PROBLEMS OF PRUDENCE: NUCLEAR EXPLOSIVES, BIOTECHNOLOGY AND GLOBAL WARMING

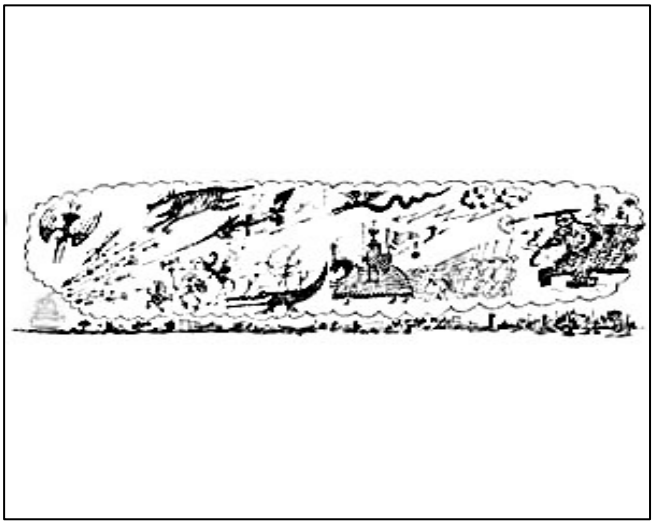
DST Lecture
John Steinbruner
October 24, 2007

I want to begin with what I hope will be disarming candor.

As it happened, I chose the topic and title of this lecture before I learned that distinguished scholars are encouraged to show pictures, tell funny stories and be generally entertaining. I do genuinely endorse that aspiration, but clearly my topic was not a good choice for such a purpose. I have to doubt my own ability, or anyone else's actually, to make it either amusing or inspiring. I hope instead to encourage constructive thoughts on some difficult, admittedly dreary but ultimately unavoidable questions of international security policy.

As a gesture to the expectation, however, I will begin with two cartoons extracted from the New Yorker's archives. The first depicts a cheerful klutz creatively deflecting Al Gore's inconvenient truth; the second a frantic soul overwhelmed by a motley collection of imagined fears. Everyone can readily recognize these standard cultural images – the outlandish optimist and the preposterous pessimist – but few identify with either character. Most of us consider ourselves to be nicely balanced between those extremes and are in fact reasonably good at managing risk in our daily lives.

But most of us have also learned, usually from unpleasant experience, that balancing risk is a performing art never completely mastered and that its higher forms are extremely demanding. That is especially true of the problems I want to discuss, which are arguably the most demanding in all of human history. Each involves potential danger of enormous but uncertain magnitude that could be substantially mitigated at reasonable cost. The effort to do so would require such extensive revision of prevailing attitudes and institutionalized policies, however, that the prospects are usually dismissed as wildly unrealistic. The problems in question pit evolving circumstance against established sentiment. Explicit appeals to realism typically align with traditional sentiment against the unwelcome implications of changing circumstance.



I will concede that sentiment -- or one might say institutionalized conviction -- usually prevails in the short term. But I want to suggest that over the not so very much longer term – within the life spans of those of you who are currently students – effective management of nuclear explosives, biotechnology and the dynamics of global warming will become sufficiently imperative to force a major rebalancing of current conceptions of risk. I also suggest that the ability to see the situation and respond constructively is likely to pose an unavoidable test of viability for all existing governments, especially our own.

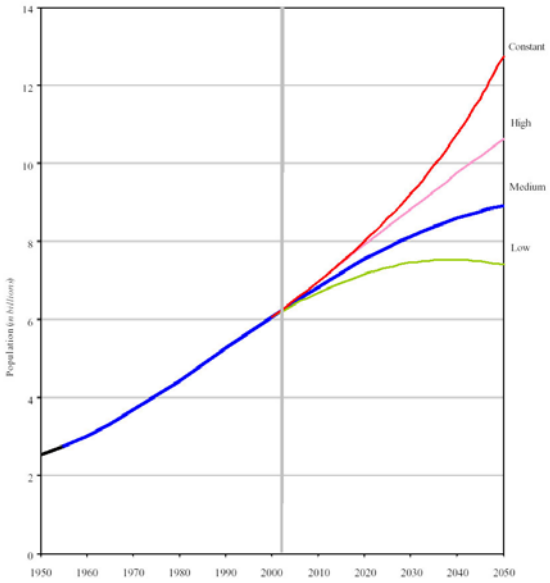
Most Americans believe that our form of government, for all it faults, is superior to all other alternatives and deserves to become the global standard. If that belief is to be credibly sustained at home and defended to an increasingly skeptical world, we will have to demonstrate the capacity to

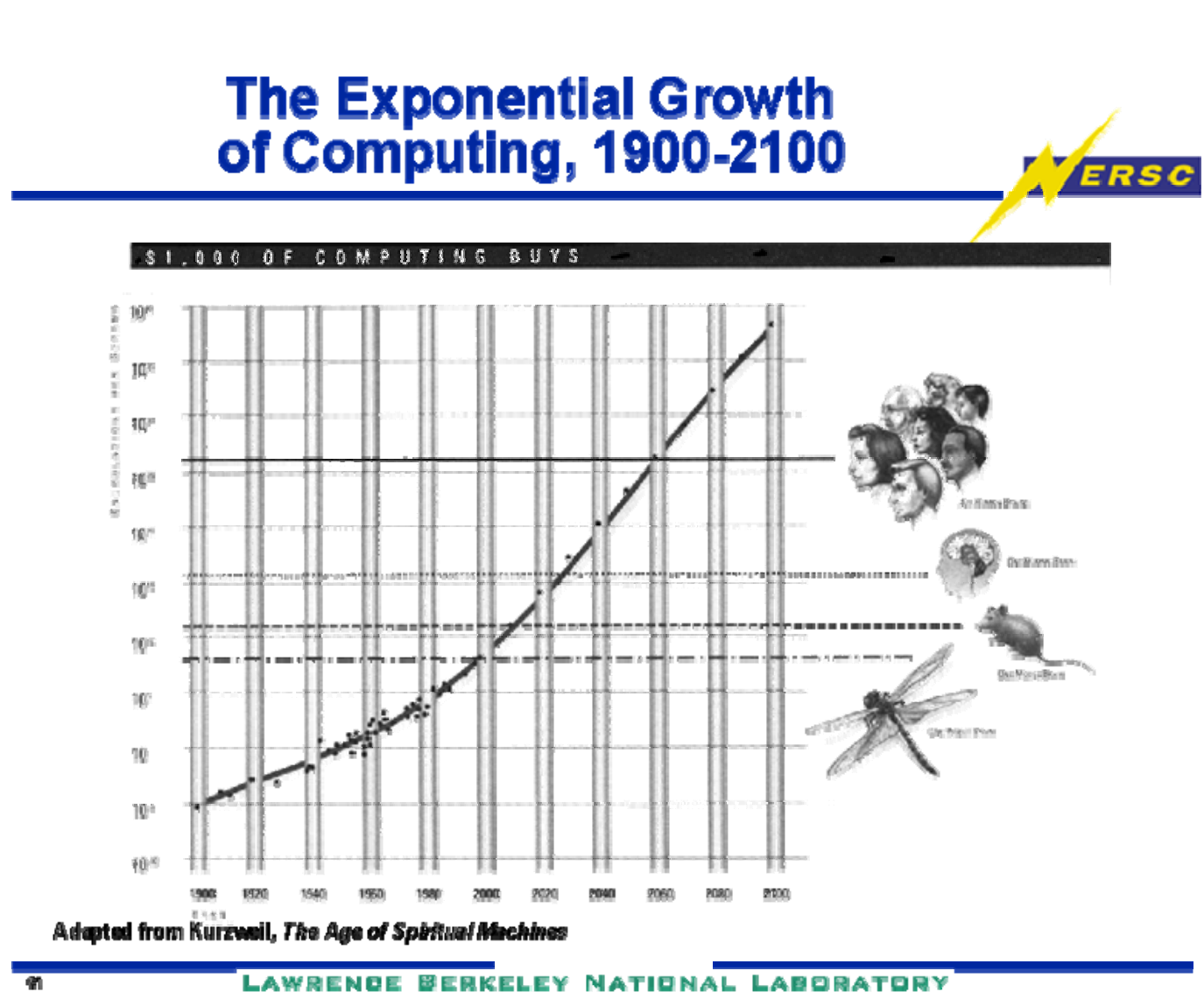
mitigate these looming global dangers in an equitable manner. A boisterous display of democracy will not be sufficient; justification depends on substantive accomplishment.

The Implications of Globalization

The circumstances that present this test of viability emerge from the dramatic expansion of the scale and range of human activity that has occurred over the past half century. Four billion people have been added to the total world population since 1950 and another 2 billion will be alive by 2025. Thereafter the projections are more uncertain but the plausible range for 2050 – roughly 8 to 11 billion – exceeds the 1950 base. Economic activity has increased in response to this surge and has been increasingly organized on global scale enabled by truly remarkable efficiency gains in the handling of information. Between 1950 and 1995 the cost of performing a standard cryptographic calculation declined by a factor of 10^8. The calculation itself provides a measure of the cost of storing and processing a unit of information in support of a practical application; the measure of efficiency gain it provides has revolutionary implications.

Estimated and projected population of the world by projection variant 1950-2050
By Population Division of the Department of Economics and Social Affairs of the UN Secretariat (2003).
World Population Prospects: The 2002 revision. Highlights

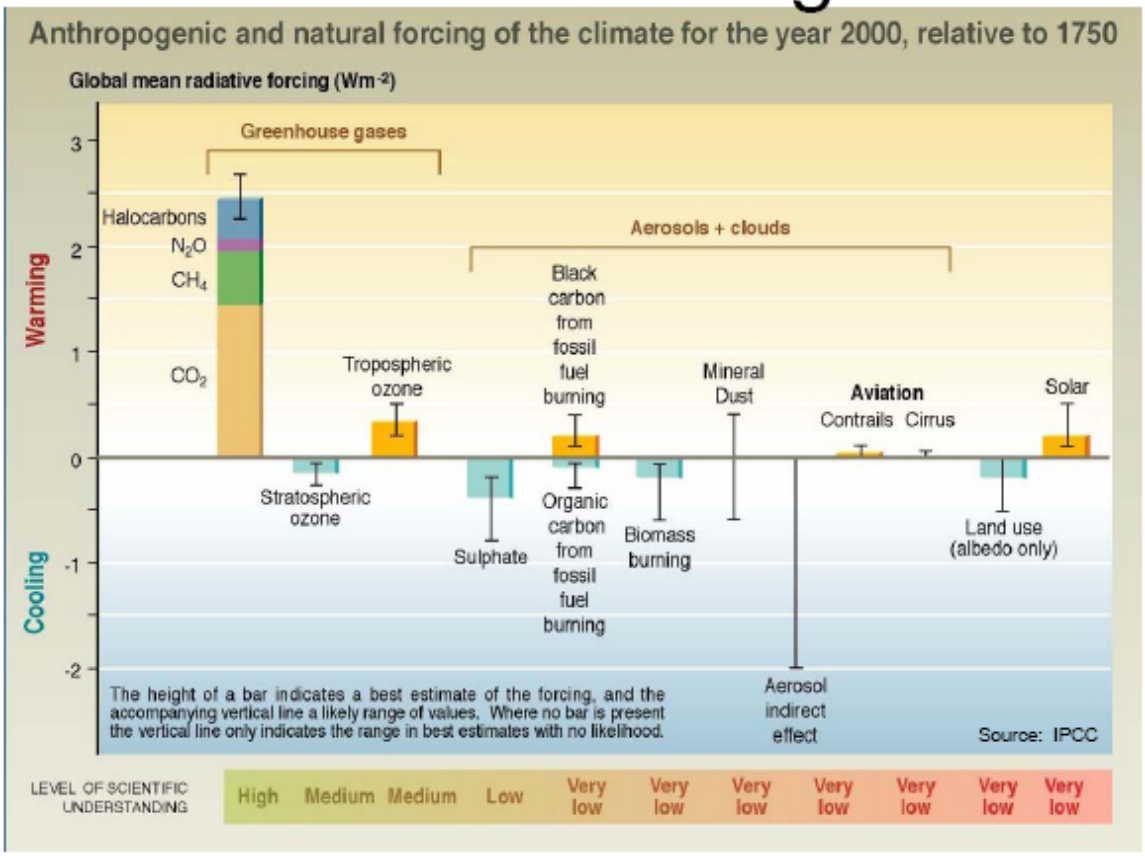




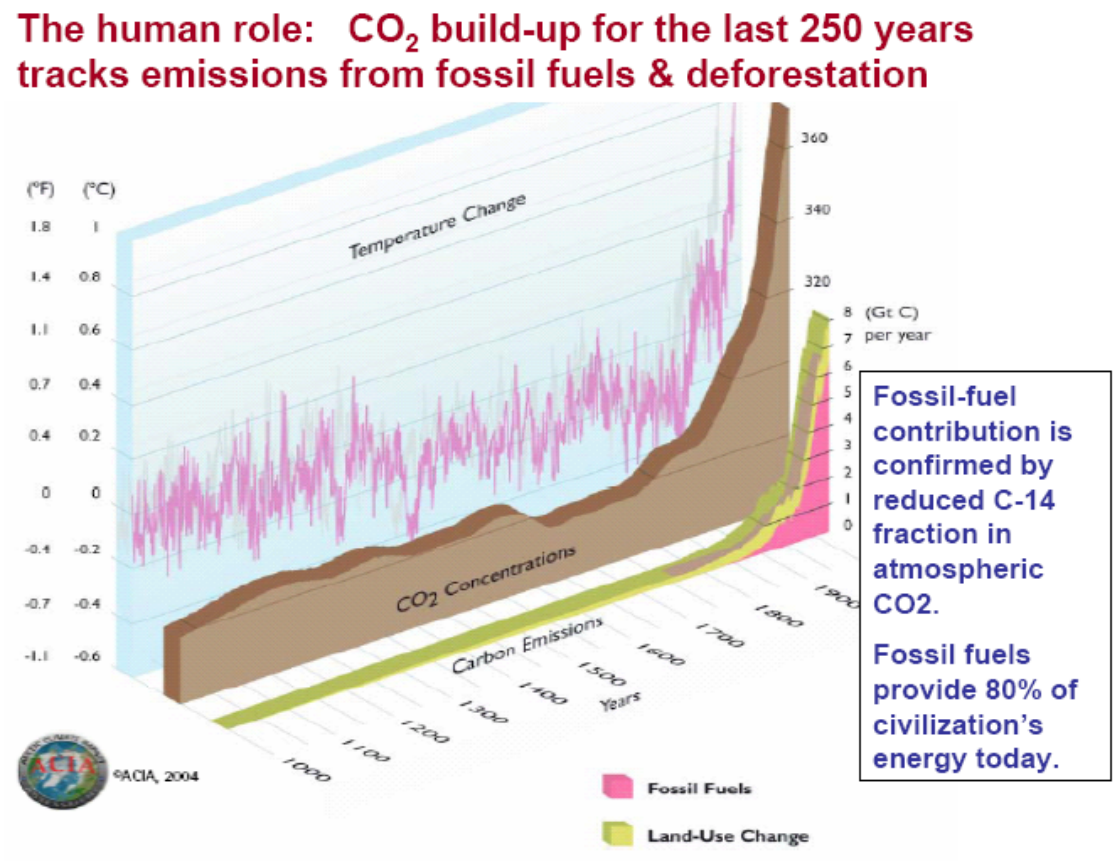
We in this room have all been major beneficiaries of these largely spontaneous developments, but our enduring enjoyment is definitely threatened by two troublesome features.

First, most of the population increase, more than 95% of it, has been occurring among the poorest segments of the world's population while most of the gains in standards of living have occurred among the richest. There has been a remarkable concentration of wealth at the very top of the spectrum with stagnation and even deterioration at the bottom. Indefinite continuation of that pattern poses obvious issues of social equity and raises the question of how access to economic opportunity relates to the incidence of violence. Of the many things that might be said about that relationship, the most important is that no one can claim to understand it well enough to measure the potential danger to social coherence it represents.

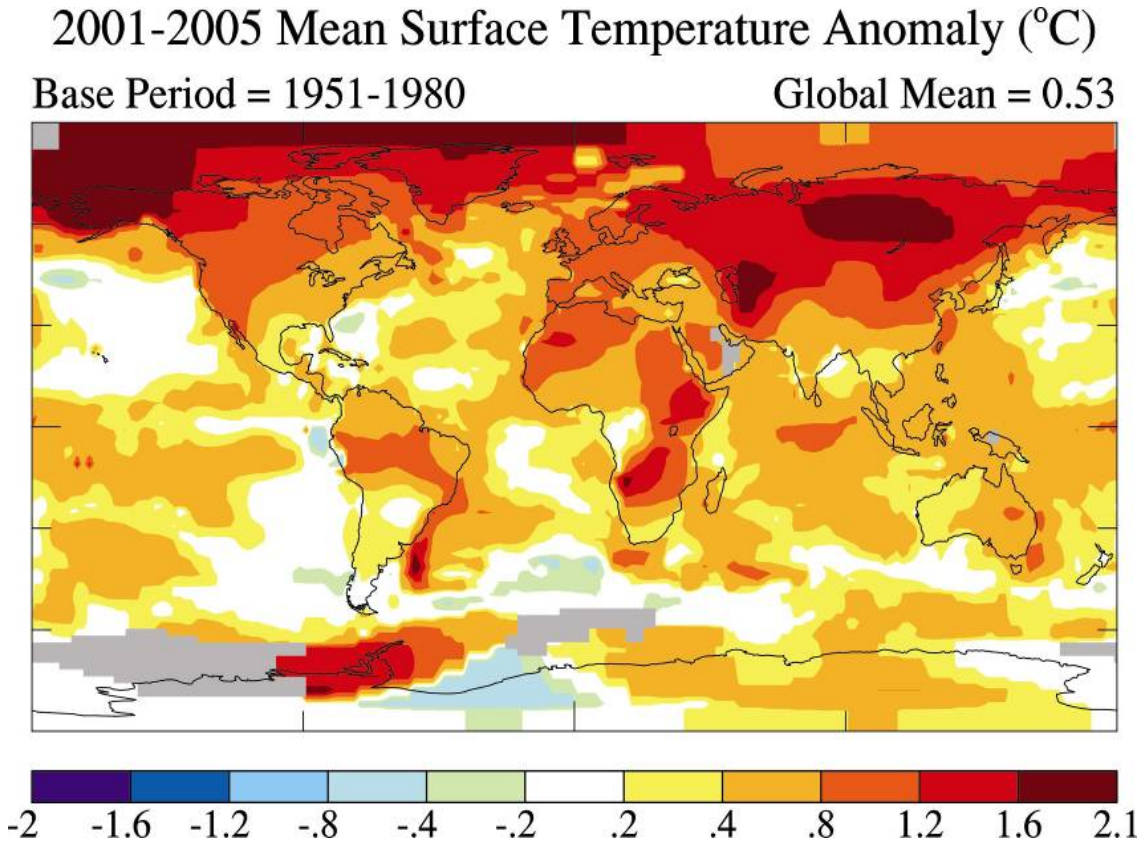
Radiative Forcing



Second, aggregate human activity is beginning to affect global ecology and the projected momentum of the total population promises to intensify the problem of greatest concern, an increase in the concentration of greenhouse gases in the atmosphere that has been occurring since the industrial revolution began around 1750. It is now evident that the amount of these gases due to human emissions will double over the 1750 base by 2050, and the resulting radiative forcing is expected to produce a rise in average surface temperature of 2 to 4 degree Celsius unless the effect is offset by some phenomenon that has not yet been identified. The exact consequences are far from evident, but some of the plausible possibilities could be massively catastrophic to human society as a whole.



Those possibilities are now commanding attention, but any viable prevention or mitigation effort will have to enable improving standards of living among the poorest population segments, who are increasingly well informed about life among the richest. That condition means that the global economy will have to grow in some sense of that term by a factor of 4 or 5 over the next 50 years, and energy generation would have to increase by a factor of 2 or 3. Meeting those requirements in a manner that limits greenhouse gas concentrations would require extensive transformation of current technology, financial practices and associated policies.



These two fundamental developments have been accompanied by a major shift in the scale and character of the organized threats that are the focus of current security policies. As a result of conventional force redeployments that occurred with the end of the Cold War, there is no immediate possibility of continental scale warfare anywhere in the world, and the classic concern for cross border aggression designed to seize and hold territory is generally remote despite the apparent precedents set in Afghanistan and Iraq. For the United States at least, that concern has largely been replaced by entanglement in indigenous civil conflicts and exposure to terrorist actions associated with those conflicts. As we are learning in the aftermath of invading Afghanistan and Iraq, problems of that sort cannot be mastered simply by adapting traditional military operations. They are determined more by justification than by firepower and are strongly affected by global as well as local attitudes. But for that reason they are more connected to global security policies than is currently appreciated.

Managing Nuclear Explosives

In this emerging context there is good reason to believe that the prevailing deployment pattern of nuclear weapons and the associated management of explosive isotopes will have to be dramatically altered, even though at the moment there is no official attempt to do so. As an extension of Cold War practices, the United States and Russia continuously maintain thousands of nuclear weapons on continuous alert status programmed to undertake massive assault on each other in immediate response to evidence of an impending attack. Each side asserts that it would only act in retaliation but both recognize the physical difficulty involved and are in fact inclined to act preemptively if it ever comes to that. Although both declare that they have reduced their weapons arsenals by large percentages, the practical fact is that it requires no more than 2000 weapons to damage each society about as much as it can be damaged. Current alert forces are believed to make 3000 weapons immediately available.

This arrangement is justified by the traditional deterrence doctrine which presumes an impulse for deliberate aggression so strong and so dangerous that it can only be resisted by threat of annihilating retaliation. And indeed no one doubts that the deployed nuclear forces do reliably prevent a deliberate, unprovoked attack authoritatively initiated by the opposing force. They do so in a manner, however, that also enables a catastrophic accident to occur.

Defenders of the deterrence doctrine dismiss this possibility as negligible, but that is clearly not a prudent assessment of the actual risk involved. It is unfortunately quite imaginable that an apparently a minor crisis might inadvertently trigger one of the underlying attack plans thereby assuring execution of the other. It is also possible that a small group of radical internal dissidents or well informed external terrorists might do so. If a nuclear reactor design had failure modes that evident and that consequential, it would never be licensed. The weighing of risk inherent in legacy deterrent practices is seriously and potentially catastrophically defective.

That fact is readily recognized by most people who bother to apply simple common sense. Whatever deterrent effect it is prudent to preserve under current circumstances, it certainly does not require the continuous wielding of an annihilating threat and indefinite acceptance of the operational risk involved. Any reasonable deterrent requirement can be assured with a very

small number of nuclear weapons that need not be deployed in immediately available status and need not be programmed for attack independent of context. If nuclear forces were put in secure, monitored storage and operational practices were altered to provide for deliberately considered use one weapon at a time, deterrence of deliberate assault would be adequately assured and the standards of managerial control would be much higher than they currently are.

Transformation to such an arrangement would require intimate collaboration between the respective forces to preclude any possibility of surprise attack, but since the leaders of both countries routinely assert that they no longer consider the other to be an enemy, such collaboration would appear to be feasible in principle.

That transformation of deterrent force deployment practices needs to be accompanied, moreover, by a comparable transformation of the management of nuclear explosive material not yet embedded in fabricated weapons, In the process of developing the existing deterrent forces, more than sixty thousand nuclear weapons are believed to have been fabricated over the course of six decades, and a network of facilities has been established to produce the explosive isotopes they contain. Those facilities are embedded in the larger network that supports the 439 nuclear power reactors currently in operation throughout the world. The combined global stocks of Plutonium and Highly Enriched Uranium are estimated to be at least 1800 metric tons, in principle enough for more than 150,000 weapons.
.

Accounting and physical security for weapons actually fabricated and for their dedicated materials has been handled by separate national governments who do not inform each other in authoritative detail. As a result no one knows the total global inventory. The United States government estimates of the number of nuclear weapons that currently exist has an uncertainty range of 5000, even though each single weapon is itself an agent of mass destruction. The International Atomic Energy Agency (IAEA) monitors most but not all of the materials involved in nuclear power generation but does not claim to provide a comprehensive, exactly accurate account of the current global inventory let alone the history of explosive isotope production. The uncertainties of historical production are such that it is inherently questionable whether a global account accurate to a single weapons unit of material could ever be constructed. Human societies have

generated nuclear explosive materials in a manner that virtually precludes exact knowledge of the threat they represent.

During the period when deliberate mass attack was considered to be the dominant form of threat, uncertainty about individual weapons did not appear to be significant. With thousands of weapons arrayed in active confrontation, there was no reason to believe that the viability of deterrence depended on the exact number. If terrorist use is admitted to be a serious concern, however, the accounting and physical security of every weapon and the equivalent amount of explosive material become matters of priority. Although it may never be possible to achieve an exactly accurate global system of managerial control, substantial improvement in current practice is definitely possible and is likely to become an insistent demand if ever there is an incident that validates fear of a terrorist threat.

It is technically possible to devise a common accounting and physical security system that would assure continuous monitoring of weapons and materials and would make unauthorized and undetected diversion extremely difficult to accomplish. Such a system could establish international standards while controlling access to the details of design and location national governments are dedicated to protecting. The development of such a system lies outside the bounds of political tolerance at the moment, but if the imagined threat of terrorism is ever demonstrated to be real prevailing attitudes would presumably be revised. Again, common sense clearly suggests that higher standards of accounting and physical security should be a matter of overriding priority,

Biotechnology

The global dispersion of nuclear explosives unquestionably poses the largest immediate physical danger to human civilization as we know it. The potentially hostile use of biotechnology, however, poses of an emerging problem of prudence comparable in magnitude but radically different in character. The basic problem is generated not by dedicated weapons programs that reflect hostile intent but by biomedical research being conducted for the most legitimate and compelling of constructive reasons. Biomedical research broadly distributed throughout the world is providing an understanding of basic life processes at the molecular level and is

simultaneously enabling powerfully therapeutic and extremely threatening applications. The benefits and the dangers cannot be disentangled at the level of fundamental science.

Although much of the apparent potential is yet to be demonstrated, it is prudent to assume that both the eradication and the intensification of some historical diseases will be possible, as will the manipulation of emotional, cognitive and reproductive functions. Transmissible agents that can propagate highly consequential effects across human plant and animal populations can be expected to enable both beneficial and destructive applications on a massive global scale. The combination of opportunity and danger poses the compelling managerial problem of promoting the one while restricting the other. There are as yet no procedures in place anywhere in the world that are adequate for that problem.

In the case of nuclear energy, the consequence of advanced scientific understanding has been naturally controlled by the inherent difficulty of acquiring the explosive isotopes. The scale of activity required to do so is subject to observation and regulation. For biotechnology, it is knowledge itself more than access to materials or equipment that confers consequence, and that fact presents a far more difficult managerial problem.

In fact it is obvious that fundamental knowledge in biology cannot be categorized and sequestered in the manner that nuclear explosive isotopes can in principle be. Nonetheless it is also evident that the most critical areas of biological research can and eventually must be subjected to the standard rule of prudence applied to virtually all other matters of major social consequence; namely, independent oversight. As best we know, no single individual is ever allowed exclusive control of a nuclear weapon, just as no single person is allowed control over public or corporate financial holdings without being subject to audit. The extension of that basic rule to those relatively limited areas of biology that have massively dangerous implications would entail independent review of proposed research projects in advance by well informed peers charged with judging not only scientific merit but also potential social consequence. In addition there would have to be some method for harmonizing case by case review judgments made in separate jurisdictions.

Developing such a process on the global basis necessary to make it effective is clearly feasible if there is sufficient determination to do so, and it is

reasonable to expect there eventually will be. The looming possibility of national competition in the destructive application of biotechnology would so obviously be ruinous that there is reasonable hope preventive regulation might prevail at the outset even though it did not for nuclear explosives. At any rate the opportunity has not yet been forfeited. Again, there is a common sense rule of prudence to apply. It would not provide absolute protection but it does offer substantial improvement.

Global Warming

For the management of nuclear explosives and biotechnology, then, common sense measures of prudence are evident but difficult to implement. For the problem of global warming, however, there are issues of conception and inference that make it far more difficult to set a reasonable standard. The radiative forcing effect of human greenhouse gas emissions and the average mean surface temperature increase that it would by itself generate have been established at high standards of scientific confidence, and those determinations provide the basis for international consensus reported by the IPCC. That core observation indicates that a variety of local, regional and global effects could occur, some of which do appear to be occurring, but none of these can be determined with the same level of confidence. The most consequential possibilities that can currently be conceived – interruption of the gulf stream, for example, or a sudden release of frozen gas hydrates – are highly speculative. In general, there is reason to fear global ecological catastrophe, but the timing, probability, magnitude and even basic character of danger cannot as yet be determined. By the time such determination could be made at high standards of scientific confidence the momentum of the effect would almost certainly be irreversible.

Hence the basic dilemma: if we wait to act until we know, it will probably be too late: if we act before we know, we might misdirect the effort and ultimately discredit any effort at all.

What, then, does prudence require in this situation? There will assuredly be no consensus answer to that question anytime soon, but there are some strong presumptions.

> First, there an obvious natural rule likely to impose itself; namely, stop making it worse. In practical terms that would mean limiting

human induced greenhouse gas concentrations to the doubling over pre-industrial levels (500 ppm) that is already unavoidable.

Second, if that rule is to be upheld over the next half century, there will have to be a massive transformation of energy technology against current market inclinations. One can count on market dynamics to bring about efficiency gains, which will be necessary but not sufficient. One cannot plausibly expect current energy markets to replace fossil fuel sources as rapidly as required. A global policy initiative will be necessary to assure transformation.

Third, the technologies that might in principle enable that transformation to occur within the time required will have to be evaluated and developed to the point of practical application. As currently understood there are five such alternatives: wind, solar, biomass, nuclear fission, and carbon sequestration. Each will have to be the focus of judicious public investment and careful assessment. These are not matters that can simply be remanded to private entrepreneurs, important as they will ultimately be.

Fourth, since nuclear power generation is both the most promising and potentially the most troublesome of the alternatives, development of that option can be expected to require special attention, including new reactor designs, dramatically improved fuel cycle management practices and harmonized international security relationships.

It would be very demanding, of course, to develop a viable nuclear power option or any of the other possibilities without being able to demonstrate beyond question the primary need to do so. There are strong justifying reasons for such an effort, however, regardless of how serious the global warming problem proves to be. The process of devising reactor designs, fuel cycle management practices and fundamental security relationships that are far more resistant to hostile proliferation would substantially enhance the management of nuclear explosives and would therefore diminish an inherent danger that does unquestionably exist. Again, the extensive, dispersed inventories of nuclear explosives that are the result of legacy security policies unambiguously present the largest physical threat to human societies that can currently be identified. Although the ultimate danger posed by

global warming is highly uncertain, there is nonetheless a clear common sense standard of prudence that can be applied.

But finally in concluding my remarks, let me tell a qualifying story as it was related to me buy a friend who insisted it actually occurred. Since I am aware of close variations of the story with other characters, I think that claim is questionable, but the story is relevant nonetheless. It has to do with a dignified Sikh orderly at the US embassy in India struggling unsuccessfully to hang a painting to the satisfaction of the ambassador's wife. She is said to have grabbed his tools in exasperation and hung the painting herself while fuming: "My god, man, have you no common sense." He is said to have replied: "Madame, common sense is a gift of god; all I have is a technical education."

I will concede that there is something to his remark. Common sense is in fact an exacting standard of prudence.

But is it an unreasonable standard? Is it beyond realistic aspiration? I certainly hope not and even dare to believe it is not. In the ongoing battle between traditional sentiment and emerging circumstance, I side with circumstance. I acknowledge that for a while common sense can be ignored, even repudiated, but I think it is likely to prove relentless over the course of your lifetimes. I urge you all to join the cause of common sense. I believe it will ultimately transcend the various ideologies that currently swirl around the central issues of prudence.

Thank you for coming. Thank you for listening.