

PERSPECTIVES

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None Dare Call It Hubris: The Limits of Knowledge

During the past four decades, many of us have come to terms with an increasing realization that there may be a limit to what we as a species can plan or accomplish. The U.S. failure to protect against and respond to Hurricane Katrina in the summer of 2005 and the apparent futility of the plan to democratize and modernize Iraq provide particularly painful evidence that we seem to be operating beyond our ability to plan and implement effectively, or even to identify conditions where action is needed and can succeed.

Our disappointing performances in New Orleans and Iraq might be less disheartening if they were the most complex problems we need to address, but they are child's play compared to the looming problems of global terrorism, climate change, or possible ecosystem collapse; problems that are not only maddeningly complex but also potentially inconceivably destructive.

Our current approach to framing problems can be traced back to the 1972 publication of the Club of Rome's *The Limits to Growth*, which posed the still-unanswered question: How much population growth and development, how much modification of natural systems, how much resource extraction and consumption, and how much waste generation can Earth sustain without provoking regional or even global catastrophe? Since that time, the way we think about human activity and the environment and the way we translate this thinking into our science policy and subsequent R&D, public debate, and political action have been framed by the

idea of external limits—defining them, measuring them, seeking to overcome them, denying their existence, or insisting that they have already been exceeded.

For technological optimists these limits are ever-receding, perhaps even nonexistent, as science-based technologies allow progressive increases in productivity and efficiency that allow the billion and a half people living in industrialized and industrializing nations today to achieve a standard of living that was unimaginable at the beginning of the 20th century. For the pessimists, there is global climate change, the ozone hole, air and water pollution, overpopulation, natural and human-caused environmental disasters, widespread hunger and poverty, rampant extinction of species, exhaustion of natural resources, and destruction of ecosystems. In the face of these conflicting perceptions, it makes no sense to try to use external limits as a foundation for inquiry and action on the future of humans and the planet. It is time to look elsewhere.

All sides in the limits-to-growth debate would probably agree on the following two observations: First, the dynamic, interactive system of complex biogeochemical cycles that constitutes Earth's surface environment is falling increasingly under the influence of a single dominant life form: us. Second, this life form, notable for its ability to learn, reason, innovate, communicate, plan, predict, and organize its activities, nonetheless exhibits serious limitations in all these same areas.

During the past 150 years, scientific and technological innovation has facilitated enormous growth: The population of

Earth has increased approximately sixfold, the average life span of those living in the industrialized nations has doubled, agricultural productivity has increased by a factor of five, the size of the U.S. economy alone has increased more than 200-fold, the number of U.S. scientists has increased by more than 17 times, and the volume of globally retrievable information stored in analog and digital form has expanded by incalculable orders of magnitude. At the same time, 20% of the planet's bird species have been driven into extinction, 50% of all freshwater runoff has come to be consumed, 70,000 synthetic chemicals have been introduced into the environment, the sediment load of rivers has increased fivefold, and more than two-thirds of the major marine fisheries on the planet have been fully exploited or depleted.

As Joel Cohen has brilliantly illustrated in his book *How Many People Can the Earth Support?*, there are many possible futures available to us. The only certainty is that present trajectories of growth cannot, and therefore will not, be maintained indefinitely. (Thomas Malthus got this point right more than 200 years ago. He simply failed to appreciate the productivity gains that science and technology could deliver.) The central question that faces us is whether we will be able to position ourselves to choose wisely among alternative future trajectories or will simply blunder onward. The markets will indeed adjust to the eventual depletion of fossil-fuel reserves, for example, but will likely be too shortsighted to prevent global economic disruption on an unprecedented scale, a situation that could even lead to global war.

If we continue to define our problem as external to ourselves—as limits imposed by nature and the environment—then we consign ourselves to a future of blundering. The limits that matter are internal. They are the limits on our collective ability to acquire, integrate, and apply knowledge.

Although it is difficult to isolate these limits neatly from one another, it is helpful to separate them into six large categories: limits of the individual, of sociobiology, of socioeconomics, of technology, of knowledge, and of philosophy. Although these might at first seem to be insurmountable shortcomings, I believe that our best hope for finding our place in nature and on the planet resides in embracing our limits and recognizing them as explicit design criteria for moving forward with our knowledge production and organization. I see potential for progress in each.

Individual limits. We all operate out of self-interest, which is entirely rational. Community spirit and altruism may be motivating factors, but given that we cannot know the effects of our individual actions on the larger systems in which we are enmeshed, the only reasonable alternative

is for each of us to pursue our conception, however imperfect, of our own interests. Yet as social systems grow more and more complex and as they impinge more and more on natural systems, our individual vision inevitably captures less and less of the big picture. Our only option is to accept the limits of individual rationality and to take them into account in formulating public policy and collective action.

Sociobiological limits. During the course of our development, humanity's special capabilities in areas such as toolmaking, language, self-awareness, and abstract thought have rendered us extraordinarily fit to engage in the competitive business of individual and species survival. We compete among ourselves at every organizational level and with other species in virtually every ecological niche. Cooperation, therefore, most often occurs at one level (a tribe or a nation, for example) in order to compete at a higher level (a war between tribes or nations). But at the highest levels—the behavior of an entire species competing with or dominating billions of other species—we have run out of reasons to cooperate or structures to foster effective cooperation. We need to consciously search for ways to transcend our socio-biological limits on cooperation.

Socioeconomic limits. We have done our best to make a virtue out of our individual and sociobiological limits through market economics and democratic politics. Yet we are unable to integrate the long-term consequences of our competition-based society into our planning processes. Our competitive nature values the individual over the group, but the aggregation of individual actions constantly surprises us. Despite our best intentions, our actions are consistent with a global economy predicated on the expectation of continued growth and development derived from ever-increasing resource exploitation. Thus, for example, we all climb into our cars in the morning thinking only that this is the most convenient way to get to work. We are not deliberately choosing to waste time in traffic jams, exacerbate the trade deficit, and pump greenhouse gases into the atmosphere.

We find it extraordinarily difficult to anticipate or accurately account for the costs and risks incurred over the long term by such group behavior. Indeed, those costs and risks vary wildly from individual to individual and from group to group. An example of this is the cost/benefit calculation that must have been made regarding New Orleans, where the probability of catastrophic flooding is low and the cost of protecting the city is high. At every level of the political system, the individual perspective outweighed the collective, with the result that adequate protection for the whole community lost out. Because of these complexities, efforts to advance the long-term interests of the whole by controlling the short-term behav-

ior of the individual are doomed to failure, which is one of the lessons of the global collapse of communism.

Technological limits. To evade the behavioral limits of biology and economics, we have turned to technology. Indeed, technology, harnessed to the marketplace, has allowed industrialized societies to achieve amazingly high standards of living. In doing so, however, we have put our future into the hands of the lowest bidder. Cheap oil and coal, for example, ensure our continued dependence on the internal combustion engine and the coal-burning power plant. The problem we face is not a shortage of polluting hydrocarbon fuels, but an excess. History shows that we will develop increasingly efficient energy technologies but that gains in efficiency will be more than offset by the increased consumption that accompanies economic growth. The increased efficiency and cleanliness of today's cars when compared with those built in 1980 are an example. Technology has allowed us to pollute less per mile of driving, but pollution has declined little because we drive so many more miles. Too often we choose technologies that save us from today's predicament but add to the problems of tomorrow.

Knowledge limits. There is absolutely no a priori reason to expect that what we can know is what we most need to know. Science uses disciplinary organization to recognize and focus on questions that can be answered. Disciplines, in turn, are separated by methodology, terminology, sociology, and disparate bodies of fact that resist synthesis. Although disciplinary specialization has been the key to scientific success, such specialization simultaneously takes us away from any knowledge of the whole.

Today the whole encompasses six billion people with the collective capability of altering the biogeochemical cycles on which we depend for our survival. Can science generate the knowledge necessary to govern the world that science has made? Do we even know what such knowledge might be? Producing 70,000 synthetic chemicals is easy compared to the challenge of understanding and dealing with their effects. Despite the billions we have spent studying our interference with the planet's biogeochemical cycles, we really do not have a clue about what the long-term result will be. And we have even less knowledge about how to organize and govern ourselves to confront this challenge.

The intrinsic difficulties of creating a transdisciplinary synthesis are compounded dramatically by a dangerous scientific and technological illiteracy among senior policymakers and elected officials. An ironic effect of technology-created wealth is the growth of an affluent class that prizes individualism over civic engagement and that feels insulated from the need to understand and confront complex tech-

nology-related social issues.

Philosophical limits. The scientific and philosophical intellectuals of "the academy" remain focused on the relatively simple question of understanding nature. The much more complicated and challenging—and meaningful—quest is to understand nature with a purpose, with an objective, with an end. What is the purpose of our effort to understand nature: to learn how to live in harmony with nature or to exploit it more efficiently? For thousands of years, philosophical inquiry has been guided by such fundamental questions as "Why are we here?" and "How should we behave?" Such questions were difficult enough to confront meaningfully when our communities were small, our mobility limited, and our impact restricted. In today's hyperkinetic world, how can we possibly hope to find meaning? The literal answers provided by science amount to mockery: We are here because an expanding cloud of gas some 15 billion years ago eventually led to the accretion of planets, the formation of primordial nucleotides and amino acids, the evolution of complex organisms, the growth of complex social structures in primates, and the dramatic expansion of cognitive and analytical capabilities made possible by the rapid evolution of neocortical brain structures. Such explanation is entirely insufficient to promote the commonality of purpose necessary for planetary stewardship. We lack a unified or unifiable metaphysical basis for action, just when we need it most.

I list these limits—which no doubt could be parsed and defined in many different ways—not to bemoan them, but to acknowledge the boundary conditions that we face in learning how to manage our accelerating impact on Earth. How can we create knowledge and foster institutions that are sensitive to these boundary conditions? This is a sensitivity that we have hardly begun to develop and that will not be found in any of compartmentalized traditional disciplines that we nurture so earnestly.

Not only do we perpetuate traditional disciplines, we assign inordinate significance to distinctions in a strict hierarchy: Disciplines trump other disciplines based on their quantitative capacities. The academy remains unwilling to fully embrace the multiple ways of thinking, the different disciplinary cultures, orientations, and approaches to solving problems that have arisen through hundreds if not thousands of years of intellectual evolution. Our science remains culturally biased and isolated: Western science is derivative of a philosophical model of domination and the manipulation of nature, as opposed to the acceptance of natural systems and dynamics.

The problems that we face are not hierarchical, nor do they

fall within strict disciplinary categories. They require multiple approaches and an integration of disciplines; we cannot expect biologists alone to solve the problem of the loss of biodiversity. Because each academic discipline has a Darwinian focus on its own survival, none has the impetus or the capacity to develop a formal language to make itself comprehensible to other disciplines. We have not developed the means for chemists to talk to political scientists, and for political scientists to talk to earth scientists, and for earth scientists to talk to engineers. The debate must engage a broad community of disciplines, and not just the expertise found within the universities but also the wisdom and expertise developed in commerce, industry, and government.

We need new ways to conceive of the pursuit of knowledge and innovation, to understand and build political institutions, to endow philosophy with meaning for people other than philosophers. We trumpet the onset of the “knowledge society,” but we might be much better off if we accepted that, when it comes to our relations with nature, we are still pretty much an “ignorance society.” Our situation is reminiscent of Sherman McCoy, the protagonist of Tom Wolfe’s *Bonfire of the Vanities*, who fancies himself a “Master of the Universe” just as his life is taken over by events far beyond his control. We have the illusion of understanding and are not humbled by the fact that we do not understand. We refuse even to consider the possibility.

Hubris, exemplified in the demands we make on science, is a major obstacle to coming to grips with our situation. We are obsessed with trying to predict, manage, and control nature, and consequently we pour immense intellectual and fiscal resources into huge research programs—from the Human Genome Project to the U.S. Global Change Research Program—aimed at this unattainable goal. On the other hand, we devote little effort to the apparently modest yet absolutely essential question of how, given our unavoidable limits, we can manage to live in harmony with the world that we have inherited and are continually remaking.

Concepts such as sustainability, biodesign, adaptive management, industrial ecology, and intergenerational equity—new principles for organizing knowledge production and application—offer hints of an intellectual and philosophical framework for creating and using knowledge appropriate to our inherent limits. Sustainability is a concept as potentially rich as justice, liberty, and equality for guiding inquiry, discourse, and action. Biodesign seeks to mimic and harness natural processes to confront challenges in medicine, agriculture, environmental management, and national secu-

urity. Adaptive management acknowledges the limits of acquiring predictive understanding of complex systems, and although the prospect of their control is illusory, the genesis of increasingly sophisticated data sets should impart increasing “predictability” to the bandwidth in which systems may behave. Industrial ecology responds to our tendency to organize and innovate competitively, and looks to natural systems for a model of innovation that can enhance competitiveness while reducing our footprint on the planet. Intergenerational equity seeks to apply core societal values such as justice and liberty across boundaries of time as well as space. Of course, we will need many other new ways to think about and organize our actions, but these few indicate a beginning.

Common to all such approaches is the idea that more flexibility, resilience, and responsiveness must be built into all institutions and organizations—in academia, the private sector, and government—because society will never be able to control the large-scale consequences of its actions. In today’s ignorance society, we must define some measure of rationality and recognize that the only way to reduce uncertainty about the future is to take action and carefully observe the outcomes. We must establish threshold criteria for, or at least attempt to define, the range of potential scenarios for which some degree of planning either to promote or obstruct a given outcome should be contemplated. The latter is the more difficult, particularly if a major risk or disaster begins to emerge. Yet we should not succumb to the paralysis of the “precautionary principle,” which saps innovation and risk-taking. The more institutional and organizational innovation we conduct, the better the chances that we will learn how to deal with the implications of our own limits.

The ideological and institutional struggle between communism and market democracy can be viewed as one such set of competing innovations, albeit poorly planned and exceedingly costly. A key result of this innovation competition is the certain knowledge that rational self-interest cannot be successfully suppressed indefinitely and that legal systems that foster dissent and freedom of choice provide a fertile culture for innovation. We now urgently need to conceptualize a new series of innovations, at much lower cost and shorter run-time, to push this result further and apply it to the problem of ensuring that our global society can continue to be sustained by the web of biogeochemical cycles that makes life possible in the first place.

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