

**SYNCHRONOUS FAILURE:
THE REAL DANGER OF THE 21ST CENTURY**

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I'm absolutely delighted to be with you this evening. I'm delighted because this occasion gives me a terrific opportunity to present the argument of my next book, which is tentatively titled: *Synchronous Failure: The Real Danger of the 21st Century*. The book will sketch out a vision of the future -- one that is, I believe, distinct from, and in some cases radically at odds with, the visions that currently prevail in the media and public-policy discourse.

I say "vision," because prediction is impossible. We can't possibly know the future's precise contours. Human affairs are too sensitive to serendipity and chance, to fad, to the whims of leadership, and to the unexpected advent of new technologies. Within our complex and turbulent social, technological, and ecological systems, small events can have macro consequences, while big events can turn out to have far less consequence than we anticipated.

The desire to predict our future dies hard, however, so it's worth reflecting, for a moment, on just how woefully wrong most attempts at precise prediction are. Let's look at the track record of technological prediction. In my recent book *The Ingenuity Gap*, I tell an interesting story about one prominent attempt. In 1967, two of the world's most competent futurists, Herman Kahn and Anthony Wiener of the Hudson Institute, released a set of predictions of year-2000 technologies, as part of a project undertaken by the American Academy of Arts and Sciences.

Kahn and Wiener listed one hundred technological innovations that would -- to quote them -- "almost certainly occur." Some they got right: they foresaw video-players, automated banking systems, and the use of high-altitude cameras for mapping and land-use investigations.

But many of their projections were wrong, sometimes laughably wrong: Kahn and Wiener anticipated the widespread use of nuclear explosives for excavation and mining, of robots "slaved" to

humans, of large-scale desalinization, and, most remarkably, of "inexpensive and reasonably effective" systems for defending against ballistic missile attack. They also missed some of today's key technologies entirely, including personal computers, video games, and the World Wide Web. Overall, despite their self-assurance and sense of certainty, their success rate was about 30 percent.

If we're not very good at predicting the direction and nature of technological change, we are even worse at predicting major social and ecological changes. Thirty years ago who anticipated the fall of the Soviet Union, the collapse of the seemingly infinite Grand Banks cod fishery, the development of AIDs, or the opening up of a vast hole in the stratospheric ozone layer over the Antarctic?

Prediction is a tough business. We generally rely too heavily on linear projections of incremental change in technologies and social arrangements. We are almost hopeless when it comes to anticipating the sharp, sudden non-linear changes that regularly punctuate human affairs.

You try it. Try to come up with a plausible scenario for what this world will look like in, say, 2025 or 2030. After a moment's reflection, you'll realize that the range of possibilities is almost infinite and that, given the rate of change in technology and human affairs, there's something profoundly unknowable about the future, even a future that may arrive well within our lifetimes.

When such a range of possibilities is open, there is little constraint on our underlying biases. Personal temperament, that tendency -- deeply embedded in our personalities -- towards optimism or pessimism, starts to dominate.

Well-grounded psychological and social-psychological research shows that human beings have, on average, an optimistic bias when it comes to assessing both threats and our efficacy in response to those threats. In other words, we tend to underestimate the risks or threats in our surroundings, and we tend to overestimate our ability to respond to those threats.

This hard-wired optimism, which is the root of our capacity for hope even in the direst circumstances,

has enabled our species to overcome extraordinary challenges and to come to dominate this planet.

So as prognosticators, we come hard against two formidable obstacles: the systems we are embedded in are too non-linear and turbulent for precise prediction, and we can't free ourselves of the biases of temperament.

But we can still, I believe, sketch a *vision* of the future. Such a vision must be derived from clear assumptions about the deep trends and forces that will shape humankind's path and that will define the general boundaries within which our precise future will lie. We may not know exactly what things will look like, but we can have an intuition about what is probable and what is wholly unlikely. And it is this kind of vision that I'll try to provide to you this evening.

I have, in some respects, a pretty grim vision. While most commentators see a future of broadened and deepened global capitalism, of widening democracy and respect for human rights, and of steady – and liberating – progress in science and technology, I believe that the next one hundred years will be a time of great instability and, quite likely, of extraordinary violence and human hardship.

Humankind is creating economic, social, technological, and ecological systems that are planetary in scope. This is the true character of "globalization." It's not only about greater economic interdependence. It's a much broader phenomenon -- a relentless increase in the connectedness, complexity, pace, and scope of *all* humankind's activities.

The systems we've created and now live within are often tightly linked in ways we don't remotely understand. Taken together, they are potentially highly unstable. They include an international financial system prone to flip between stable and turbulent modes, a perturbed climate that may be on the cusp of dramatically new patterns of behavior, and a global political-economic regime that's generating immense stresses and potential for mass violence.

Many of the challenges our species now faces are unlike anything we've confronted in the past. Never before have we been able to disrupt the fundamental processes of Earth's climate and ecology; and never before have we created economic, technological and social systems – from continent-wide industrial agriculture to the international financial system – with the enormous connectedness, complexity, and speed of operation that we see around us today.

Whether we are talking about new antibiotic resistant diseases or shiploads of migrants from poor countries dumped on our shores, the problems that we face spill across geographical and intellectual boundaries, their intricacies often exceed our wildest imaginations, and they converge and intertwine in totally unexpected ways.

Humankind, I argue, is on the cusp of a planetary emergency. We face an ever-greater risk of a *synchronous failure* of our social, economic and biophysical systems, arising from simultaneous, interacting stresses acting powerfully at multiple levels of these global systems.

In reflecting on this vision of the future, I've probed my own temperament a lot recently, asking why I have such a deep sense of foreboding about where we're heading as a species. If anything, this has now biased me against jumping to pessimistic conclusions.

Certainly, we must all acknowledge that many things are going very well in the world today. On average around the world, people are living far longer, healthier, and happier lives than they were even a generation ago. A larger proportion of the human population is living in democracies than ever before. Market-based economic policies are now accepted around world. There is a general concert of views among the great powers. The spectre of nuclear cataclysm has largely vanished. In many ways, this is the best of times.

And yet . . . and yet, something tells me that this positive story is far from complete. I keep coming back to another set of unassailable facts. These are facts about a formidable array of powerful, underlying pressures -- what I've come to call "tectonic stresses" – building beneath the superficial activity and buzz of human affairs.

Many of these tectonic stresses are not clearly visible on a day-to-day basis for those of us in rich countries. Yet they are nonetheless growing in force, and there's a risk that they are becoming interconnected and self-reinforcing in a way that could eventually overwhelm the adaptive capacity of our societies.

What are these deep stresses? I'll identify five that are particularly powerful, and I'll also identify two additional factors that powerfully multiply the effect of the five stresses. Given my time limitations this evening, I'll discuss each of these seven factors only briefly. Nevertheless, we should keep in mind that not *one* of them is being effectively managed at

the moment, and any one could cause global society immense hardship in coming decades.

Many of these tectonic stresses are, it might be said, existential -- they are directly related to, or affect, the biophysical substrate of human existence on this planet. The first is human population growth and the demographic imbalances that this growth is producing around world.

By the time our population stabilizes, we will see, almost certainly, at least 50 percent further growth from the current 6 billion. We will see, in fact, as much absolute growth in the next fifty years -- about three billion people will be added to the world's population -- as we saw in the last 40 years. Conservative commentators are wrong: the population explosion is not over, by any means; indeed, we are probably just past its halfway point.

Ninety-five percent of the future growth will occur in poor countries. It sustains a destabilizing youth bulge in many of these countries' populations. In some countries in Africa, over 50 percent of the population is below 15 years of age. The youth bulge, in turn, produces large numbers of urbanized, unemployed, young males -- the most dangerous social group of all, and the most easily recruited to radical political causes.

Of particular concern are differential rates of growth between regions, especially between the world's rich and poor regions. These are most noticeable at the interfaces between these regions, such as the boundary between Europe and Africa.

In 1900, Africa's population was about one-third that of Europe. In 2000, the populations of the regions were roughly equal. By 2050, Africa's population will be three times that of Europe.

Already we are seeing bodies washing up on the shores of Spain as thousands of migrants try to cross the perilous Straits of Gibraltar, and we're seeing riots outside the French entrance to the Chunnel train system to Britain. Rich countries have experienced only a tiny fraction of the migration pressures they will experience in coming decades.

The second tectonic stress is the rising capacity of humanity to fundamentally perturb its natural environment and Earth's biogeochemical systems.

At the micro or local level, this capacity is seen in greater scarcities of renewable resources -- such as fresh

water, cropland, forests, and fish stocks -- for the three billion people on the planet who directly dependent on these resources for their day-to-day livelihood.

These scarcities are caused, in part, by population growth; but they are also due to the interacting influence of other factors -- such as failed markets and governments.

By 2025, two-thirds of the world's population will live in water-scarce regions; about one-third will face severe water shortages.

Overgrazing, erosion, and salinization of cropland, and loss of soil nutrients, already affect tens of millions of hectares of vital agricultural land in poor countries around world.

Forests are important because they maintain and stabilize hydrological cycles. Moreover, sixty percent of the world's population depends on traditional fuels -- charcoal, wood, straw, or cow dung -- as a principal energy source. For 40 percent, some 2.5 billion people, it's their only energy source. Yet currently virgin tropical forests are disappearing a rate of around 15 million hectares per year or 0.5 to 1 percent of the world's total. While this rate might not seem extreme, the forest loss is highly concentrated in certain countries -- including Brazil, Indonesia, and Malaysia -- with severe effects on local populations.

And regarding fish supplies, according to latest statistics, the situation is far worse than previously thought. It turns out that China has been grossly overstating its catches for many years, which means that total global landings probably started to decline some time ago. Well over half the world's fisheries are overfished or severely overfished (and in a state of collapse), which critically affects the 1 to 1.5 billion people who depend on these stocks for their main source of protein.

All of these changes in the availability of water, cropland, forest, and fish affect the ability of people in poor countries to feed themselves and fundamentally affect their prospects for economic development.

On the macro or global level, examples of the human capacity to perturb biogeochemical systems can be found in the doubling of the flux of reactive nitrogen in the biosphere (because of our use artificial fertilizers), in the thinning of the ozone layer, and in climate change.

I'm going to talk about climate change for a

moment. There is evidence, most notably in high latitudes, that climate changes are starting to occur very quickly. The signal of human-induced warming appears to be emerging from the noise of regular climate variations. For example, upward-scanning sonar used by the American military to determine the thickness of Arctic ice shows that the icepack has thinned by about 40 percent in the last 40 years. The average thickness is now about 2 meters, and the thinning appears to be continuing at the rate of about a tenth of a meter every year.

Straightline extrapolation suggests that we could see in three decades or so the appearance of wide swathes of open water in the Arctic. Given that open water absorbs about 80 percent more solar energy than sea ice, this development alone could change the energy balance for the whole northern part of the planet.

But straightline extrapolation is a dangerous game in the climate business. One thing that we do know is that climate change, if it occurs, will likely come in sharp, nonlinear jumps -- a form of change that human societies have great difficulty anticipating or adapting to.

Furthermore, the costs of climate change will be disproportionately borne by those who can least afford them, especially those in poor regions and areas of marginal agricultural productivity. Rapid climate change produces adjustment problems, and poor societies are least able to keep up.

The third tectonic stress is the critical problem of energy supply -- especially of hydrocarbons -- for a rapidly growing world economy.

There is still a lot of oil and natural gas around -- although reserve estimates for many countries have almost certainly been inflated for economic and political reasons. But the most abundant, easiest to extract, and cheapest pools of hydrocarbons have already been found, and their production is starting to decline (in some areas, like continental United States, this decline is well-advanced). Meanwhile, alternative or new pools are far more expensive, smaller in size, dirtier (for example, oil shales and tar sands) and located in geopolitically unstable regions.

The fourth stress is disease. Although not readily apparent to those of us in rich countries, the world is facing ferocious pandemics of tuberculosis and AIDS. Tuberculosis, the top killer among infectious diseases, had infected nearly a third of the human

population; it kills three million people year (a remarkable 5 percent of total deaths from all causes), and its incidence is growing fast.

AIDS has devastated the economies and military and civil infrastructures of many sub-Saharan African countries. It is literally eating the guts out of these societies. And AIDS is now making rapid inroads in India and China. While there has been recent grudging acknowledgment of the danger of AIDS in China, the problem has received little official attention in India. Let's be clear, though, about the implications: even if the infection rate peaks in these countries at 10 percent -- which is only 1/2 to 1/3 of what we're seeing in southern Africa currently -- we would be looking at 200 million infected people in two countries alone, with incalculable consequences for the development of the world's largest Southern economies.

But we should not just be concerned about AIDS and tuberculosis and other well-known and widespread diseases. As the transportation and trade networks of global society have been extended into the smallest and most distant niches of the planet's ecological systems, the rate of appearance of new, unheard of diseases has risen dramatically. Pathogens that previously inhabited only small, localized human populations -- populations often immune to the pathogens' effects -- now have access to the whole human species. And we should keep in mind that the human species is now the second biggest mass of genetically identical organic material on the planet (after the mass of krill in the Antarctic) -- an extraordinarily rich and densely connected environment for the spread of disease.

The fifth stress is the widening wealth gap between rich and poor around the planet. U.N. data suggest that this gap has, in crude terms, roughly doubled in size in the last 40 years. In 1960, the income of the richest 20 percent of the world's population was 30 times that of the poorest 20 percent; today, it's over 80 times greater. Research shows that highly unequal societies tend to be violent -- Humankind is creating a grotesquely and increasingly unequal global society, and we can expect it to be increasingly violent.

The world economy is a mess, and critical economic policymakers -- such as the heads of national central banks, the IMF, and the World Bank -- seem flummoxed. Many of the richest economies are stagnating, while in poor countries nearly half the world's population still lives on less than \$2 a day.

The U.S. economy – critical to world growth – is, in many respects, sliding sideways. European growth is also almost nonexistent, and Germany's unemployment rate is nearing double digits. The Japanese Nikkei Index has dropped to levels unseen in two decades, with renewed doubts about the stability of the country's banking system. Latin America is in financial crisis; a decade of market liberalization on the continent has produced growth rates half those of the '60s and a rise in the number of poor people. Turkey's economy is in shambles. And Africa . . . well, Africa and its 700 million inhabitants aren't even on the economic map.

Through larger markets and the rising importance of ideas for the production of wealth, we are creating a global winner-take-all economy. The global economy also suffers from chronic overproduction relative to consumption: at the moment, the world probably has 30 to 40 percent excess productive capacity.

Put simply, global capitalism is superb at producing vast amounts of stuff but nowhere near as good at generating sufficient demand for that stuff. Relative to the level of demand, there are too many factories, farms, mines, airliners, hotels, book publishers, and the like. In fact, global capitalism's relentless "creative destruction" – the constant churning of technological change that overturns corporations and repeatedly throws people out of work – often erodes the very consumer demand that capitalism desperately needs to sustain itself.

In a tightly integrated global economy characterized by inadequate demand, a country's economic policy must emphasize – first and foremost – competitiveness. As if caught on an ever-faster treadmill, policymakers must race to make their own country's economy more efficient, more productive, and more nimble than all the rest. If their country succeeds in producing its goods and services more cheaply than its competitors, it will capture a sizable slice of available demand. If not, it will probably be left far behind.

In this environment, poor and weaker societies increasingly feel penetrated by globalized Western markets and culture, and this causes widespread resentment. In general, widening gulfs of wealth and opportunity mean that vast populations around world have chronically unsatisfied expectations.

The destabilizing social, economic, and political effects of these five tectonic stresses are powerfully boosted by two other factors -- factors that I call "multipliers."

The first of these is the rising complexity, connectedness, and velocity of human technologies, institutions, and social interactions.

Over a century ago, the French sociologist Emile Durkheim referred to this as the rising "dynamic density" of human societies. In contemporary terms, I use this concept to refer to the rapidly growing number of entities or nodes in the complex technological, social, and economic networks we create around us; the rapid increase in the density of linkages among these nodes; and the truly exponential increase in the rate at which we are moving material, energy, people, and especially information across those links. This increase in connectedness and interdependence produces many benefits, but it can also result in unexpected system behavior, including cascade effects as damage in one part of a global network -- whether caused by a new pathogen, a computer virus, or a financial shock -- multiplies and spreads rapidly to other parts of the network.

Good examples of such destabilizing cascades in the international economy include the Mexican peso crisis in 1994 and the Asian crisis of 1997 and 1998. The world economy is increasingly volatile in its overall behavior: as modern communication technologies tighten the coupling and increase the pace of transactions within international markets, the international financial system is becoming more prone to sharply nonlinear, boom-bust cycles, to sudden shifts between stable and turbulent modes, and to contagion effects, as a crisis in one national economy cascades outwards to affect others.

The second multiplier is the relentlessly escalating power of individuals and sub-groups – like terrorists and insurgents – to destroy things and people.

Put bluntly, the bad guys are getting stronger, fast. They have better weapons: the trend over the centuries has been towards unremitting improvement in the lethality of all weaponry, which generally has meant that steadily fewer people could kill steadily larger numbers of people more quickly than ever before. In particular, small arms and light weapons – such as assault rifles, rocket propelled grenades, mortars and the like – have become more lethal as their technology has advanced. They have become more rugged, cheaper, more portable, easier to use, and more accurate, and their striking range has increased. The result is extraordinary and unprecedented technological leverage. Now, as we've seen recently in this city, two people with one sniper's rifle can terrorize several million people for weeks.

Violent small groups will achieve their ultimate technological leverage when they obtain weapons of mass destruction. Notice I say when, not if. I'm not being a wide-eyed alarmist here -- the best people in the business of analyzing this threat, believe the risk of nuclear terrorism, especially, is very real. The world now harbors in excess of 1000 tons of uranium 235, much of it stored in scattered and insecure locations in the former Soviet Union. With sufficient skill it takes only 50 kilograms to make a crude atomic device. If a terrorist can obtain 100 kilograms, less than one hundredth of a percent of the total world stockpile, little skill is needed: with such a quantity, it's relatively easy to create an explosion in the multi-kiloton range. Cities like this one are very likely targets.

In addition, terrorists and other violent groups have vastly improved access to sources of information through the Internet and the Web, and they can use these new communication technologies to better coordinate their attacks and organize themselves. A standard laptop now has computational power comparable to that available to the entire US Defense Department in the 1960s. This power allows violent groups to use state-of-the-art encryption technologies to hide their communication. Excellent encryption technologies are widely available as free-ware on the Web.

Violent groups will soon recognize the rewards from attacking non-redundant, high-value nodes in our increasingly complex technological and economic networks. These attacks will be intended to precipitate cascades of failures or the collapse of whole technological and social systems. They will also take advantage of the tendency of modern societies to concentrate high-value assets -- especially skilled people and advanced equipment -- in relatively small geographic locations, like the World Trade Center. And they will learn how to divert powerful, non-weapons technologies to destructive ends -- like ramming airliners into skyscrapers. Once terrorists look around, they will find that our rich, technologically advanced, and complex societies are replete with supercharged devices -- packed with energy, combustibles, and explosives -- that can be quite easily diverted or hijacked for hostile ends.

These, then, are the seven factors -- five tectonic stresses and two multipliers -- that will powerfully influence the trajectory of human development over the next century. The bottom line of the preceding analysis is the following: Demographic, environmental, technological, and economic pressures

are producing two outcomes that have immense implications for global political stability. First, these pressures are contributing to social upheaval, dislocation, and unmet expectations that boost the grievances of a large fraction of the human population. Second, by undermining the capacity of governments and states, these pressures also boost opportunities for violence by aggrieved groups. In short, they produce exploitable resentments, political instabilities, and radicalized societies.

People often get angry when they see around them wide gaps of wealth and opportunity. If they identify with a group on the losing side of one of those gaps, it can lead to a sense of humiliation and a profound sense of one's group having been disrespected. These resentments are ready for exploitation by megalomaniacs like Osama bin Laden. We now live in a world brimming with such righteous causes.

There are, as a result, greater numbers of very angry and sometimes fanatical people around; these people are more mobile than ever before; and some of them are willing to sacrifice their lives to destroy those groups and people they believe are the source of the world's injustice.

The capability of violent groups to launch such attacks is rising very fast. Soon, perhaps very soon, small groups of people will be able to humble whole nations. We haven't even begun to think through what this means for our institutions, our economies, and our democracies.

But the argument I've made to this point actually understates the severity of the challenge we face. By discussing sequentially these seven factors that threaten humankind's future -- and by treating them as discrete and isolatable -- I haven't given enough weight to the critical fact that all these pressures are developing at the same time. Change of an unprecedented rate and magnitude is happening simultaneously in a wide range of domains critical to our well-being. It's as if humankind has its collective foot slammed down on the world's accelerator pedal. And it's this simultaneity of events that's at the heart of my concern about synchronous failure.

At the same time that water, cropland, and forest resources are critically overstretched in many regions, we are causing major changes in the planet's climate that accentuate the impacts of these resource shortages. At the same time that global energy supplies are increasingly concentrated in some of the planet's most dangerous and politically

unstable zones, the world economy needs cheap energy more than ever to maintain its fitful growth. At the same time that we need to boost global consumption to keep the world economy from slipping into a deflationary spiral, we are confronted by ever more abundant evidence that our current consumption is already severely overloading the absorptive capacity and resilience of the planet's biosphere. And at the same time that yawning gaps of wealth and power are developing within the human population, technological developments have put staggering destructive power in the hands of small groups that may be angered by those gaps.

We aren't thinking in terms of simultaneity, because we tend to "silo" our problems. We treat our challenges -- from climate change to international economic instability to terrorism -- in isolation, and we tend not to see the whole picture. But the simultaneity of pressures in our world presents two dangers. First, key institutions at the global and national levels may simply be overwhelmed by the rush of events; these institutions may not be able to stay on top of, let alone manage, the tangled and converging pressures they face. The second danger of simultaneity is that several of the tectonic stresses I've described will reach a crisis point at the same time, causing entirely unpredictable cascades of failure through our tightly coupled and hyper-complex global systems.

For instance, what happens if the following three events occur together or in quick succession? A sharp shift in climate that cripples food production and destabilizes regimes across Asia; a major international financial crisis that sends currencies and markets tumbling around the world; and a string of terrorist attacks -- costing tens of thousands of lives -- on several Western capital cities. Although we can't estimate the exact probability of any one of these events, we can say with reasonable confidence that their individual probabilities are rising. The probability of their joint occurrence is, of course, much lower, but we can be sure that it's rising too, especially if -- as is likely -- these three events are not causally independent of each other. And this is only one scenario of an uncountable number of possible combinations of the seven factors I've identified. Indeed, if some form of synchronous failure does occur, it's likely that it will occur in a way that we've never anticipated, because the range of possibilities is almost infinite. We shouldn't be surprised by surprise.

Such a convergence of events as I've described -- climate shift, financial crisis, and mega-terrorist attacks -- could overwhelm the adaptive capacity and resilience of even the richest and most powerful societies. A breakdown of global institutional and social order might then happen very suddenly -- essentially "out of the blue." It could be completely unexpected, because the pressures I've identified -- demographic, environment, economic, and the like -- will have been building under the surface for a long time, quietly eroding the resilience of our national and global systems. When they eventually converge and climax, there may be little adaptive capacity left to absorb the shock.

I come to this conclusion in part because of recent research into the causes of major social revolutions, like the French and Russian revolutions. This research shows that social breakdown occurs when societies are under multiple stresses at many social levels simultaneously. As, Jack Goldstone, one of the world's leading theorists of revolution writes: "Massive state breakdown is likely to occur only when there are simultaneously high levels of distress and conflict at several levels of society -- in the state, among elites, and in the populace."¹ This is the condition we're now creating at the global level.

It's easy to dismiss or pigeonhole this kind of argument as ridiculously alarmist. Here's where temperament comes in, once again. To be frank, I hope I'm wrong in my analysis, but the evidence of the seven driving factors I've identified here this evening is strong.

Perhaps the chance of the convergence of these factors in the next decades is low -- who knows, maybe it's no more than 5, 10, or 15 percent -- but the costs to human society would be immense if something like this were to occur. The possibility, I believe, needs to be taken very seriously.

So what should we do? What are some possible policies or plans to prevent such an outcome?

I believe it's entirely within human ability to prevent any form of synchronous failure. There is much that we can do, and at least a quarter of my coming book will be devoted to policy prescriptions.

We must first recognize, though, that for the first

¹ Jack Goldstone, *Revolution and Rebellion in the Early Modern World* (Berkeley: University of California Press, 1991), p. 469.

time in our species' history, we have to be aggressively proactive on multiple fronts simultaneously. Each of the five tectonic stresses and two multipliers I've identified requires its own policy responses. There's no magic bullet, no single solution or institutional response that will cover all these problems.

We need to be increasing, not decreasing, our support for worldwide family planning; we need to boost efforts around the planet in soil, forest, and water conservation; we need to take climate change far more seriously and begin planning for a global transition to a suite of new energy technologies (including carbon sequestration, geologic storage, and hydrogen power) that will dramatically reduce our carbon emissions; we need to work out reasonable protection for intellectual property rights and then get antiretroviral drugs into the hands of the millions of people infected with AIDS around the world; we need to reform the international financial system so that it no longer wrecks the economies of major countries like Indonesia and Argentina in response to the corrupt economic policies of their elites.

We also need to reduce the vulnerability of our complex economic and technological systems to cascade effects and nonlinear failures. This may require a radically different way of thinking about economic development and globalization. Sometimes the best policies may not be those that increase integration, interconnectedness, speed, and efficiency. Sometimes, in order to boost overall system resilience, it might be necessary to loosen the coupling within our economic and technological systems, for instance by making greater use of decentralized, local energy and food production, and by slowing the connection speed between system components, so that people have time to think before they act. And it might be necessary to increase buffering capacity of these systems, for instance by moving away from just-in-time production processes and by increasing inventories of feedstocks and parts for our factories.

It's on the matter of the increasing destructive power of small groups that I have most difficulty providing clear prescriptions. This multiplier is driven by technological trends that we can't derail without doing extraordinary damage to our overall economic progress, because the technologies that terrorists use – like laptop computers and the Internet – are often the same ones we use on a day-to-day basis.

To lower our vulnerability to attack, we will have to consider, in coming years, dispersing our high-value assets – in 100 years, skyscrapers may seem like

quaint anachronisms. But we also have to recognize that the war on terrorism is not a war in any conventional sense. It's more like a worldwide guerrilla conflict, in which the enemy chooses where to strike and then disappears into a vast crowd of passive supporters. I'm not sure that the US, given the way it has defined this conflict, can win this war – because the US has defined for itself an essentially infinite security frontier, from nightclubs in Bali to resorts in Mombassa.

Yet as we try to prepare for the future's broader challenges – not just the challenge of terrorism – our first step must be to recognize and better understand the diverse nature of these challenges – their true scope, character and urgency, and, most importantly, the relationships among them. Just because things look like they're going well on the surface, as they do to many people in America now, it doesn't mean that things are actually going well underneath.

Much of our thinking about the future should be "out of the box" scenario development, which explicitly involves trying to move beyond the linear extrapolation of current trends.

Since we can't possibly know exactly how things will turn out in coming decades, or exactly when sharp social, economic, or ecological nonlinearities will occur, we need to develop in advance strategies for response and adaptation to multiple contingencies. In other words, when nasty surprises occur, which they sometimes will, we will be much better off if we have contingency plans "on the shelf" and ready to go.

We especially need ideas on how to build governance capacity at the national and global levels, because – most fundamentally -- the challenges we face are about the provision of public goods -- like health infrastructure, well-functioning markets, protection of our common environment, and security from violence. The adequate provision of public goods requires capable institutions of governance.

Interdisciplinary research is key here – we need to get the demographers, energy specialists, and climate scientists talking to the agronomists, political scientists, and economists. But interdisciplinary research is something we don't do well, because of turf battles among disciplines, institutions that reinforce disciplinary boundaries (especially the system of disciplinary journals), and lack of funding.

We are clearly faced with immense political and

intellectual tasks – in public policy, in public education and mobilization, and in scientific research. We need to be investing vastly greater resources in these areas. But if we're prepared to invest the necessary resources, and if we are prepared to back the right policies with the necessary political will, I'm convinced that my vision of synchronous failure will never be realized.

Thank you.