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Ensuring the Future in Times of Change

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I have often asked myself: When did science change the world? Not in small ways, but in big ways?

- Penicillin? —Perhaps.
- Electricity? —Maybe.
- DNA? —Likely but not yet.
- Transistors and microelectronics? —Not yet but likely.
- Or technology like the printing press? —Possibly.

By "change" I mean when did the fundamental relationships between nations become so altered that man's basic character for dominance, control, and self-interest was forced to change?

When the neutron was discovered in 1932, it was an important and convenient finding for science. Lots of things started making sense. Soon thereafter followed fission and the chain reaction—and the rest fundamentally changed history:

- The first nuclear test, 61 years ago.
- A world war terminated.
- Nuclear power for ships, then electricity.
- Two of the largest industrial enterprises ever conceived—one in the US and one in the Soviet Union.

- Two thousand nuclear tests. Thousands of weapons. Mutual assured destruction.

The twentieth century, in my view, was divided into two parts. The first half was largely one with historical strategic thinking coupled with modern—and exceptionally lethal—conventional weapons; the second was a whole new way of thinking between nations—with weapons capable of destroying civilization as we know it.

In the first half, the world had its first global conflict, with Russia alone suffering a million combat deaths, the US raising and deploying an Army of 3.5 million men, and Germany forced to sign the Versailles Treaty—a treaty to end all wars, a treaty restricting it to an army of less than 100,000 men, ships of less than 10,000 tons, and no submarines.

The treaty failed. A second global war followed.

- Sixteen million US men in arms.
- Twenty-seven million Russians dead.
- Much of western Europe destroyed.
- Japan no longer a military or industrial power.
- Women in the US workforce.
- The middle class given access to higher education.

The second half of the century was a whole new strategic setting:

- An uneasy, but reasonably predictable stand-off between nuclear armed superpowers.
- Allies confident in the assurance of nuclear protection.
- Surrogate conflicts short of strategic war.

- Dazzling displays of technological prowess in the space race, arms race, and influence race.
- Thousands of nuclear weapons. Hundreds of tons of plutonium and enriched uranium produced.
- A war—given the name Cold—that was too complex to avoid but too deadly to fight.

So the nations of the world struck a deal. One hundred and eighty-eight nations pledged to limit nuclear weapons to just five countries. Everyone else would have none. The haves would not share. The have-nots would not ask, but would always tell.

Today the global picture for nuclear weapons has changed significantly. The Moscow treaty of 2002 will reduce the deployed weapons to between 1700 and 2200 by the end of 2012. Steps to achieve that level will result in a stockpile about half its level of 2001—the smallest since the Eisenhower administration and about a factor of four smaller than at the end of the Cold War. The nuclear arms race has truly turned a corner. We are working today in Russia to help secure nuclear materials. We have declared tens of tons of plutonium to be excess and available for disposition in both countries. We are supporting the blending down of excess enriched uranium, which is allowing many power reactors to operate on former weapons materials.

Yet the possession of nuclear weapons has not been limited to the original five nations. Tests conducted by India, Pakistan, and apparently North Korea have shown that the global community cannot rely on the formality of treaties or the influence of economic or diplomatic pressure to contain the spread of nuclear weapons capability among nations.

We are confronted with wide access to the ability to obtain fissile material—either through uranium enrichment or plutonium production. Man has created about three million kilograms of fissile material since the discovery of fission. Each kilogram, if completely fissioned, is the equivalent of about 18 kilotons. Consequently our systems across the globe must assure that our safeguards and security provide for protection of about one part in a million. Therefore we must ensure that international inspections and controls are adequate and enforced as essential international norms.

I would assert that the first chapter in the history of the nuclear age has been written. Its content defined the strategic engagement of nations in the second half of the twentieth century. Science changed the world, perhaps like at no other time. A cold war came and went. Nuclear power started quickly, leveled out, and restarted more systematically. Nuclear weapon stockpiles grew to staggering levels, then reduced to manageable sizes. Nuclear proliferation went from a threatening concept to the top of the list of national security issues.

The nuclear history is, however, a book that has only begun to be written. The potential of the nuclear age is certainly not realized and likely not recognized. We stand today at the pivotal time in history when that future will be defined. Nuclear energy for electricity generation is now demonstrated to be efficient and safe. It holds the promise of contributing to a better world in three significant ways:

First, it can provide a stable supply of energy for an energy-strapped world—not a total solution but a big partial one.

Second, it can produce energy without contributing to our concern for greenhouse gases and global warming.

Third, since parts of the world will move inevitably towards nuclear power production and the generation of more weapons-potential material, a global framework of all nations committed to the responsible deployment and control of nuclear technology and material could establish the foundation for a lasting solution to the concern over proliferation.

What then is the future?

The United States has been clear and consistent about the role it will play in nuclear deterrence and in proliferation under the Nonproliferation Treaty, but it has had mixed approaches to the view on nuclear power. We began by developing the technology, the infrastructure, and the commercialization of all aspects of the nuclear fuel cycle. We tried to influence the world away from enrichment and reprocessing by suppressing our technological role. The world did not follow in kind. It is now clear that the world will develop a nuclear future. The imperatives of energy, population growth, and economy have clearly emerged. A world without nuclear energy is almost unimaginable. The United States must reevaluate its role in a world that will not wait for us to act, but looks to us for moral and technical leadership.

This is a time of historic change. It is a time when the course can be set for a better world. It is time when we (the people in this room) can leave the legacy of a new foundation for the nuclear future.

What about change?

Sometimes it seems that the three generations of Americans who grew up during this time of nuclear-centric history do not have the sense that much can change, or that the world will change at the pace of the evolution of our own society. But history shows us otherwise. For instance, put yourself in the place of some of our Russian colleagues. If you were born in 1910 in Russia, you would have seen, in your lifetime:

- World War I, with a million casualties and almost 4 million prisoners of war.
- A revolution ending the absolute monarchy of the Tsar.
- A civil war resulting in Bolshevik rule.
- The suppressions of freedom under Stalin.
- World War II, with 27 million deaths.
- The rise to be a nuclear superpower.
- A cold war with the West.
- A space race and arms race.
- Detente with the West, faltering with an invasion of Afghanistan.
- Glasnost.
- Perestroika.
- The collapse of the Soviet Union.
- Elections—Gorbachev, Yeltsin, and Putin.

And all this only to have your grandchildren—like us all—face an uncertain future.

Change can happen, significant change in a short time. It can be much more than we anticipate and are accustomed to.

Today, all the signs of major transitions are around us.

- The growing population.
- Emergence of new major economies.
- The growth of radical terrorism.
- Global energy dependence.
- A threatened environment.
- A radical change in the US competitive position in Science and Engineering.

We must accept that we are a mature country in a rapidly evolving world—a world that will not wait for us and will be a much poorer place if we do not play a leadership role.

The future of nuclear energy—whether it be in strategic deterrence, global proliferation, or power generation—is the one arena where the course could be set now. Nuclear science set the course for the last half of the last century. It may well do so for the next century as well.

Here is what I wish for—for and about the nuclear future:

- Reasoned, civil, objective debate.
- Honest, unbiased communication.
- Global unity of purpose.
- Technology that fulfill the promise of unquestioned safety, security, and reliability.
- An America that chooses to lead.

The first chapter has been written. Most of us in this room have lived it. The outline for the second chapter is being drafted. It is my hope that this meeting, those in attendance, and those they represent, will choose to set the stage for achieving the

promise that those fundamental discoveries of science, just one lifetime ago, made possible.

It is our choice. It is time.