of this complete step, serious warning tremors have occurred in July 2008. That was when *Izvestia*, a Russian newspaper often used for strategic governmental leaks, reported that, if we proceeded with our Eastern European missile defense system, then nuclear-armed Russian bombers would be deployed to Cuba. During Senate confirmation hearings as Air Force Chief of Staff, General Norton Schwartz responded that "we should stand strong and indicate that is something that crosses a threshold, crosses a red line." While the Russian Foreign Ministry later dismissed *Izvestia's* report as unfounded, some elements within the Russian Defense Ministry seem to be in a similar state of mind to the one that prompted Khrushchev to deploy his Cuban missiles.

A later report appeared only in Russian, so I'll include an English translation of key parts:

> (Headline in bold) **Our Side Has Already Landed on Cuba and Has Done Reconnaissance. The Readiness of "White Swans" and "Bears" to "serve" on the Island of Freedom [Cuba]Was Confirmed to *Izvestia* By The Russian Defense Ministry, *Izvestia*, July 24, 2008**: Strategic rocket carriers Ty-160 ("The White Swan") and Ty-95MC ("The Bear" according to NATO's classification) can be sent to air bases in Latin America and Africa at any moment, said The Defense Ministry to *Izvestia*. Moreover, we are talking not only about Cuba, but Venezuela and Algeria. It is interesting to note that Venezuela's President Hugo Chavez, having been on a visit to Moscow last Tuesday, said that Caracas would be happy to accept the Russian military. … The military does not hide the fact that sending strategic rocket planes to the shores of the United

States is a reaction to the deployment of elements of the American anti-missile defense in Poland and the Czech Republic, and to the expansion of NATO eastward.

Two months later, in September 2008, Russian bombers visited Venezuela, but fortunately did so without much public attention. In terms of assessing future risks, it is instructive to consider whether the risk would have been greater if Obama, rather than Bush, had been president when the bombers made that flight to Venezuela – as would be the case if Obama's political opponents are more likely to use such an event to tar him as soft on national defense. That in turn would spotlight the issue for the American electorate and place pressure on the president to act in ways that increase the risk of approaching the nuclear threshold. Domestic politics played a similar role in the Cuban Missile Crisis: Both Kennedy and McNamara agreed that the Cuban missiles did not upset the strategic balance, but were heavily influenced by domestic politics – including the upcoming midterm elections – to counter the Soviet move with a strong response. We'll see more on that later in this handout.

These incidents in July 2008 stopped half a step short of a full-blown crisis, but that is little cause for comfort. In terms of the sequence of events that turn a 99.9% safe maneuver into a fatal accident, we were at a very dangerous point in the process and need to recognize complacency as our true enemy.

A preliminary risk analysis of nuclear deterrence

In March 2008 I published what appears to be the first quantitative risk analysis of nuclear deterrence. That paper was intended for an engineering audience and therefore used some mathematics that is beyond the reach of the layperson. However, I believe the basic ideas can be expressed in plain English, as I will attempt in the next few sections. I look forward to hearing how you find it. If the math is more complex than you can handle, don't worry since it is not be crucial to what follows. If you cannot follow the math, the descriptive material will help explain why the risk is so much greater than most people realize.

An in-depth risk analysis would have required expertise in a number of areas, and involved a team effort. Working by myself, I therefore simplified the analysis by considering only one possible trigger mechanism for a nuclear war, a crisis involving Cuba. Because that approach ignores other potential causes, it underestimates the risk and is called a *lower bound*. Thinking in terms of Figure 3.3's state diagram, I broke the process into four steps:

1. The occurrence of an event that had the potential to initiate a crisis involving Cuba.

2. Whether or not the potential initiating event actually produced a crisis.

3. Whether or not the crisis crossed the nuclear threshold.

4. Whether or not crossing the nuclear threshold resulted in full-scale war.

Step 1: Potential Initiating Events

A study of the first 50 years of the nuclear deterrence era (1960-2010)[17] showed that there were three potential initiating events (step 1 above).Three events divided by 50 years produces an occurrence rate of such events of 6% per year. Equivalently, I estimated that such events will occur approximately every 17 years since 1/0.06 = 17. The three events I identified were:

- The United States placing missiles in Turkey, starting in 1961. This has been discussed in detail earlier, and in fact did produce a crisis.

- In the 1980s, President Reagan was so disturbed by Cuba supplying weapons to a leftist insurgency in El Salvador that he threatened to reimpose a naval blockade of Cuba. Such an action would have violated one of our key concessions (lifting the blockade) in return for which the Russians removed their Cuban missiles. Had Reagan reimposed the blockade, the Russians would likely have taken some action, possibly even threatening to redeploy missiles unless the blockade was lifted. Such a reaction was made more likely by the fact that, at that same time, Reagan was in the process of deploying Pershing IRBMs (so-called "Euromissiles") in Western Europe, over strenuous Soviet objections. While not as close to the Soviet border as the Turkish Jupiters had been, the only way the Soviets could match such weapons was with missiles in Cuba.

- The United States' Eastern European missile defense system, discussed in detail earlier in this handout, came close to precipitating a crisis, and still might.

Step 2: Potential Initiating Events Becoming a Crisis

The next step in my analysis was to estimate the probability that, once an event that had the potential to initiate a crisis involving Cuba had occurred, it actually did so. Only one of the three possible initiating events listed actually resulted in a Cuban crisis, so that empirical probability (i.e., based on the observed data) is ⅓. Because only the first initiating event led to a full-blown crisis, it might be argued that we learned from that mistake and ⅓ is too large an estimate today. But, the fact that the latter two possible initiating events occurred at all is evidence that we did not adequately learn from the first mistake, or that we learned the wrong lesson. Because these two factors tend to cancel each other, I used ⅓ as a reasonable estimate. Multiplying this by the 6% chance each year of a potential initiating event, results in a 2% probability of having a Cuban

[17] Although nuclear weapons were first developed in 1945 and a second nation obtained them in 1949, until approximately 1960 there were too few weapons for the strategy to be called deterrence in the sense that we think of it today.

crisis each year. Equivalently, I estimated that we can expect to see a Cuban crisis about once every 50 years. This is not a precise estimate and 1% (100 years between crises) or 4% (25 years between crises) could also be argued, but would not change the conclusion appreciably.

Step 3: Crossing the Nuclear Threshold

Up to this point, I was able to make use of historical data in estimating probabilities, but that is not possible in estimating the probability that a crisis comparable to 1962's actually crosses the nuclear threshold. Because nuclear weapons have not yet been used during the deterrence era (i.e., when the other side could retaliate), this estimate, of necessity, involves some subjectivity. In such cases, risk analysis uses a technique known as *expert elicitation*. In that process, opinions of experts with different views of the risk are combined. Since my expertise in this area is limited, my analysis used a crude form of expert elicitation to estimate the probability of crossing the nuclear threshold once a full-blown crisis existed by citing, and then analyzing, the following data points:

- During the crisis, Kennedy ordered families of White House staff to either leave Washington or be near a telephone[18] providing evidence for his estimate that the chances of war were "somewhere between one out of three and even." [19]

- Kennedy's Secretary of Defense Robert McNamara described his feelings at the height of the crisis in the following terms: "As I left the White House and walked through the garden to my car to return to the Pentagon on that beautiful fall evening, I feared I might never live to see another Saturday night." [20]

- Kennedy's National Security Advisor McGeorge Bundy thought the odds of war were much lower, on the order of 1%.

- Douglas Dillon, another of Kennedy's advisors, also had little fear of the crisis blowing up and, at a 1987 conference commemorating the crisis' 25th anniversary, stated: "My impression was that military operations looked like they were becoming increasingly necessary. ... The pressure was getting too great. ... Personally, I disliked the idea of an invasion [of Cuba] ... Nevertheless, the stakes were so high that we thought we might just

---

[18] Fedor Burlatsky, *Khrushchev and the first Russian Spring*, Scribners, New York, 1988, page 168.

[19] Theodore C. Sorensen, *Kennedy*, Harper & Row, New York, 1965, page 705.

[20] Robert McNamara, *Blundering Into Disaster: Surviving the First Century of the Nuclear Age*, Pantheon Books, New York, 1986, page 11.

> have to go ahead. Not all of us had detailed information about what would have followed, but we didn't think there was any real risk of a nuclear exchange."[21]

These statements from participants support a range from 1% to 50% for the odds of the crisis crossing the nuclear threshold.[22] In my analysis, I used a range of 10% to 50% for this probability, discounting Bundy's and Dillon's optimism for the reasons explained in the following two subsections.

The unknown nuclear torpedo A major danger of crossing the nuclear threshold was totally unknown to Kennedy and his advisors. Only on the 40th anniversary of the crisis in 2002, did we learn that two Soviet submarines that had been forced to surface by American destroyers each possessed 15-kiloton nuclear torpedoes (comparable to the weapons that destroyed Hiroshima and Nagasaki) and that the subs' captains considered using them. The destroyers were under orders to enforce the American naval blockade of Cuba and used what they regarded as signaling depth charges to command the subs to surface. Though smaller than normal depth charges, they still caused damage to the sub, leading the crews to believe they were under attack.[23] Because submarines maintain radio silence when being hunted, at least one captain also feared that World War III had started up on the surface. Due to being submerged for a long period of time, the temperature on one of the subs had skyrocketed past 120 degrees, adding to the already heavy pressure on the crew. A book on the incident, quotes the captain of that sub as saying, "There may be a war raging up there and we are trapped here turning somersaults! We are going to hit them hard. We shall die ourselves, sink them all but not stain the navy's honor!" Fortunately, others on board the sub succeeded in calming the captain and he eventually surfaced, even though such a "surrender" was a blot on both the officer's and the Soviet navy's honor.

Soviet battlefield weapons for repelling an American invasion During the crisis, there was repeated, strong pressure for an American invasion of Cuba that either was unaware of or did not adequately consider the risk that the Soviets might have battlefield (tactical) nuclear weapons on the island to repel such an invasion – which they did. Given the logistical advantage the US had (a supply line only ninety mile long versus thousands of miles for the Soviets) and repeated American threats to invade Cuba, Kennedy and his advisors should have considered that the

---

[21] James G. Blight and David A.Welch, *On the Brink: Americans and Soviets Reexamine the Cuban Missile Crisis*, Hill and Wang, New York, 1989, page 72

[22] It should be noted that the three statements do not specifically mention the first use of a nuclear weapon. They could be interpreted as being about conventional war between the US and the USSR, or they could be interpreted – especially McNamara's statement – as relating to full-scale nuclear war. These two factor tend to balance one another.

[23] Adding to the danger, Washington had only communicated to Moscow its "Submarine Surfacing and Identification Procedure" *after* the crisis had started. Given that submarines routinely practice radio silence in a war zone, I suspect that these details on the signaling procedure never reached the sub.

Soviets would take such a step and were delaying the announcement until (and if) it was needed. Yet declassified records show that, at a minimum, that possibility was given inadequate attention and often seems to have been totally overlooked.

The unsuccessful 1961 Bay of Pigs invasion had humiliated the United States and, when the Soviet missiles were discovered on Cuba, intensified pressure to invade, topple Castro and eliminate, once and for all, what many saw as a communist cancer in the Western hemisphere. Kennedy secretly taped the meetings of his ExComm (the group of advisors he assembled to deal with the crisis), and Sheldon Stern, the longtime historian at the John F. Kennedy Library is the acknowledged expert on decoding these often-barely-audible recordings. Stern describes a meeting on Friday, October 19, 1962, when the existence of the missiles was still being kept secret from the American public and even Congress:

> General Earle Wheeler, Army Chief of Staff, increased the pressure by insisting that only bombing [the missiles], a blockade, *plus* an invasion could protect the United States against a nuclear strike from Cuba. … 'You'll have to invade the place,' [Marine Corps Commandant David] Shoup … declared, banging the table for emphasis.[24] (emphasis in original)

While Kennedy never convinced his military advisors of the wisdom of delaying an attack on the missiles and Cuba, he did manage to restrain that sentiment within the ExComm. But three days after the above described meeting, Kennedy was confronted with forceful, new pressure to invade when, two hours before he told a stunned nation about the missiles in a nation-wide television broadcast, he briefed key Congressmen and Senators for the first time:

> [Georgia's] Senator Russell suddenly lashed out: "Mr. President, I could not stay silent under these circumstances and live with myself. … We're either a first-class power or we're not. … And I think that you should assemble as speedily as possible an adequate force and clean out that situation. … The time's gonna come, Mr. President, when we're gonna have to take this gamble … for the nuclear war." … Russell insisted that an invasion would present the Soviets with a *fait accompli* and make war *less* likely – the same arguments made three days before by General LeMay. … Another influential Southern Democrat, Senator William J. Fulbright, abruptly weighed in against the blockade. An invasion, he insisted, was *less* risky [because] … "it's just between us and Cuba … [but] if you're confronted with a Russian ship, you *are* actually confronting Russia."[25]

---

[24] Sheldon M. Stern, *The Week the World Stood Still: Inside the Secret Cuban Missile Crisis*, Stanford University Press,Stanford, CA, pages 68-69.

[25] Sheldon M. Stern, *The Week the World Stood Still: Inside the Secret Cuban Missile Crisis*, Stanford University Press,Stanford, CA, pages 87-90.

Definitive evidence that the Soviets had battlefield nuclear weapons on Cuba only came to light twenty-five years later, after the breakup of the Soviet Union lifted the veil of secrecy from many of the records of meetings. In their 1997 book *One Hell of a Gamble,* (W. W. Norton & Co., New York) Aleksandr Fursenko and Timothy Naftali used access to formerly secret Soviet-era documents to conclude:

> Page 212: Khrushchev understood the importance of the decision he had just made [to send tactical nuclear weapons to Cuba] and took pains to maintain direct control of these special weapons. A day after he authorized the new shipment, the Minister of Defense [Malinovsky] drafted an order permitting the Soviet commander in Cuba, General Issa Pliyev, to employ these battlefield nuclear weapons in the event that communications to Moscow were cut and a U.S.-led invasion had begun. The order required two signatures. Malinovsky's deputy, Marshal Zakharov, signed in his capacity as army chief of staff, but Malinovsky did not. … The document was to sit [half] unsigned in the files until events in Cuba warranted a change. [It should be noted that there is a major difference between authorization to use nuclear weapons and the ability to use them. With or without authorization, Pliyev almost surely had the *ability* to use the nuclear weapons under his command, as did a number of lower level Soviet officers. The use of Permissive Action Links or PALs (similar to a combination lock) to prevent unauthorized use of nuclear weapons did not become widespread until later. In the event of an American invasion, Pliyev might well have used the weapons even if not authorized to do so. Later discussion of the unauthorized use of a Soviet surface-to-air missile to shoot down an American U-2 is germane.]
>
> Page 241 bottom: [Khrushchev's] mind kept returning to what the Soviet Union would have to do if the United States attacked Cuba. As "another possibility… In case of attack," said Khrushchev, the Kremlin could declare that "all of the equipment belonged to the Cubans and the Cubans would announce that they will respond." He assured his colleagues that he did not envision letting Castro threaten the use of the medium-range ballistic missiles against a U.S. invasion, but as a way of deterring the United States the Cubans could declare that they would "use the tactical ones."
>
> Page 242: On the assumption that a U.S. invasion was more likely than a blockade, the Presidium worked out a set of instructions for the Soviet commander in Cuba, General Pliyev. The group's first reaction was to take steps to avoid an accidental nuclear exchange. A cable was drafted that ordered Pliyev to "put all of his forces on alert" but not to contemplate using any of the nuclear weapons deployed at his command. The more the Soviet leaders thought about the restrictive language of this cable, however, the less they liked it. If the Americans attacked Pliyev and the 41,000-man Soviet contingent in Cuba would be outnumbered. The nuclear tipped Luna and cruise missiles were his only potential salvation. Unwilling to sacrifice the Soviet group, the Presidium tentatively came up with a

different set of instructions. Pliyev would be authorized to use the tactical nuclear weapons in the event of a U.S. landing; but without a direct order from Moscow, he was not to fire the 1,100-nautical-mile R-12.'s. …

Pages 242-243: And what would be the US reaction to the first use of nuclear weapons by the Soviet Union? A look at the blast effects of these weapons left little doubt that if Pliyev used his battlefield nuclear weapons there would be enormous pressure on President Kennedy to destroy Cuba, at the very least. Each Luna had a range of 31 miles and a two-kiloton nuclear payload.… Each one would have a devastating effect on the battlefield. … with the 12 at his disposal the Soviet commander in Cuba could easily destroy any beachhead established by U.S. Marines in an invasion of Cuba and obliterate the U.S. base at Guantánamo, at the southeastern tip of the island.

Page 243: The cruise missiles, the FKR, if used, would not have as dramatic an effect on the battlefield but, as predicted by Soviet military journals, could inflict heavy costs on the U.S. Navy task force participating in an attack. One FKR cruise missile carried enough power, roughly twelve kilotons of TNT, to blow a U.S. aircraft carrier group apart. Of the eighty missiles with nuclear warheads originally ordered to be shipped, the Kremlin had already sent thirty-six to the island.

Despite such dangerous thinking, some rationality also prevailed:

Page 243: Concerned that Khrushchev and the Presidium were rushing to the brink of nuclear war prematurely, Malinovsky recommended to the group that it wait until 1 AM, or 6 PM Washington time, to authorize Pliyev to fire the Lunas. Fearful that Washington would somehow learn about this delegation of authority, Malinovsky cautioned that they should not give the Americans "a pretext to use their own nuclear weapons" before this was absolutely necessary. Persuaded by Malinovsky, the Kremlin decided to send the first set of conservative instructions immediately, barring the use of any nuclear weapons. The second set of instructions – the order prepared in September 1962 but not signed by Malinovsky – would be held pending developments in the Caribbean.

Summary The two previous subsections are intended to support my discounting McGeorge Bundy's 1% estimate for the crisis leading to war, and Douglas Dillon's statement that "Not all of us had detailed information about what would have followed [an invasion of Cuba], but we didn't think there was any real risk of a nuclear exchange." As you can see, not only did Dillon not have detailed information on "what would have followed," but that was also true for Kennedy and all of his advisors. At a minimum, they were unaware of the nuclear torpedoes on the Soviet submarines, and the record shows little to no concern for the possibility (which turned

out to be an actuality) of Soviet tactical nuclear weapons being used to deter – and if need be repel – an American invasion.

Multiplying the 10% to 50% range that I estimate for the probability of such a crisis going nuclear by the 2% per year probability of a Cuban crisis occurring in the first place, results in a range of 0.2% to 1% per year for the probability of crossing the nuclear threshold.[26] Over one human lifetime (78 years in the United States), the corresponding risk ranges from 15% to 50%. As usual, I rounded those numbers to avoid implying greater accuracy than is warranted.

When other potential initiating events that could cause us to cross the nuclear threshold (e.g., a nuclear terrorist attack, or a crisis involving Georgia) are included, the risk becomes even larger. Given the statement by Kissinger and Senator Lugar's survey, mentioned earlier in this handout, nuclear terrorism, all by itself, has a much higher probability of causing a nuclear disaster. Considering a sequence of events such as above is important however, since a first use of nuclear weapons in a Russian-American confrontation carries a higher risk of producing a full-scale war.

Two issues that will be considered in later sections of this handout deserve to be mentioned now: How relevant is data from 1962 to today's world? And what do we do if you disagree with my estimate? Stay tuned for the answers in the last two sections of this handout.

Step 4: Full-Scale War

The previous section's conclusion – that a crisis involving Cuba has somewhere between a 15% and 50% chance of causing a nuclear disaster over the lifetime of a child born today – is so serious that, in a way, this section is not needed to make the case for changing our approach to nuclear weapons. That somewhat alleviates the difficulty of again estimating the probability of an event that has never happened, and one that is even more difficult to envision than crossing the nuclear threshold.

This last step is to estimate the odds of a full-scale nuclear war resulting from a Cuban crisis, given that the nuclear threshold already has been crossed during the crisis. While Kennedy did not specify what he meant by the 1962 crisis ending in war, his evacuation order to the families of White House staff lends support to the hypothesis that he meant full-scale nuclear war. McNamara's stated fear that he would not live out the week is also consistent with that interpretation. If that is the case, then the probability range calculated in the last section is really for a full-scale war, not just crossing the nuclear threshold. However, to avoid being seen as alarmist, my estimate used a range of 10% to 50% for this probability as well. Multiplying that

---

[26] While it is sometimes wrong to multiply probabilities, it is can be done here because the probabilities are *conditional probabilities*. Explaining that would be far beyond the scope of this handout, but I wanted you to know that I took that issue into account. A similar comment applies in the next section (Step 4).

range by the previous range (0.2% to 1% per year) for crossing the nuclear threshold results in a range that runs from 0.02% per year to 0.5% per year. The corresponding risk of a full-scale nuclear war over the lifetime of a newly born child ranges from 1.5% to one-in-three, *considering only crises involving Cuba as the cause of the war.* When all possible trigger mechanisms are considered, the risk becomes even higher.

Other Risks During the Crisis

The following list of additional dangerous incidents that occurred during the crisis might support an even higher estimate of the probabilities involved in steps 3 or 4:

Operation Northwoods demonstrates how intent the Joint Chiefs of Staff were on toppling Castro. (That link is to scanned, declassified documents. Wikipedia has the main text in computer readable form.) In March of 1962, the Joint Chiefs recommended this plan that proposed a number of possible ruses "to place the United States in the apparent position of suffering defensible grievances from a rash and irresponsible government of Cuba and to develop an international image of a Cuban threat to peace in the Western Hemisphere" with the "ultimate objective … [being to] provide adequate justification for US military intervention." If the goal were not so serious, the proposed ruses would read like a slapstick comedy routine. There are too many to list here, so I will just mention the *piece de resistance:* "A 'Remember the Maine' incident could be arranged … [For example,] We could blow up a US ship in Guantánamo Bay and blame Cuba." Fortunately Kennedy rejected the plan.

When the crisis first started to unfold, Kennedy was unaware that we had similar missiles in Turkey.[27] In a meeting, Kennedy explained why the Soviet missiles in Cuba were so unacceptable: "It's just as if we suddenly began to put a major number of MRBMs in Turkey. Now that'd be goddam dangerous, I would think." His National Security Advisor McGeorge Bundy then reminded him, "Well we did, Mr. President." Somewhat flustered, Kennedy tried to find an excuse, "Yeah, but that was five years ago. … That was during a different period then." In actuality, our Turkish missiles became fully operational in April 1962.

Even after Kennedy had equated our Turkish missiles to the Soviet missiles in Cuba (and been reminded that they existed), a dangerous attempt was made to hide that equivalence throughout the decision process:

> The decision-makers in 1962 were well aware of the analogy between U.S. Jupiter missiles in Turkey and Soviet missiles in Cuba but preoccupied with finding ways to deny it. At an October 18 meeting the conferees' tortured reasoning led them to agree that the difference lay

[27] Richard K. Betts, *Nuclear Blackmail and Nuclear Balance*, The Brookings Institution, Washington, DC, 1987, pages 112-113.

> in the universal understanding "that sensitive areas, such as Berlin, Iran, or Laos, should not be turned into missile bases, and that missile installations only be established pursuant to open military alliances, such as NATO."[28]

The United States repeatedly violated Cuban airspace, initially with high level U-2 photo reconnaissance missions, and later, when more detail was needed to convince the general public (including UN ambassadors), low-level jets screaming over Cuba at 500 knots barely above treetop level. In spite of the fact that Cuba and the Soviets would have been within their rights to fire on these American planes, the Soviet government and top brass recognized the danger of escalation and issued strict orders to prevent an unnecessary incident. In spite of this attempt to keep the crisis under control, on October 27, Major Rudolf Anderson was killed when a Soviet surface-to-air missile shot down his U-2 spy plane.

The downing of Major Anderson's U-2 led a number of Kennedy's advisors to urge military action. Assistant secretary of defense Paul Nitze saw it as, "They've fired the first shot." Chairman of the JCS, General Maxwell Taylor argued, "We certainly shouldn't [conduct any more U-2 flights] until we retaliate, and say that if they fire again on one of our planes that we will come back with great force." Secretary of Defense McNamara felt that, "We ought to go in at dawn and take out that SAM site [that had downed Anderson]."[29]

The surface-to-air missile that hit Major Anderson's U-2 was fired without the required permission. Trying to contain the crisis, General Pliyev had given orders that such action should only be taken on his command, but his deputies were unable to reach him during the short time when they had any chance of hitting Anderson's U-2. Fursenko and Naftali explain the irony:

> For all of Khrushchev's efforts to control the use of force in Cuba, he had not been able to prevent the first American casualty. His commanders in Cuba had given a liberal interpretation to his earlier order to defend their positions from a U.S. air attack. [Pliyev's deputies who authorized firing the missile "mistakenly believed that whatever photographs Anderson's plane was taking would facilitate a U.S. air attack later that day or the next."] The crisis now moved into its most dangerous phase since October 22 [when Kennedy announced the naval blockade].[30]

On the same day that Major Anderson's U-2 was shot down, Captain Charles Maultsby flew a U-2 out of Alaska, became lost, entered Soviet airspace, and was detected by their air defense. Soviet fighters scrambled in an effort to shoot him down, and Roger Hilsman, the State

---

[28] Richard K. Betts, *Nuclear Blackmail and Nuclear Balance*, The Brookings Institution, Washington, DC, 1987, page 113.

[29] Michael Dobbs, *One Minute to Midnight*, Alfred A. Knopf, New York, 2008, page 293.

[30] Aleksandr Fursenko and Timothy Naftali, *One Hell of a Gamble*, W. W. Norton & Company, New York, 1997, page 278.

Department's chief of intelligence saw that, "The implications were as obvious as they were horrendous: the Soviets might well regard this U-2 flight as a last-minute intelligence reconnaissance in preparation for nuclear war."[31]

While Soviet or Cuban attacks on American aircraft within their airspace were seen as "firing the first shot," potential Soviet penetration of American airspace was seen in a very different light. General John Gerhart, commander in chief of the North American Defense Command asked the Pentagon for advance permission "to use nuclear weapons … in the event of an IL-28 [Soviet bomber] raid from Cuba which penetrates U.S. air space." The Joint Chiefs agreed to his request, in the event that his air defense system indicated a general "Cuban and Sino-Soviet attack."[32] While such a plan made military sense if Soviet bombers were en route to destroy an American city, it also opened up the possibility for errors similar to Maultsby's unintentional violation of Soviet airspace and the unauthorized firing of the missile that took out Major Anderson's U-2.

The day before Major Anderson was shot down, on October 26, a Soviet convoy was ordered to move a cruise missile with a 14-kiloton nuclear warhead into position to attack the American naval base at Guantánamo Bay should war break out. Traveling at night, with lights blacked out, on treacherous roads, one of the vehicles fell into a ravine, killing three people and injuring a number of others. The sudden sound of the crash, accompanied by screams, at first led some in the convoy to believe they were under attack by rebel forces or even American troops. Fortunately, the vehicle carrying the warhead was not involved. If the Soviet warhead had accidentally detonated, in the confusion and chaos, it could have been mistaken for an American nuclear attack on Cuba.

---

[31] Michael Dobbs, *One Minute to Midnight*, Alfred A. Knopf, New York, 2008, page 269.

[32] Michael Dobbs, *One Minute to Midnight*, Alfred A. Knopf, New York, 2008, page 248.

Resolution of the Cuban Missile Crisis

Early in the crisis, Kennedy felt that, at a minimum, he would have to bomb the Soviet missiles.[33] Fortunately, with cooperation from the press which had been ready to break the story but held back in the interests of national security, he was able to keep the situation secret from the public for six days, during which time he was better able to recognize the implications of such actions. He realized an attack on the Cuban missiles would require an equally forceful Soviet response, most likely a tit-for-tat bombing of the American missile sites in Turkey or blockading West Berlin, where a crisis the year before had brought the world close to war. Adding to the danger, an attack on Turkey, under NATO's Article 5, was to be considered the same as a Soviet attack on American soil. Kennedy also came to realize that an air strike could not guarantee taking out all the missiles, jeopardizing Miami, Washington, and other American cities that were within range of the surviving missiles. Even if the Soviet hierarchy did not authorize such an attack, it was recognized that a low level officer in charge of a missile battery might take matters into his own hands if under attack.

Thus, in spite of his own initial reaction and repeated external pressure for both an air strike and an invasion of Cuba, Kennedy decided to start with a naval blockade of the island, and so announced in his Monday, October 22, television broadcast to the nation. While that would not prevent more of the missiles that were already on Cuba from becoming operational (reconnaissance had shown feverish work to complete the missile sites), it would prevent new ones from arriving, and send a strong message to the Soviets with less risk of escalation than an outright attack.

Kennedy was aided in his effort to portray Khrushchev's actions as fundamentally different from America's placement of missiles in Turkey because the latter had been done openly, while Khrushchev had repeatedly denied any intention to place missiles on Cuba, thereby making the Soviet actions appear more sinister. Khrushchev had acted surreptitiously because he correctly assumed that American public opinion would react violently to his action. He reasoned that announcing the missiles only after they were fully operational, would leave America little choice but to accept what the Soviet Union had lived with for years – hostile forces close to its borders.

A naval blockade is technically an act of war, and when first appraised of Kennedy's intention to force Soviet ships to undergo inspection before docking in Cuba, Soviet Ambassador Anatoly Dobrynin did, in fact, declare: "That would be an act of war."[34] In an attempt to parry that accusation, Kennedy decided to use the less onerous term *quarantine*, and sought (and obtained) approval from the OAS (Organization of American States) for that action. In spite of these fig

---

[33] Aleksandr Fursenko and Timothy Naftali, *One Hell of a Gamble*, W. W. Norton & Company, New York, 1997, page 238.

[34] Michael Dobbs, *One Minute to Midnight*, Alfred A. Knopf, New York, 2008, page 73.

leafs – which Kennedy's tapes show were seen as complete suit of clothes by his advisors – the president and his ExComm held their breath as Soviet ships approached the line Kennedy had drawn in the water. On Wednesday, October 24, the ships stopped moving toward the line, leading Secretary of State Dean Rusk to observe, "We were eyeball to eyeball, and the other fellow just blinked."[35]

While those Soviet ships reversing course relieved some of the tension, the crisis was far from over. Other ships approached the quarantine line days afterward, producing new concerns about what would happen and how to respond. The confrontation between the American destroyers and the nuclear-torpedo-armed Soviet submarines occurred three days later, on Saturday, October 27. That is also the day that Anderson's U-2 was shot down, Maultsby's U-2 violated Soviet airspace, and McNamara reflected that he feared he might not live to see another Saturday night.

The danger continued for months after the public end of the crisis. A 2007 article cites evidence in the John F. Kennedy Library to claim that, "The U.S. Joint Chiefs of Staff (JCS) continued to prepare to invade Cuba if the diplomatic settlement fell apart. Military readiness for such an operation peaked on 15 November." The danger of that occurring was exacerbated by Castro prohibiting American inspections on Cuban soil, leading Kennedy's advisors to fear that perhaps the Soviet missiles had not all been removed. If Khrushchev could lie before and during the crisis, falsely maintaining that no Soviet missiles were on Cuba, why should we now trust that the weapons had been removed? Those fears persisted even though, as shown in the photograph on the next page,[36] the Soviets took steps to help American reconnaissance verify the missiles removal, leaving the missiles in plain view as they left Cuba.

Both sides operated under tremendous time pressure during the crisis. The Soviets felt the need to have all missiles operational as soon as possible, in order to fulfill Khrushchev's original plan of having a local nuclear deterrent to prevent American attacks on either the missiles or Cuba. For exactly the same reason, Kennedy and his advisors felt pressure to take out the missiles or invade Cuba *before* more missiles were operational. Confusion resulted from that pressure. For example, Kennedy received two conflicting messages from Khrushchev. The first, sent privately on Friday evening, October 26, was a highly personal, even rambling letter that talked of the horror of war and offered to remove the Soviet missiles in return for an American pledge not to invade Cuba. The entire letter is on line as part of a large collection, and you can locate it within

---

[35] Michael Dobbs, *One Minute to Midnight*, Alfred A. Knopf, New York, 2008, page 88. Dobbs notes that Rusk and the others mistakenly believed that it was the missile-carrying ships that turned around at that point in time, even though they had done so the day before. But, even a Soviet ship carrying innocuous cargo could have tested the blockade, with possibly deadly consequences. What the ships carried was less important in some ways than what the Americans feared they might carry.

[36]

the collection by searching on *Moscow, October 26, 1962*. A second, public, more formal, and more demanding letter arrived the next morning. It took a stance of equality with the U.S. by proposing that the Soviets remove their Cuba, the United States remove its missiles from Turkey,

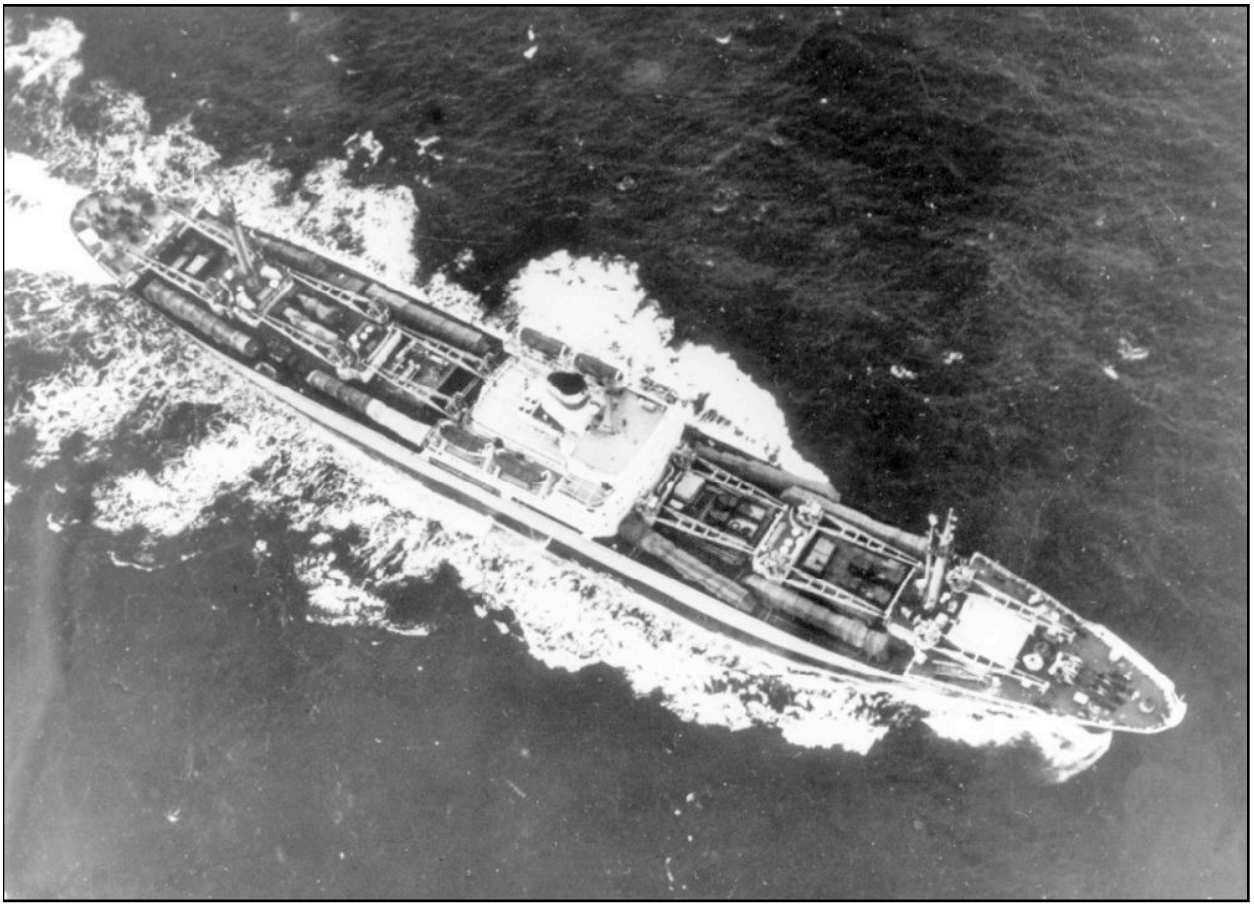

Figure 3.4: On 12 November 1962, US reconnaissance planes photographed the Soviet freighter 'Kurchatov' on her return to the Soviet Union. Missiles can be seen on the ship's deck.

the U.S. agree to respect Cuba's borders (including a no invasion pledge), and the U.S.S.R. agree respect Turkey's borders (including a no invasion pledge). Concerning the dilemma Kennedy faced in dealing with these two very different proposals, JFK Library historian Sheldon Stern wrote:

> President Kennedy had actually been probing the Turkish option for more than a week and asked, "where are we with our conversations with the Turks?" Assistant Defense Secretary Paul Nitze responded firmly, "The Turks say that this is absolutely anathema" and view it "as a matter of prestige and politics." … Under Secretary of State George Ball declared that approaching the Turks on withdrawing the Jupiters "would be an extremely unsettling business." "Well," JFK barked, "this is unsettling now George, because he's got us in a pretty good spot here. Because most people will regard this as not an unreasonable proposal. I'll just tell you that." "But, what 'most people,' Mr. President?" Bundy asked skeptically. The

> president shot back: "I think you're gonna have it very difficult to explain why we are going to take hostile military action in Cuba … when he's saying, 'If you get yours out of Turkey, we'll get ours out of Cuba.' I think you've got a very tough one here." …

In the end, Kennedy largely ignored the second letter and respond to the first, with private assurances – that he insisted be kept strictly secret – that our Turkish missiles would also be removed within months. This saved Kennedy from having to deal, at least immediately, with objections from Turkey, and gave the appearance that he had won the contest of wills. Being the apparent winner had important domestic political overtones since midterm elections loomed early in November. Had the missile trade been publicly known, Kennedy would have been skewered by the Republicans who were still smarting from his use of a fictitious missile gap to defeat Richard Nixon in the 1960 presidential election.[37] Instead, basking in the glow of seeming victory in the Cuban crisis, the Democrats performed much better in those elections than originally forecast. Of course, Kennedy's advantages from this secret deal were Khrushchev's problems. Although Kennedy did not have to deal with Turkey feeling publicly betrayed, Khrushchev exactly that problem with Castro. And, even though in reality Khrushchev had struck a good bargain, getting the two key concessions he wanted (a no invasion pledge from the U.S. and removal of the Turkish missiles), on the surface he appeared to lose. While other factors were also involved in his ouster as leader of the Soviet Union two years later, in October 1964, one of the accusations was "juggling the fate of the world [in Cuba]."[38]

Does Historical Data Have Relevance Today?

Returning to my preliminary risk analysis of nuclear deterrence, a key question is the extent to which historical data is relevant to estimating today's failure rate for nuclear deterrence (i.e., the risk that deterrence will fail within the next year, or the year after, etc.). The four steps that I used in that analysis allow us to break down that question into four sub-questions:

- How relevant is the historical data to the rate of occurrence of potential initiating events?
- How relevant is the historical data to the chance that a potential initiating event results in a crisis?
- How relevant is the historical data from the Cuban Missile Crisis to the chance of a new crisis crossing the nuclear threshold?

---

[37] While these days, it is usually Republicans who paint (and taint) Democrats as "soft on defense," they learned the value of doing this from Kennedy.

[38] William Taubman, *Khrushchev: The Man and his Era,* W. W. Norton & Company, New York, 2003, page 12.

- How relevant is the historical data from the Cuban Missile Crisis to the chance of a new crisis that has crossed the nuclear threshold escalating to full-scale war?

How relevant is the historical data to the rate of occurrence of potential initiating events? This first sub-question can be at least partially answered by noting that the three potential initiating events I identified with respect to Cuba (the Turkish missiles, Reagan's threats to reimpose a naval blockade of Cuba, and our Eastern European missile defense system) occurred from 1959-62 (from signing an agreement with Turkey to full operation of the missiles), 1981-87 (from the start of President Reagan's term in office until he and Gorbachev became friendly) and from 2002-2009 (from President Bush's withdrawing from the ABM Treaty through President Obama modifying the original plan in ways that were not as threatening to the Russians – though it could be argued that potential initiating event is either still active, at a reduced level, or in hibernation, awaiting a new president who might reactivate the original plan). The starting points for these potential initiating events occur approximately every 20 years, including after the end of the Cold War. Further, events such as the 2008 Georgian war (which we will study in greater detail) show that potential initiating events are continuing to occur. An in-depth study would catalog many more such events, rate their severity, and result in a plot of these events versus time. That effort would likely show variation with time, and that variation could then be brought into the analysis to produce a better estimate of the risk we face. However, based on the evidence I have seen thus far, I doubt that it will affect the overall conclusion of my preliminary study that the risk of nuclear deterrence failing is orders of magnitude greater (i.e., at least ten times greater, and probably hundreds or thousands of times greater) than society will accept with respect to other technologies capable of causing widespread destruction (e.g., nuclear power plants).

How relevant is the historical data to the chance that a potential initiating event results in a crisis? In July 2008, the last potential initiating event I identified (our Eastern European missile defense system) came close to producing a full-blown crisis over Cuba. As discussed earlier in this handout, after the Russians indicated they would respond to that perceived threat to the credibility of their deterrent by basing bombers on Cuba, Air Force Chief of Staff, General Norton Schwartz responded that "we should stand strong and indicate that is something that crosses a threshold, crosses a red line." As can be seen from the 1962 Cuban crisis, drawing red lines boxes one into a corner. As Michael Dobbs observed in his book *One Minute to Midnight* (page 16), Kennedy had done that in 1962:

> Under attack by the Republicans for his passivity over Cuba, the president had issued a public statement on September 4 warning the Soviets that "the gravest issues would arise" if they developed "a significant offensive capability" in Cuba. He had planted a marker in the sand, and was now committed to defending it. "Last month I should have said we don't care," Kennedy said wistfully, as if to himself. [It is now October, and he is facing Soviet missiles

on Cuba.] "But when we said we're not going to, and then they go ahead and do it, and then we do nothing …" His voice trailed off. Doing nothing was no longer an option.

The Russian response to General Schwarz' "red line" could just as well have been to draw one of their own, or point out that they had effectively already done so when they strenuously objected to the placement of American missiles in Poland.[39] Such a response would have brought us much closer to, if not into, a full-blown crisis. Fortunately, the Russians took a much more cautious approach, issuing a formal denial of the first press report, while still having military planes quietly visit both Cuba and Venezuela. (See the subsection *Step #6: Khrushchev's deployment of ballistic missiles in Cuba* earlier in this handout for details.) Even that response could have blown up if American media, or the president's political opposition, had picked up on it and brought it into the public spotlight. And, as noted earlier, the chances of that happening depend on who is president and the nature of his or her political opposition. If something like that were to happen now, with Obama in office, I suspect that that risk is higher.

An in-depth risk analysis would look at this question in more detail, but again, the preliminary evidence seems to indicate that any changes in the estimate for a potential initiating event producing a crisis will not be so large as to invalidate the need for reducing the risk. In fact, some changes will increase the risk. For example, in the past, we have benefited somewhat from Russian leaders knowing the horror of war on their own soil and tending to act more prudently as a result. As a new Russian generation takes power, that tendency may be reduced, increasing the risk.

How relevant is the historical data from the Cuban Missile Crisis to the chance of a new crisis crossing the nuclear threshold? Once a crisis that serious has erupted, the primary question becomes the maturity level of the actors involved. The more mature they are, the more likely they can defuse the crisis before any nuclear weapons are used. What is required is an ability to put aside hurt pride and understand the opposing point of view – not necessarily to agree with it, but in order to respond more effectively. There has been some growth in human maturity over the last 50 years, with women's rights and minority rights being indicators. But that growth is limited geographically and tends to be one of the first victims of war fever. For example, even though there is little to no credible evidence that Saddam Hussein was associated with the terrorist attacks of 9/11[40] as a result of war fever building in America, from 2001 to 2003, the fraction of Americans who associated Iraq with the attacks went from 3% to 45%. In

---

[39] Some of the missile interceptors in Bush's plan were to be based in Poland. In September 2009, President Obama modified the plan, at least initially moving to what many saw as a more flexible (and less threatening to Russia) sea-based system.

[40] Saddam Hussein was a secular dictator, who did not share power with religious elements – or any others. Al Qaeda is a fundamentalist Islamic organization which wants to replace such secular governments with Islamic-based ones.

the later poll, 45% believed Saddam Hussein was "personally involved" in the attack. In a related poll also done in 2003, 44% of Americans believed that "most" or "some" of the hijackers were Iraqi citizens. In fact, none were.

While there are improved safeguards on nuclear weapons today, compared to 1962, that make it harder to bypass the chain of command, once a crisis has reached major proportions, there will be strong pressure to remove those safeguards. If a commander in the field is facing a possibly nuclear-armed adversary, he is at a major disadvantage if he must receive approval before firing. As an example of the military's greater concern that nuclear weapons be available for use compared to their concern that they might be used without authority, consider the following story related by Bruce Blair in 2004. Blair is president of the World Security Institute, a former Minuteman Launch Control Officer, and an expert on nuclear command and control:

> Last month I asked Robert McNamara, the secretary of defense during the Kennedy and Johnson administrations, what he believed back in the 1960s was the status of technical locks on the Minuteman intercontinental missiles. … McNamara replied, in his trade-mark, assertively confident manner that he personally saw to it that these special locks (known to wonks as "Permissive Action Links") were installed on the Minuteman force, and that he regarded them as essential to strict central control and preventing unauthorized launch. …
>
> What I then told McNamara about his vitally important locks elicited this response: "I am shocked, absolutely shocked and outraged. Who the hell authorized that?" What he had just learned from me was that the locks had been installed, but everyone knew the combination.
>
> The Strategic Air Command (SAC) in Omaha quietly decided to set the "locks" to all zeros in order to circumvent this safeguard. During the early to mid-1970s, during my stint as a Minuteman launch officer, they still had not been changed. Our launch checklist in fact instructed us, the firing crew, to double-check the locking panel in our underground launch bunker to ensure that no digits other than zero had been inadvertently dialed into the panel. SAC remained far less concerned about unauthorized launches than about the potential of these safeguards to interfere with the implementation of wartime launch orders. And so the "secret unlock code" during the height of the nuclear crises of the Cold War remained constant at OOOOOOOO. … The locks were [finally] activated in 1977.

A more recent example of this unsafe approach is described in one of my blog posts from October 2010. When a system failure at Warren AFB in Wyoming affected fifty ICBM's, various security protocols built into the missile delivery system, like intrusion alarms and warhead separation alarms, were offline. Assuaging fears that America's nuclear deterrent might have been compromised during this failure, it was noted that the missiles still could be launched from airborne command centers. An administration official offered assurances that "at no time did the

president's ability [to launch] decrease." That sounds risky because there is an unavoidable tradeoff between the danger of not being able to launch our missiles when wanted versus accidentally launching them. The system design can reduce the risk of either of those errors, at the expense of increasing the other. A design that allows the missiles to be launched during a system failure would seem to increase the risk of an accidental launch.

For these reasons, I suspect that an in-depth risk analysis will find little change in the odds of a new crisis crossing the nuclear threshold, even when just a Russian-American crisis is considered. When the new risks of nuclear terrorism and a war between India and Pakistan are factored in, it is conceivable that the odds today are worse than they were in 1962. There is another factor that reduced the risk of crossing the nuclear threshold in 1962 that is unlikely to be repeated in a modern-day crisis, and therefore would tend to increase today's risk:

Kennedy had almost a week from the discovery of the missiles until he was forced to go public with that information and present a plan of action. During that time, as he thought through the implications of his initial plan to bomb the missiles, his opinion changed, and he fought off repeated calls for such action from others, notably the entire Joint Chiefs of Staff. One of Kennedy's advisors during the crisis, George Ball, talking about a group meeting some years after the crisis: "Much to our own surprise, we reached the unanimous conclusion that, had we determined our course of action within the first 48 hours after the missiles were discovered, we would almost certainly have made the wrong decision, responding to the missiles in such a way as to require a forceful Soviet response and thus setting in train a series of reactions and counter-reactions with horrendous consequences."[41] Unless a modern day crisis of similar proportions also offered the president time to think through options before acting, the risk of crossing the nuclear threshold would be increased. Kennedy had the luxury of so much time partly because the press cooperated when he asked them to hold their stories until after his television address. Such media cooperation is less likely in today's world.

How relevant is the historical data from the Cuban Missile Crisis to the chance of a new crisis that has crossed the nuclear threshold escalating to full-scale war? My estimate of 10% to 50% for this probability depended more on human behavior during times of crisis than any specifics of the Cuban Missile Crisis. Hence it would seem to be just as applicable today as with respect to 1962.

Integrating Criticism of my Preliminary Risk Analysis

Earlier in this handout, I raised the question: "What do we do if you disagree with my estimate?" This section answers that question.

---

[41] William L. Ury, *Beyond the Hotline: How We Can Prevent the Crisis that Might Bring on a Nuclear War*, Houghton Miflin Company, Boston, 1985, page 37.

The first question to ask in this event is "Do our estimates differ enough to affect our conclusions?" For example, my preliminary risk analysis indicates that our current nuclear strategy is at least 1,000 times riskier than living next to a nuclear power plant. If we agree that an acceptable level of risk would be no greater than living next to one such plant, then my analysis indicates that the risk needs to be reduced by at least a factor of 1,000. Even if your estimate of the risk is 100 times smaller than mine, that still would leave at least a factor of 10 that needs to be dealt with.

Moving beyond that first question, a very insightful paper on risk analysis (use this link if you cannot access the first one) by MIT's Prof. George Apostolakis argues that risk analysis needs to be seen as a process, not a one-time effort, and that decisions should be risk-informed as opposed to risk-based. That is, risk analysis should be one of the tools brought into the decision process, but should not be thought of as a dictator, telling us exactly what needs to be done.

Apostolakis also explains that risk analyses need to be peer reviewed and improved based on that process. If the best risk analysis in an area has problems, that calls for correcting those problems to the greatest extent possible, not throwing out risk analysis as useless. Decisions made in the absence of a quantitative risk analysis still depend on subjective estimates of the risk, but those making the decisions no longer have to justify the assumptions that support their conclusions. In contrast, my risk analysis of nuclear deterrence forced me to explain why I chose the numbers I did, allowing objective criticism to correct errors. If you disagree with my estimate of 6% per year for the rate of occurrence of potential initiating events, you can explain why you believe the evidence I presented is incomplete or inapplicable, and offer new evidence of your own. If you disagree with my estimate of 10% to 50% for the probability of a full-blown Cuban crisis crossing the nuclear threshold, again we can argue our positions more objectively. Contrast the benefit of knowing where and why we disagree in our estimates with the situation when no risk analysis is available. Then, our argument would be similar to two children arguing "Is too!" versus "Is not!" except here those positions would become "Our current nuclear strategy is too risky!" versus "Our current nuclear strategy has worked fine for 65 years, so don't mess with success. It's too dangerous!"

My own experience dealing with nuclear deterrence from a risk analysis perspective over the last several years has convinced me of the value of that approach, and I hope this introduction has conveyed some of the lessons I have learned.