ENVIRONMENTAL FUTURES RESEARCH AT THE U.S. ENVIRONMENTAL PROTECTION AGENCY

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Abstract. Relatively little research on environmental futures has been carried out in the United States. An exception is the long-running futures research that the U.S. Environmental Protection Agency (EPA) has been conducting since the 1970s. This paper reviews past and current efforts toward developing a capacity for environmental foresight within the EPA, and discusses some lessons for other agencies and institutions concerned with the future of the environment.

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) was born in 1970 facing backwards towards the past. Its major challenge over the past 40 years has been dealing with the damages caused by the revolutions in industrial production that occurred earlier in the 19th and 20th centuries. This job, ranging from the cleanup of abandoned waste sites to the regulation of toxic chemicals, will still take decades to finish.

Today, however, we are at a critical point where technical changes even larger than those that produced the earlier revolutions in industry are converging. We are in the early stages of multiple revolutions in production, information and communications, logistics, and the interaction of new technologies such as nano- and biotechnology. These revolutions could pose a host of new environmental problems, but they also offer the possibility of creating a more environmentally advanced technological infrastructure based on highly efficient use of energy and materials, clean sources of energy, a "greening" of the chemical industry, and a new generation of industrial technologies in which pollution is viewed as a design failure, not an inevitable by-product of production.

Imagine, if you can, what might have happened if a powerful and well-organized environmental movement, strong environmental legislation, and a well-functioning government agency for environmental protection had emerged in the period between the 1850s and 1880s when science first began to strongly interact with technological development and major new industries began to arise. How many of today's environmental problems could have been avoided if environmental concerns had been integrated into the decisions of business leaders, government officials, and citizens from that time onward?

That opportunity was, of course, missed. The understanding, political will, and legal mechanisms needed for that to happen were not yet in place. Now, however, with new technological revolutions beginning to unfold, we have another opportunity to properly perceive the changes that are underway, integrate environmental concerns into our decisionmaking, head off potentially serious environmental damages, and shape emerging technologies for both economic success and the health of the planet. To be successful, one of the changes that urgently needs to occur is for the EPA to face forward toward the future and devote more of its attention to the environmental challenges and opportunities posed by emerging technologies.

In a 1995 report, "Beyond the Horizon" (U.S. EPA 1995), the EPA's Science Advisory Board issued a call for improving the Agency's capacity for exactly this kind of environmental foresight. It challenged the EPA "to begin to anticipate future environmental problems, and then take steps to avoid them, not just respond to them after the fact." It urged the EPA to change its priorities over time so that eventually, "as much attention should be given to avoiding future environmental problems as to controlling current ones."

How well has the EPA done in moving in this direction? A review of foresight-related efforts over time in the Agency shows that the shift in direction has begun but still has a long way to go.

EARLY FORESIGHT EFFORTS

Almost from EPA's inception, there have been scattered and sporadic efforts within the Agency to explore the use of scanning, scenarios, modeling, and visioning exercises

for environmental foresight. The best of the early initiatives was in 1975 when EPA's Office of Pesticide Programs commissioned the Center for the Study of Social Policy at SRI International to prepare a report on "Alternative Futures for Environmental Policy Planning: 1975 - 2000." In retrospect, this study pioneered important new methods and images of the future, but it is unclear whether it had any direct impact on policy and planning within the pesticides program (U.S. EPA 1975).

The largest single foresight initiative was the establishment in the early 1990s of a formal Futures Studies Unit in the Office of Policy, Planning and Evaluation. Innovative EPA programs such as Energy Star were born from the groundbreaking work of the futures unit. It helped organize greater intergovernmental cooperation to promote environmentally advanced technologies, and supported the Science Advisory Board's Environmental Futures Committee in producing the "Beyond the Horizon" report in 1995. But the futures unit was isolated within the Agency, and many of its forecasting efforts produced "bad news" that others inside and outside the Agency did not really want to hear. The Unit's director, David Rejeski, left EPA for the White House Office of Science and Technology Policy, where he felt he could have more influence, and in 2001, when the Bush Administration came in, the entire Office of Policy, Planning and Evaluation was eliminated.

The "Beyond the Horizon" report gave foresight efforts greater legitimacy within the Agency. During the latter part of the 1990s, a variety of foresight projects were undertaken by different offices within the Agency, including the Office of Radiation and Indoor Air, the Office of Research and Development, the Office of Human Resources, the Office of Emergency and Remedial Response, and the Office of International Activities (National Advisory Council for Environmental Policy and Technology 2002). Although these efforts produced credible results, they were all sharply limited. They were "one-shot" activities rather than part of an ongoing, systematic foresight process. They occurred in isolation from each other, with little sharing of results or lessons of experience. They had only minor impacts on the senior agency executives' priorities, and no discernable impact on the Agency's strategic planning.

THE "FUTURES NETWORK" STRATEGY

In September 1999, Anita Street and Michael Brody in the Office of the Chief Financial Officer (OCFO), which coordinates the Agency's strategic planning process, launched an effort to create an Agency-wide Futures Network. OCFO contacted senior career executives in different parts of the Agency and asked them to appoint program and regional staff who have planning responsibilities or a particular interest in futures analysis to work within the Futures Network to promote environmental foresight.

The success of the effort hinged on the Network members' ability to serve as legitimate ambassadors from their offices to the Network, and from the Network back to senior career executives and colleagues within their offices. The hope was that the Network could help overcome some of the limits of past efforts by stimulating futures analysis throughout the Agency, promoting capacity-building, helping people share information across organizational boundaries, and keeping the Agency's senior career executives aware of and involved in foresight activities.

After establishing the Futures Network, the OCFO team decided that basic training in "building scenarios" would be a good way to familiarize Network members with futures methods and to lay the foundation for a consistent approach to futures analysis. OCFO allied with the Office of Research and Development (ORD) to sponsor 30 members of the Network for 3 days of intensive training provided by the Global Business Network, a leader in the field of corporate scenario planning. The following spring, OCFO organized a follow-on 1-day workshop for Network members run by the Institute for Alternative Futures (IAF), a leader in scenario planning with public and nonprofit organizations.

The strategy the OCFO team and IAF developed was to use Network members to interview Agency senior executives on their assumptions about the future of the environment and the Agency's evolving role in environmental protection. The goal was to identify topics Agency leaders believed worth exploring further through

the use of scenarios. Network members used a standard form developed by IAF to conduct 34 interviews with senior executives representing nine headquarters and nine regional offices. The results of these interviews were presented back to senior managers at a Futures session preceding the Agency's Annual Planning Meeting. Many participants in this meeting were surprised to find that their personal views about the need for extensive change in the Agency were more widely shared than they had realized.

Following this session, the OCFO, IAF, and a scenario team made up of several Futures Network members used the views gathered in the interviews to construct four scenarios of the period between 2000 and 2020. The scenarios and the process used to develop them are described in detail in Appendix 1. Below is a simplified description of the four images of the future.

- Full Speed Ahead
  - Global "long boom" – rapid globalization
  - Low social cohesion
  - Moderate energy prices
  - Huge increases in use of energy, materials, and water

- A Darker Age
  - Stock market crash, lingering recession, economic strains worsening as Baby Boomers retire
  - Sharply rising oil and food prices, poor nations hurt worst
  - International terrorism
  - Polarized politics, growing intolerance, loss of community

- Soft Landing
  - Economic slowdown in late 2000s, continuing into 2020s
  - Global oil production reaching peak in 2010s and slowly declining
  - By 2020, growing realization a slowdown is inevitable and has a positive side (e.g., forces efficiency and reduces pollution)
  - Painful adjustments but growing social cohesion and community

- Eco-Efficiency Revolution
  - During 2010s, "mini-crises" and rising energy costs changing the character of economic growth
  - Rapid innovation in efficient energy, resource, and water use
  - Rapid development of energy sources such as wind, solar, batteries, hydrogen
  - "Greening" of the private sector
  - Advanced green technology applications of bio- and nanotechnology

In conjunction with a meeting of the Agency's Reinvention Action Council, EPA senior career executives met to engage in a "strategic conversation" based on these scenarios (Olson and Street 2002). The primary goal of the meeting was to encourage an open, honest exchange of ideas and opinions about possible future scenarios and to examine the Agency's current directions in the light of these potential futures. No budgets were at stake, and no decisions were needed. The whole point was to set aside pressing business and talk together about issues and aspirations that may be important over the generation ahead.

To prepare for the meeting, each participant was asked to cast a ballot allocating points (totaling 100) to reflect his or her assessment of the desirability, the likelihood of occurrence, and the relative severity of environmental impacts of each scenario (Table 1). The balloting results were reported to the group, which then discussed the challenges the Agency may face in the future and changes in the Agency's current directions that may be necessary to meet those challenges.

The Full Speed Ahead scenario was seen as most likely, largely because it came closest to reflecting current trends as well as the underlying assumptions and preferences of most leaders in business and government. Many in the group were surprised to find, however, that their collective assessment was that even though this is an appealing scenario in the short run, it is a destructive and

Table 1.—Results of EPA senior executives' balloting

Scenario	Desirability	Likelihood	Severity
Eco-Efficiency Revolution	60%	23%	17%
Full Speed Ahead	6%	45%	32%
Soft Landing	32%	17%	13%
A Darker Age	2%	15%	38%

negative scenario in the long run, with impacts nearly as severe as the gloomiest future, A Darker Age. The majority clearly favored the Eco-Efficiency Revolution scenario, and the Soft Landing scenario was actually viewed as having the lowest environmental impacts. Group members were therefore confronted with a disturbing conclusion from their own assessment of the scenarios: what they believe to be the most likely future, and the future that many government policies are geared toward promoting, is very different from what they believe is the preferred future that they would like to help create.

The discussion of how to bridge this gap between the scenarios seen as most likely and most preferable revealed a wide range of ideas about changes that may be needed in EPA's strategic direction. Some of the potential changes discussed by the group are summarized in the list below and the associated participant quotations taken from the meeting notes.

1) Dispense with day-to-day activities that others can do in order to focus EPA attention on higher priorities.

   "The scenarios make you realize that things we do today (like permitting) should go to the states, so that EPA can elevate its attention to higher priorities."

2) Take on a stronger role in promoting environmental technologies.

   "We need to stimulate heavy investment in environmental technology now, 'while things are good'."

3) Increase EPA's global involvement and international leadership.

   "We need to achieve greater domestic consensus, elevate the Agency's international leadership . . . and help create incentives for the private sector to help developing countries adopt environmentally superior technologies."

4) Expand information and outreach activities.

   "Connect what we do—EPA's programs—to people . . . Localize global issues for people so they can understand and respond."

5) Emphasize the importance of research for EPA's overall effectiveness.

   "The biggest threat to EPA is our limited ability to measure impacts and articulate risks. Unless we can do this better, people won't invest in environmental protection."

6) Coordinate environmental solutions across institutions.

   "Solutions to environmental problems require more coordinated action across government departments. EPA should take the lead in defining coordination needs . . . State and federal roles need to be better integrated . . . Make more use of partnerships to achieve goals."

7) Working with Congress, move toward multi-media, whole-system approaches to environmental protection.

   "Establish greater legislative flexibility for dealing with environmental problems."

At the meeting's end, one of the participants said,

"We've been meeting for years and this is the first time we've had a truly strategic conversation."

LOSS OF MOMENTUM

At this point, with a Futures Network in place and senior executives engaged in the process, it looked like environmental foresight was on its way to being a significantly larger focus of Agency attention. An EPA citizen advisory committee reporting to the EPA Administrator, the National Advisory Council on Environmental Policy and Technology (NACEPT), attempted to reinforce this direction of change with its 2002 report, "The Environmental Future:

Emerging Challenges and Opportunities for EPA" (NACEPT 2002). The report identified a wide range of emerging environmental issues and made three major recommendations in line with the recommendations the Agency's Science Advisory Board had made 7 years earlier:

1) Create a comprehensive, continuous, and institutional futures scanning process to identify emerging trends and issues.
2) Support the ongoing work of EPA's Futures Network and provide additional training on forecasting methods.
3) Incorporate futures analysis into EPA's strategic planning.

Unfortunately, the Futures Network initiative began to lose momentum over the next several years. Several factors were at work. The largest was the shift from the Clinton to the Bush Administration. The senior executives who worked with the scenarios had rated climate change as the top priority issue for EPA, but that and several other issues they rated as high priorities were not priorities for the new Administration. None of the changes they believed would improve the functioning of EPA were things the new Administration favored.

In retrospect, it is also clear that the Agency had not set itself up well for maintaining the effort. No full-time staff was responsible for foresight activities. The people leading the effort had other major responsibilities that had first call on most of their time. Not enough activity was generated for the Futures Network to keep its members engaged. And all the normal resistances that bureaucracies have to doing foresight came into play.

In 2002, David Rejeski, who had led the EPA Futures Studies Unit and was now at the Woodrow Wilson International Center for Scholars, and Bob Olson from IAF, who was continuing to work with the OCFO group in EPA, organized a workshop sponsored by the National Aeronautics and Space Administration that brought together people from several government agencies who had been involved in foresight efforts to discuss long-term (50-year) goals for society and the challenge of stimulating government agencies to think 50 years out (Rejeski and Wobig 2002). In a brainstorming and electronic voting process, participants highlighted the following reasons for resistance to foresight and long-term thinking:

- Lack of political will
- Leadership failure—lack of vision
- Organizational structure
- Fear of controversy or failure
- Annual budget process
- Tyranny of the inbox
- Insufficient methodology/training

CONTINUING EFFORTS

Despite the loss of momentum from the peak in 1999-2000, the Agency, and especially OCFO, has maintained a continuous foresight effort. OCFO provided contract support to help develop a Foresight and Governance Project in the Woodrow Wilson International Center for Scholars (now called the Science and Technology Innovation Program). This program went on, with major foundation funding, to do some of the best work anywhere on environmental and social issues around emerging areas like nanotechnology, genomics, and systems biology. OCFO supported NACEPT's work in developing its report on "The Environmental Future: Emerging Challenges and Opportunities for EPA." It also supported a writing project that led to a book, "Environmentalism and the Technologies of Tomorrow," that dealt with emerging developments in a wide range of areas including energy and resource productivity; nanotechnology; genomics; ecological sensing and computing; geoengineering; the future of manufacturing; and economic, corporate, and governance changes for moving toward a sustainable society (Olson and Rejeski 2005).

For a time in the mid-2000s, the Agency's ORD ran a regular environmental scan and produced a handbook of foresight methods. Although work in OCFO was the first to call attention to the importance of emerging developments in nanotechnology and genomics, ORD coordinated the cross-Agency efforts involved in creating a Nanotechnology White Paper and Genomics White Paper that gave those areas much greater visibility.

Toward the end of the decade, the OCFO futures team succeeded for the first time in getting a foresight component into the revision of the Agency's strategic plan. The plan was organized around five long-term goals, with a different team of people working on each goal. A "futures workshop" was held with each of these five goal teams. In the plan revision, each goal section had an "Emerging Issues" section that set out the key issues that arose in each workshop and in follow-on research. Progress in environmental sensor technology emerged as an important topic in nearly all these workshops, and OCFO and IAF produced a white paper on emerging sensor capabilities for widespread circulation in the Agency. Publication of the white paper led to a field trial with Web-linked real-time nitrate sensors and other experiments in the Agency.

Over the past several years, OCFO has sponsored a small but ongoing scanning project to identify emerging technologies that may pose serious environmental problems or could provide new environmental solutions. The Futures Network (now called the Futures Community of Practice) has been called into action around a number of topics, such as evaluating the importance to the Agency of different emerging technologies and issues, and advising the NACEPT Council and the Administrator on hiring needs to insure that EPA has the competencies it needs to meet tomorrow's challenges. Other initiatives include foresight workshops with other agencies, workshops with state officials, and a foresight competition in which winning proposals for foresight projects were offered small amounts of funding or research support.

LESSONS OF EXPERIENCE

Finally, several lessons have emerged from EPA's experience with environmental foresight that may be useful for other organizations concerned with the environment or with improving their foresight capabilities.

- The strategy of developing a Futures Network that reaches throughout the organization and has links to its senior career executives is highly worthwhile. It is a strategy that can be pursued in other government agencies and institutions.
- Develop some kind of "legitimizing process" where high-level people in the organization become involved and identified with the effort without putting many demands on their time. The Futures Network was one approach, but many other approaches are possible.
- Where possible, have a high-level champion or champions who will support and protect the foresight function over time.
- Avoid becoming an isolated unit; develop ties to other parts of the organization; connect to decisionmakers as closely as possible and try to understand where foresight can meet their needs.
- Frame efforts around stimulating thoughtful conversations and making better decisions today, not "knowing the future."
- Have a dedicated staff and a line-item budget to support the foresight function.
- Make an ongoing scanning/early warning system an integral activity.
- Utilize at least one formal method that is credible and understandable to all involved.
- Whenever possible, present the results of futures analysis to relevant decisionmakers in some form of interactive session that gives time for participants to integrate ideas into their thinking in a group setting.

CONCLUSION

The record of EPA's experience with environmental foresight shows that real progress has been made toward developing a capacity for better environmental foresight. However, this progress is still incomplete and fragile and could easily be lost. Environmental foresight is not yet institutionalized in a way that assures it will continue after its strongest current proponents retire. The Agency is still far from the goal stated in "Beyond the Horizon" of giving as much attention to avoiding future environmental problems as to controlling current

ones. Proponents of environmental foresight in the Agency need to work more closely with senior leadership to gain their support and appreciation for the value of futures thinking, strive to secure sufficient resources for the Agency to seriously engage in futures work, and promote the development of a culture of incentives and consequences to encourage foresight in planning.

ACKNOWLEDGMENTS

The author would like to acknowledge and thank Michael Brody (at EPA), Anita Street (formerly at EPA, now at the U.S. Department of Energy), and David Rejeski (formerly at EPA, now at the Woodrow Wilson Center) for their efforts over many years to help build capacity for environmental foresight within EPA. Parts of this paper are drawn from an earlier paper written with Anita Street and published in 2002 (Olson and Street).

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APPENDIX: THE OCFO SCENARIO DEVELOPMENT EFFORT

In July 2000, OCFO formed a Scenario Development Team, a subgroup of the existing Futures Network. OCFO solicited volunteers to conduct research and define the axes around which to build the scenarios. After carefully considering the issues of concern raised by senior managers during interviews, the Team identified several topics for further research:

- climate change
- aquifer depletion/water quality
- urban sprawl (including non-point source pollution and biodiversity loss);
- biotechnology and nanotechnology
- chemicals in the environment (specifically, chemicals or sets of chemicals for which associations between exposure and effects are difficult to ascertain, and where there may be synergistic and cumulative effects of low exposures)
- existing persistent environmental problems that may surprise EPA as a result of changes in societal drivers; for example, an aging population may lead to mass migrations, so areas currently in compliance might be in violation of national air quality standards in the future.

The Scenario Development Team thought it important to choose a mix of topic areas that included issues that are global in scale, issues that were not on EPA's "radar screen," and some conventional persistent problems that are steadily worsening. An issue paper was developed on each of these topic areas. Each issue paper included an overview describing the general nature of the problem, trend data, the range of views on how the problem might change between now and 2020, and environmental and human health implications. The most important findings, or "nuggets," fed into the scenarios.

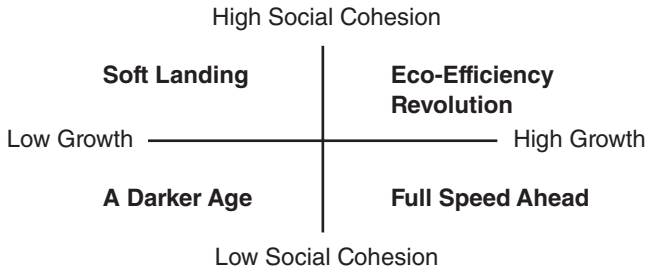
The scenario team then set out to select two axes to serve as a framework for building the scenarios. The chosen axes, economic growth and social cohesion, were selected to highlight social dynamics that have a profound effect on the environment but are often not considered in EPA policies and decisionmaking.

The economy axis was defined in terms of growth or decline in the total production and consumption of goods and services. These quantities are what Gross Domestic Product (GDP) measures in national economies and what Gross World Product (GWP) measures at the level of the world economy. At one end of the economy axis there is high growth in both U.S. GDP and GWP. Toward the other end of the axis, growth rates slow or even become negative.

The social cohesion axis was defined in terms of the extent of shared values, mutual trust, inclusiveness of participation, and willingness to face common challenges and cooperate in meeting them. Cohesion also requires a shared commitment to fairness, because extreme gaps between rich and poor and other forms of social injustice undermine mutual trust.

At one end of the social cohesion axis, most individuals, communities, and organizations are aligned around shared environmental values and committed to the importance of environmental protection. The different actors within society are willing to cooperate with each other and support government action to meet widely recognized environmental challenges. Toward the other end of the axis, society is increasingly fractionalized. Many people are indifferent or hostile to environmental values or refuse to recognize the seriousness of environmental challenges. Economic inequities, social conflicts, and practices that exclude people from participation create distrust and limit society's ability to cooperate in meeting challenges.

These two axes intersect to create four quadrants representing four possible alternative futures or scenarios that were entitled Eco-Efficiency Revolution, Full Speed Ahead, Soft Landing, and A Darker Age.



To flesh out the scenarios, the team engaged in an exercise using interconnected computers and groupware that allowed everyone to brainstorm ideas simultaneously and anonymously, and comment on each other's ideas. The writers for each of the scenarios mined this computer-enhanced brainstorming session to add specificity and realism to the basic scenario plots. Each scenario was then written as a three- to four-page narrative. The boxes below capture the scenario highlights.

It is important to be clear that these scenarios are not predictions. They are simply alternative stories of how the future might unfold — stories that compile information about divergent trends and potential developments into internally consistent images of plausible alternative futures. The four scenarios are not equally likely, although Scenario Development Team members believed they are all within the realm of plausibility. They were designed to span the full range of potential future conditions. The actual future is not likely to match with any one of these four images, but it will probably fall somewhere within the "possibility space" that the scenarios explore.

The future is inherently uncertain. Scenarios force us to face that uncertainty, but they also make the uncertainty easier to think about by bounding it within a small number of explicit stories. This disciplined process makes possible a level of strategic thinking, strategic conversation, and strategic planning that is more sophisticated than activity based only on the momentum of business-as-usual or on implicit and unexamined assumptions about the future.

Eco-Efficiency Revolution (High Economic Growth and High Social Cohesion)

- "Remediable crises" become turning points, changing the character but not the pace of growth.
- Energy price increases during the 2000s make energy a major issue.
- Fuel cells proliferate for power generation in the 2000s; fuel cell cars come on the market in the later 2000s. In the 2010s, ultra-light "hypercars" flourish, running directly on hydrogen. Use of energy from wind and photovoltaics grows rapidly.
- In the late 2000s, a water crisis threatens China's stability. The United Nations Asian Water Initiative recommends changes related to water efficiency, water resource development, deforestation, desertification, and climate change. China embarks on an all-out effort to implement these recommendations.
- The idea of "Eco-efficiency" is popularized globally by the rapid spread of more efficient, cleaner energy technologies and China's successful response to its water crisis.
- In the 2010s, an eco-efficiency design revolution affects energy production and use, the chemical industry, manufacturing, construction, and transportation.
- "Greening of the private sector" occurs as eco-efficiency proves highly profitable. High economic growth is focused on investment in a more environmentally advanced technical infrastructure.
- Environmental protection increasingly focuses on a larger strategy of sustainable development, including technology research and development, improved science, coordination across agencies and levels of government, partnerships with the private sector, open information access, and innovative approaches to public dialogue.
- The United States plays an international leadership role promoting a shift to eco-efficient technologies.
- WATER – Water-efficiency technologies are adopted extensively.
- CHEMICALS – Production increases rapidly but with a shift toward "green chemistry."
- SPRAWL – Hypercars encourage continuation of sprawl, fragmenting ecosystems.
- BIO/NANO TECH – "Biotechnology soft path" emerges, not a rejection of biotech.
- CLIMATE – Emissions are reduced by the shift toward higher energy efficiency, fuel cells, and renewable energy, with positive economic impacts.

Full Speed Ahead (High Economic Growth and Low Social Cohesion)

- The global "Long Boom" is still going strong in 2020, with info-tech the critical catalyst.
- The information revolution becomes an across-the-board technology revolution as it transforms every other area of technology, from genomics to manufacturing.
- A breakthrough to molecular nanotechnology and nanomanufacturing occurs late in the 2010s.
- Market-oriented policies around the world accelerate economic globalization.
- Integrated transnational corporations emerge and merge on a global scale. By 2020, a handful of economic giants dominates the world's increasingly borderless economy.
- Large transnationals sometimes play countries off against one another with little regard for health and environmental impacts on people in weaker countries; but they also serve as efficient conduits for transferring technology, capital, and expertise.
- Not everyone benefits from growth. Rich-poor gaps widen sharply within and especially between nations. Economic disasters befall nations that resist globalization. Dysfunctional nations in Africa, the former Soviet Union, and Asia are left behind.
- Huge increases in the use of energy, materials, and water have significant environmental impacts but receive little attention given the focus on growth and the promise of nanotechnology.
- WATER – Decisionmakers take a supply-oriented approach with huge infrastructure costs and growing conflicts.
- CHEMICALS – Chemical production increases rapidly, with new chemicals introduced too fast for adequate testing. Production increasingly shifts to locations closer to major new overseas markets, where there are growing health and environmental impacts, and novel problems from chemical interactions.
- SPRAWL – Sprawl continues unabated with loss of wetlands, ecosystem fragmentation, other impacts.
- BIO/NANO TECH – Regulatory process fails to keep up with new biotech products; significant problems emerge such as gene transfer and phenotypic surprises, loss of biodiversity in food crops; nanotechnology offers high promise but poses novel risks of serious accidents and malicious misuse.
- CLIMATE – Rapid growth in energy/fossil fuel use leads to rapid rise in CO_2 concentrations; measurable impacts occur in areas such as loss of tundra, extreme weather events.

Soft Landing (Low Economic Growth and High Social Cohesion)

- Growth is rapid through most of the 2000s with global information infrastructure coming into place.
- An economic slowdown occurs at the end of the 2000s, with further slowing in the next decade.
- Initially, there is high frustration at our inability to halt or reverse the slowdown.
- Over time, an understanding grows that the slowdown is caused by unchangeable realities.
- Aging populations in industrial nations reduce investment as elders spend down savings, as younger workers are heavily taxed to support retired elders, and as working-age populations shrink.
- Many developing nations struggle to keep up with rapid population growth and the massive challenges they face of housing construction, infrastructure development, public health, and education.
- Global oil production peaks in the 2010s and begins to decline; there seems no escape from higher prices.
- During the 2020s, a realization spreads that this gradual slowdown has a positive side. Environmental impacts drop with slowing energy consumption and resource use. The slowing pace reduces stress, and family and community strengthen.
- Global growth "rebalances" as many developing nations with lower wages attract investment.
- Rising energy prices make it practical and necessary to improve energy efficiency; less money is available, but economic pressures to invest in efficiency are unrelenting.
- Global "cyberactivism" emerges as a major force in the evolution of global governance. Computer language translation dramatically enhances transnational citizen activism. Key goals of activists include helping nations most in need, protection of the global environment, democratization of emergent global institutions, and monitoring and regulation of transnational corporations.
- WATER – Water is used with greater efficiency; access to freshwater is recognized as a human right; and more careful communal decisions are made regarding development of water resources.
- CHEMICALS – U.S. chemical production declines; the greening of domestic manufacturers serves as a model for the developing world, but decreasing resources are available for research and development, cleanup, and scientific research on impacts.
- SPRAWL – Sprawl abates; smart growth emerges as the new ideal with more clustering of growth and transit-oriented development.
- BIO/NANO TECH – The promise of genetically engineered crops remains unfulfilled; agriculture takes more organic and ecological approaches.
- CLIMATE – Rise in greenhouse gases slows with lower growth.

A Darker Age (Low Economic Growth and Low Social Cohesion)

- Warning signals emerge in the 2000s: lingering recession, incidents of international terrorism, instability in the Middle East, soaring oil prices, tightening global grain prices as China imports more, evidence that the 1990s Asian financial crisis was never really resolved, turmoil in Russia and China, and more.
- Nervousness about all these factors leads some investors to pull out of the market; big institutional investors follow suit, and in 2005 global stock markets crash.
- Crashing stocks set off a chain reaction of protectionist actions and negative economic and social events, which act to prevent an economic recovery.
- In the United States and other industrial nations, economic strains worsen sharply as Baby Boomers retire.
- In developing nations, large numbers of people are thrown back into grinding poverty.
- Rage grows against the world's rich, catalyzing a large increase in terrorism, including bioterrorism.
- Large numbers of newly desperate people and environmental refugees try to enter the United States.
- Many social problems worsen, including a politics of blame, growing intolerance, a narrowing sense of community, and an accelerating spread of AIDS and other new plagues.
- Some environmental impacts ease with slowing growth, but others worsen; some hard-won improvements in such basic environmental areas as air and water are lost.
- WATER – Water quality worsens, aquifers become contaminated, waterborne diseases are even more prevalent, and conflicts over access escalate.
- CHEMICALS – Production of chemicals slows down, but regulation declines.
- SPRAWL – Sprawl slows with the economy, but inner cities suffer from significant deterioration.
- BIO/NANOTECH – Progress is derailed by recession, and adverse effects receive little attention.
- CLIMATE – Greenhouse gas emissions continue to rise but slow with lower growth; no transition to superior technologies is fostered; tropical disease vectors advance in latitude.