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Today's Visions of the Science of Tomorrow

At the end of every year, John Brockman, a literary agent and the publisher of Edge.org, a Web site devoted to science, poses a question to leading scientists, writers and futurists. In 2002, he asked respondents to imagine that they had been nominated as White House science adviser and that President Bush had sought their answer to "What are the pressing scientific issues for the nation and the world, and what is your advice on how I can begin to deal with them?" Here are excerpts of some of the responses.

Mapping the Planet

Over the last decade, the human genome project has laid the foundation for a comprehensive understanding of human biology. The translation of the new understanding into cures for human diseases will be a slow and difficult process.

Meanwhile, a new century has begun. It is time to begin a bold new initiative in biology: a planetary genome sequencing project to identify all the segments of the genomes of all the millions of species that live together on the planet.

This would require, first, the aggressive development of new technology for deciphering genes, comparable to the development of computer technology during the last half century, so that the cost of sequencing genes can continue to fall as rapidly as the cost of computing.

The goal would be to complete the sequencing of the biosphere within less than half a century, at a cost comparable with the cost of the human genome. This project would bring an enormous increase in understanding of the ecology of the planet, which could then be translated into practical measures to sustain and improve the environment while allowing continued rapid economic development. It could also lead to the stabilization of the atmosphere and the climate. Let this century be the century of cures for planetary as well as human diseases.
— Freeman Dyson, retired professor of physics, Institute for Advanced Study, Princeton, N.J.

Professor PlayStation

While American schools are notoriously underserving their students, American children are rushing home from class to learn how to succeed in the alternative universes of video games. They spend dozens of hours every week exploring virtual worlds, each with its own set of rules. Barring a complete overhaul of our schools, makers of game systems like Nintendo and PlayStation will continue to be the most successful institutions when it comes to captivating young minds.

South Korea has already figured this out. More than 60 percent of Korean homes have broadband Internet access — and online, multiplayer role-playing games are immensely popular. Recently, the largest Korean textbook distributor and an independent software designer joined forces to make such a game in which children study math, science and history.

Here in the United States, the Army is using video games to reach teenagers. With a $7 million budget, it is building a series of games to be made available as a free download over the Web. The first title, "America's Army," helps players learn about war tactics by requiring them to rush through shooter missions armed with guns and grenades.

But where are the games created to teach young Americans civilian skills? While televisions and slide shows play a

large role in classrooms, video games are still appallingly underused. Let's match the money and effort spent on "America's Army" to develop freely available games that teach about math and science, history and citizenship.
— Justin Hall, electronic entertainment journalist and creator of the Web site Justin's Links.

Little Geniuses

We need more support for the most productive, and most underfinanced, scientific community in the country. These scientists and educators do more to provide the basic intellectual infrastructure of the nation than any other group. Every year they make fundamental discoveries in physics, biology, mathematics and psychology, as well as ensure that the discoveries of previous generations of scientists are passed on to future generations. Yet they typically receive salaries of zero to $15,000 a year, and 16 percent are below the poverty line. Most of the science educators in this group actually make major financial sacrifices to do their work. They receive less federal and state support than any other part of the scientific community — no grants, no scholarships, no research and development write-offs.

These unsung geniuses, are, of course, children under five and the many women (and a few men) who take care of them. This may seem like a motherhood issue; well, actually, it is a motherhood issue. But it's sound science policy too. Give our children what all scientists need —lunch, the right toys, a safe place to play, interesting problems to solve and someone to talk to, and watch them invent a new world.
— Alison Gopnik, author of "The Scientist in the Crib: What Early Learning Tells Us About the Mind."

Think Small

The United States has been increasing its research efforts in a broad field called nanotechnology. Nanotechnology — its name comes from the Greek work for dwarf — refers to mechanical engineering on a molecular scale. Technology based on molecular manufacturing will lead to computer systems a billion times more powerful than what we have today, aerospace vehicles with 98 percent less structural mass, and medical tools that can repair tissues, organs and cells at a microscopic level.

Molecular manufacturing will be based on molecular machine systems able to manipulate and assemble molecular components to make larger products. If you look in a conventional factory today, you will see electronic devices sensing and controlling processes, but the actual work shaping, moving and assembling parts is done by machines that, quite naturally, use moving parts to move parts.

Yet today's research programs are not focused on developing the molecular machine technologies essential to molecular manufacturing. Researchers often see any machinery as somehow archaic, left over from the 19th century. Thus interest in topics like biotechnology and microelectronics has diverted resources into short-term efforts that are worth doing, but not at the expense of neglecting the long-term promise of nanotechnology.
— K. Eric Drexler, founder of the Foresight Institute and author of "Nanosystems: Molecular Machinery, Manufacturing and Computation; Unbounding the Future."

Science Without Secrets

My advice is to keep science public. Secret knowledge, no matter how laboriously acquired, is less than science.

Some knowledge, of course, must remain secret for the security of the nation. But unless there is a clear security risk, publish all else. Why? Science belongs to the people: they pay for it; they benefit from it. The benefits of scientific knowledge accrue far more rapidly when that knowledge lies open for all to see, to test and to try.

In my field, quantum computation, openness is beneficial. Quantum mechanics is famously weird, and one of the consequences of quantum weirdness is that even a small quantum computer, consisting of a few thousand atoms, has the potential to break all existing public-key cryptosystems.

Thus, quantum computers pose a significant threat to the security not only of classified encoded material, but also of most commercial transactions. Yet our national security agencies have elected to award grant money for quantum computing research with the stipulation that the results be published.

This is a wise policy. There is no doubt large-scale quantum computers will pose a risk to security. But they don't how exist, and constructing them will require the scientific and engineering community to solve wide-ranging problems of nanofabrication and control. The potential benefits of such research are a thousand times greater than any drawback from potential disruption to security.
— Seth Lloyd, a professor of quantum-mechanical engineering at the Massachusetts Institute of Technology.

Fending Off the Big One

As an astrophysicist, I admit that few issues in my trade could be considered pressing. However, there is one aspect of my work that could have deadly consequences — or, more precisely, will have deadly consequences if it is ignored. Here is where heaven and Earth meet: in the long-run certainty that people will die from the effects of an asteroid, large or small, hitting the planet.

NASA has been discovering and tracking asteroids, but the financing had not been sufficient to catalog most of them, and no money had gone to study how an asteroid might be deflected, even though the technology has, in principle, been available.

Fortunately, it is rather straightforward to develop a spacecraft that could reach a 100-meter diameter asteroid and give it a nudge so that it would miss the earth. For example, scientists have made great strides with plasma engines — which are much more effective than traditional chemical engines and use radio waves to heat their fuel and magnetic fields to direct a stream of ultrahot ionized gases — which could be used as space "tug boats."

All we have to do is carry out a test mission in which we demonstrate the ability to significantly alter an asteroid's orbit. Then when we discover an asteroid with our name on it, we will be prepared. Plasma engine advances would also speed up human expansion into space. This initiative could open the door to populating other worlds while at the same time making our own world a safer place.
— Piet Hut, astrophysicist, Institute of Advanced Study, Princeton, N.J.

Intellectual Globalization

Both art and science address the most profound issues of the day yet often face each other across a great divide. A new National Institute for Humanism would encourage collaborations across the arts, humanities and sciences in tackling important questions about who and what we are. Call it the intellectual equivalent of globalization.

Milan Kundera once wrote that every novel offers some answer to the question. "What is human existence and wherein does its poetry lie?" I submit that so does every work of important science.
— Nancy Etcoff, author and instructor in the department of psychiatry at the Harvard Medical School.

Cassandras of the Labs

Scientists are as much victims of fashion as ordinary mortals are — a fact illustrated by the rich history of junk science and false alarms of the last 30 years. Recall a few instances:

In the mid-1970's, many climatologists warned of an ice age that would severely diminish agricultural productivity by the year 2000.

In 1972, the United States banned DDT, only to find out, years later, that the evidence of the pesticide's harmful effects on human beings is inconclusive. In the meantime, millions of people — 1 in 20 African children, for example — have

died of malaria, as Europe and the United States remain reluctant to support controlling mosquitoes with DDT.

And let's not forget the dire warnings about natural resources. In the 1970's, we were told that there would be essentially no oil left by the 1990's.

Science retains its alarmist streak today. The scuttlebutt among the scientists I know is that they have a better chance of getting a government or private grant if they indicate that their research might uncover a serious threat or problem. Media fascination with bad news is partly to blame, along with the principled gloominess and nagging of nongovernmental pressure groups. But government itself has played its natural part.

The point is not to be cynical about science fads but to know enough to choose wisely when it comes to supporting pure science, along with research that can give us beneficial technologies.
— Denis Dutton, Department of Philosophy, University of Canterbury, New Zealand.

Really Popular Science

I believe that if 1 percent of the money now being distributed for science went to research that was of real interest to taxpayers, science would become more popular.

At present, money generally goes to research sought by the scientific establishment, corporations and government bureaucracies. The administration of science is neither democratically accountable, nor carried out in a democratic spirit.

My proposal is that 99 percent of the research funds continue to be allocated in the usual way. But I suggest that 1 percent be spent in a way that reflects the curiosity of lay people, who pay for all publicly financed research through taxes. It would be necessary to create a separate body. One possible name would be the National Discovery Center.

The center would be governed by a board representing a wide range of interests, including nongovernmental organizations, schools and voluntary associations. Individuals could send suggestions in over the Internet. Local and national organizations could lobby for projects. Potential subjects for research could be discussed in the news media.

This new venture would make science more attractive to young people, stimulate interest in scientific thinking and hypothesis-testing, and help break down the depressing alienation many people feel from science.
— Rupert Sheldrake, author of "Dogs That Know When Their Owners Are Coming Home, and Other Unexplained Powers of Animals."