Democracy in the Age of Science:  
Trust, Numeracy, and the Voice of the People

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Introduction: The End of Trust

In recent years, we have seen a frightening erosion of an element of trust that has stood as the axis about which American politics revolves. We lost trust in our leaders long ago. We are losing trust in the experts who advise these leaders. We are losing trust in the newspapers that inform us about what is happening in the world. But most frighteningly, we are losing trust in ourselves, in the ability of a democratic people to exercise its power wisely as voters, as jurors, and as citizens.

This lack of trust imperils democracy. Fareed Zakaria observed in his wise book, The Future of Freedom that much more than the right to vote, democracies are characterized by the level of trust their political institutions earn from the people. When the people cannot trust their political institutions—their legislators, the judges in the courts, the bureaucrats at government agencies—the democracy breaks down and becomes a sham. When people can trust that they will get a fair hearing in court, that their politicians are pretty honest, and that they can get services from government agencies without having to pay bribes then the system will work.

But what happens when trust vanishes not only for a democracy’s leaders but for the people themselves?

Distrust of the people is nothing new. In the fourth century BC, Plato wrote that democracy would fail because it would produce a society filled with the sort of soft, spoiled citizen who would

live out his life … indulging the appetite of the day, now winebibbing and abandoning himself to the lascivious pleasing of the flute … idling and neglecting all things.

In other words, the ancient Greek equivalents of sex and drugs and rock and roll. Plato continues,

And frequently he goes in for politics and bounces up and says and does whatever enters his head. … And there is no order to his existence, but he calls this life of his the life of pleasure and freedom and happiness and cleaves to it to the end.

Such a society, Plato warns, will not accept leaders who call on the people to sacrifice or to exercise moderation and responsibility. It will elect leaders who fawn upon the voters and corrupt the state until a tyrant steps in and takes over.

In 1857, as England was moving toward true democracy, Macaulay wrote to an American friend,

I have long been convinced that institutions purely democratic must, sooner or later, destroy liberty, or civilization, or both.
In recent years, many Americans too have lost their trust in the wisdom of the people. Our Constitution guarantees the right to a trial by jury, but we have become increasingly distrustful of juries. We see people go free who seem obviously guilty. We hear tales of outrageous malpractice and product liability verdicts—juries blaming McDonalds for the burns on a woman who spilled coffee into her lap or awarding an Alabama physician $4 million for a bad paint job on a $40,000 car—and they convince us that a jury of our peers cannot be trusted to render wise decisions. Calls for term limits demonstrate our lack of faith that the people will vote for honest challengers over corrupt and pandering incumbents.

The people’s collective wisdom is frequently mistrusted when matters of public interest involve complex scientific or technological issues. In almost every area of public policy or public interest, science and technology play important roles. Global warming, nuclear energy, genetically modified foods, stem cell research, weapons of mass destruction, and the scientific evidence used in the courts are just a few examples of how our world is defined by our technology, the promises it offers, and the threats it presents. If voters cannot understand these scientific issues, how can they vote wisely?

Science in a Democracy

Let us consider what science is and what its role should be in a democracy.

In 1909 the novelist Henry James defined science as “the absence of prejudice backed by the presence of money.” Science would cut through superstition, create wealth, and bring humankind into a new enlightened era. From the seventeenth through the mid-twentieth century science was a fundamentally democratic activity. It offered a path to objective truth that anyone could follow, just as the Protestant Reformation offered an individual path to salvation that did not depend on priests.

On scientific matters, it was possible for the lowest shopkeeper to challenge the theories of the most exalted professor. At the turn of the nineteenth century, the science of geology was invented practically single-handedly by William Smith, the orphaned son of a village blacksmith whose geological discoveries and their application to coal mining and water management enabled him to rise from hardship to great fame and fortune. This view of science persists in the vision Vannevar Bush expounded at the end of World War II, in which science provides an endless frontier for America to explore and develop.

At the same time, many of those suspicious of democracy drew distinctions between the better classes, who were educated and cultured and could appreciate and participate in scientific advancement and the lower classes who were slaves to their appetites and incapable of acting wisely and temperately. The psychologist Gustave LeBon wrote in 1895 that

If democracies had possessed the power they have today at the time when the mechanical loom, the steam engine, and the railroads were invented, the making of these inventions would have been impossible. … It is fortunate for the progress of civilization that the power of the masses began to expand only when the great discoveries of science and industry had already been accomplished.

By the 1950s, the novelist C.P. Snow warned that the growing complexity and importance of science together with disdain toward science on the part of literary intellectuals, was dividing society into two cultures—the scientifically literate and the scientifically illiterate. The world around us is far more technologically sophisticated than it was in Snow’s time, but the people—voters, jurors, even judges and Senators—have not become increasingly literate in mathematics and science and this poses a great problem for the future of our democracy. How can a democratic nation make wise decisions about global warming, strategic missile defense, nuclear energy, or stem cell research if we cannot follow the science behind these issues?

One approach to the problem of public ignorance is seen in our representative democracy. No one has time or energy to learn about every matter that concerns the nation, so rather than voting...
on each issue in national plebiscites, we elect representatives to act on our behalf. The authors of
the Constitution imagined that our Representatives in Washington would be drawn from the nation's
elite: the best educated, wisest, and most temperate men. Of the founding fathers, not only were
Benjamin Franklin and Thomas Jefferson distinguished scientists, but James Madison, James Monroe,
John Adams, and George Washington all had extensive training in science and engineering and they
imagined that their successors would be equally well educated.

Today, when science and technology come before Congress, our representatives are all too often
even more ignorant than the rest of us. Less than one percent of Congress has been educated in
science. Senator Trent Lott once said that taking math and science in high school had been "a waste
of my time, a waste of the teacher's time, and a waste of space" One consequence of this was that
when one of his constituents could not get a patent for a proposed perpetual motion machine, Lott,
who didn't understand that such a machine would violate several basic laws of nature, co-sponsored a
bill to force the Patent Office to issue the patent. Fortunately, the bill was withdrawn when Sen. John
Glenn, who knows a little science from his astronaut training, exposed the fraud.

More seriously, many of you may remember that in 1990, a charlatan called Iben Browning pre-
predicted that on December third of that year a catastrophic earthquake would strike somewhere near
New Madrid, MO, devastating cities along the banks of the Mississippi. There was no scientific basis
for this prediction and Browning's previous record included advising NASA in the late 1960s that the
moon was covered with such a thick layer of fine dust that a manned moon landing would vanish
without a trace. Nonetheless, credulous news reporters spread the alarm and mayors, governors, and
other officials wasted millions of dollars on unnecessary disaster preparations.

Technocracy

Many scholars, both liberals such as Supreme Court Justice Stephen Breyer, and conservatives, such
as John Graham, President Bush's regulatory czar at the Office of Management and Budget, have sug-
gested that the people and Congress were just too ignorant to be allowed to decide technically complex
matters and that such decisions should be turned over to scientific experts working for government
bureaucracies, who would establish environmental, health, and safety regulations on the basis of com-
plex mathematical calculations of costs and benefits to ensure that these regulations were economi-
cally efficient.

This approach to government, known as technocracy, has many points in its favor. We often defer
to experts, acknowledging that their superior knowledge and experience in a particular area allows
them to make better decisions on our behalf than we could make for ourselves. If my doctor were to
tell me that my appendix was infected and I needed immediate surgery, I would trust his judgment.
I pay an expert to help me with my taxes each April. If I so readily turn my personal affairs over to
experts, is there any reason not to similarly turn complex scientific and technical matters of public
policy over to experts in science and technology?

One problem is establishing trust. In the United States, it is impossible to say the phrase, “Trust
me, I'm from the government,” without sarcasm or irony, but scientists were once trusted to provide
impartial and reliable advice. In 1974 two chemists, Sherwood Rowland and Mario Molina, warned that
chemicals called Freons that were used to pressurize spray cans could destroy the ozone layer that
protects us from the most dangerous ultraviolet rays from the sun. The American people believed
this warning and within a year, long before the government could issue any regulations, consumer
pressure for environmentally friendly spray cans led manufacturers to eliminate Freon.

Today things could not be more different. When scientists report on the environment the first thing
we ask is, “whose side are they on?” Our trust that science provides impartial truths has weakened
and scientists are too often seen, like lobbyists and lawyers, as hired guns out to defend a position
regardless where the facts point.

Three major problems arise when scientific experts weigh in on politically controversial science:
Are they honest? Are they biased? And are they correct?
How can we know how much to trust scientific expertise? The simple answer is that we, the people, must remain ever vigilant. In President Reagan's words, "trust, but verify." But if the voters do not have the scientific and mathematical literacy to verify what the experts tell us, how can we know whether they are giving us reliable information or spinning the facts to pursue private goals? Even where the experts are honest, how can we tell whether they are misguided, mistaken, or perhaps unconsciously biased?

To some extent, we rely on an adversarial approach, modeled on the exaggerated courtroom dramas we watch on television. On every issue there are two sides, which must receive equal time and in the end the jury, or the audience, decides which was more persuasive. But if scientists, like lawyers, act as hired guns advocating for the side that pays them, this undermines the much older notion of science as a cooperative search for actual truth.

The poet, mathematician, and humanist Jacob Bronowski wrote that the scientist must cultivate three things: A creative mind, a habit of truth, and a sense of human dignity. The creative mind is what recognized patterns in nature and draws from them the laws that govern the universe. But these patterns may illustrate laws or mere fancy or delusion and so must be subjected to rigorous testing. Scientists must be so firmly committed to truth that they will discard a beloved hypothesis when new experiments or observations prove it wrong. Finally, a scientist does not work alone, but as part of a large community of scientists whose depend on each other's work to advance their own. Respect for human dignity is a matter of character: if scientists cannot count on one another for honesty and competence, the whole enterprise comes to a halt and sinks, as though into quicksand.

**Ad-hominem attacks**

Observers of American politics have long been saying that civility and trust are disappearing and that politicians who might once have agreed to disagree now go for blood as they attack not just the ideas of their opponents, but their character, their integrity, and their good name. As political debates have come increasingly to revolve around scientific questions, mudslingers now make scientists their targets as well.

In 1979 Herbert Needleman, a young professor at Harvard Medical School, published a comprehensive study of the extent to which very small amounts of lead poisoned children. This did not make Dr. Needleman many friends in the lead industry and the lobbying arm of this industry, the International Lead-Zinc Organization first challenged Needleman's work on scientific grounds, but as the scientific evidence supporting Needleman began to mount, the lead industry went further, first attempting to discredit Needleman personally, then making secret payments to two scientists to file charges of scientific misconduct against Needleman. The message to other scientists was clear: if you mess with the lead industry you will pay a great price.

Needleman's defense cost him over ten thousand dollars and took a great deal of time away from his research. In the end, he was exonerated of misconduct, although he was found to have made some minor innocent errors in his research.

In the years since the United States banned lead in gasoline, the amount of lead in children's blood has dropped by about a factor of five and because of this children born after 1980 will be on average about three IQ points more intelligent than their parents.

Consider global warming. There is almost complete consensus among scientific experts that burning fossil fuels and other industrial activities are slowly warming the planet, but some politicians and special-interest groups continue to treat climate science as though it were a partisan activity. Having failed to discredit global warming through legitimate scientific channels, they now resort to personal attacks on individual scientists.

Last February The Wall Street Journal used its front page to launch a personal attack on a prominent climate scientist, Michael Mann. What is significant here is that the Journal did not just question Professor Mann's research, but attacked him personally, making a number of demonstrably false claims about Mann's conduct. If it were not sufficiently intimidating for a young assistant professor to have
his character and good name be attacked on the front page of one of the nation’s largest newspapers, Joe Barton (R-TX), Chair of the House Energy and Commerce Committee, sent Professor Mann an accusatory letter demanding that within three weeks, he deliver detailed accounts of all the money he had ever received to support his work and copies of all the data and computer programs he had used in his research. It was clear from the tone of Barton’s letter that he was less interested in the data or the accounts than intimidation.

When politics and personal attacks dominate science, disaster can follow. In the 1940s and 50s, the Soviet Union experienced a Marxist version of the Intelligent Design controversy we see today. Trofim Lysenko, a shoddy biologist but a canny opportunist, announced that Darwin’s theory of evolution and Mendel’s theory of genetic inheritance were disproved by Marx’s doctrine of dialectical materialism. According to Lysenko, Darwin’s key idea that evolution was driven by the competition between species was not science so much as Capitalist propaganda. Communists knew that cooperation, not competition, was the natural order, so biologists who believed Darwin were shipped off to the Gulag and Lysenko ran Soviet agriculture according to the state religion of Marxism-Leninism. Nature did not care about ideology and kept doing what it always does, which unfortunately did not agree with Lysenko’s theories. Crops failed and famines, already terrible because of Stalin’s tyranny, became even worse.

In no way does the United States resemble Stalinist Russia, but if we put political aspirations ahead of scientific reality and substitute character-assassination for reasoned scientific debate we too will pay a great price.

Adversarial approach and uncertainty

An approach to settling scientific controversies that relies on personal attacks will destroy the respect for truth and dignity that are necessary for science to function. Fraud in science is certainly a problem, but outside Communist countries it is unheard of for large numbers of scientists to conspire in fraud. Scientists can only do their work when they can trust one another. Someone who pollutes the community with fraudulent research will be shunned. Conversely, if the scientific community does adopt a faulty theory, whoever demonstrates with clear experiment or calculation that the theory is wrong will be richly rewarded by their peers.

But keeping the discourse civil may not be enough. We often address scientific controversies in the adversarial manner of a courtroom trial, with two sides staking out their positions, each trying to disprove the other. When there are competing hypotheses, scientists often feel passionately about the superiority of one or the other. One of the best ways to settle such disputes is to test the propositions against observations or experiments. Eventually, an incorrect hypothesis will be disproved.

The problem, when we must use the science to make policy, is that sometimes it takes a long time to settle scientific disputes with great certainty. Disputes over what caused the ice ages were not settled until the mid-1970s, more than forty years after the correct explanation was first proposed. The question whether continental drift was real lasted from 1912 until almost 1970.

It is fine for abstract science to take many decades to settle its conflicts, but if we are worried about pollution poisoning our children or global warming raising the sea level and flooding coastal cities we cannot wait until we are completely certain of the answer. Sometimes, as Condoleezza Rice said about Saddam Hussein, “The problem here is that there will always be some uncertainty about how quickly he can acquire nuclear weapons. But we don’t want the smoking gun to be a mushroom cloud.”

The same is true of global warming. So far as we know, the hurricanes we have seen in the last two years, and the catastrophic flooding of New Orleans, have nothing whatsoever to do with global warming. We do predict serious consequences, such as rising sea levels, as the climate warms, but scientists cannot say with any great certainty whether warming will make hurricanes more frequent or more severe. Perhaps the hurricanes will be worse, perhaps not. By the time we find out, it will be too late to change our course.
Where science is able to settle matters with conclusive experiments it doesn’t matter what the scientist’s personal or political opinions are. Democrats, Republicans, Libertarians, and Communists all agree on the chemical structure of DNA. Ideology has nothing to do with it. Although it has taken a long time to get there, even scientists who work for tobacco companies agree that smoking causes lung cancer and heart disease. But when science is uncertain, while the controversies are still alive, we must ask the scientists not just for their knowledge but also for their opinions, for their gut feelings. In these circumstances, trust does not come easily.

At these times, scientists must learn humility. There are some areas in which they can speak with complete authority because their theories, such as the theory of relativity or the theory of evolution, are solidly established. In other areas, there is no solid theoretical foundation and scientists must take care to distinguish things about which they are certain—that we are indeed warming the climate by burning fossil fuels—from those about which there is great uncertainty—the actual damage that climate change will cause.

If scientific experts could be clearer and more accurate in telling lawmakers and the public what they know with certainty and when they are uncertain and merely speculating it would be easier to decide when to defer to their judgment and when to turn the question over to the people or their elected representatives, but even the scientists may not know. Repeated studies have showed that experts tend to be overconfident about how much they know—they tend to understate the degree of uncertainty in their predictions and pronouncements.

Congress and the public must learn to make decisions under uncertainty. If we remain paralyzed until we have conclusive evidence it may be too late.

Political Bias

A final problem is that scientists’ political beliefs may affect their scientific judgment even when they think they’re being objective. In 1980, a political scientist asked a number of experts on nuclear power to answer a series of scientific questions about future energy resources, such as how the supply of uranium, the demand for electricity, and the price of solar power would all change over the next ten years. Surprisingly, although there was no scientific relation between the questions—the supply of uranium has nothing to do with the price of solar power—the respondents’ answers to the scientific questions fell into one of two groups. It turned out that people who politically favored a program to build a certain kind of nuclear power plant gave answers to the scientific questions that supported that program and people who opposed the program gave scientific answers that did not support it. Only a small number of people had some supporting answers and some opposing. The fact that people's answers lined up so neatly with their political opinions suggested that their politics had swayed their scientific judgment.

This puts us in a difficult position regarding expertise. On the one hand, we need scientists to help us understand the choices we face in many public policy decisions. On the other hand, when the science is uncertain, then the expert’s gut feeling about the science will almost certainly be influenced by personal or political opinions and thus not clearly better than the public’s opinions.

Conclusion

My hope is that if the public, its representatives, and scientific experts can engage in respectful conversation instead of hostile shouting; if we can assume that those who disagree with us are sincere, although they may be mistaken; if we can be as attentive to the beam in our own eye as to the mote in our opponents’, we will be able to make better use of scientific expertise and achieve better results for ourselves, for our environment, and for the legacy we bequeath to our descendants.

But this kind of trust must be earned on all sides, so the question I struggle with as I watch what could be substantive and productive debates over environmental policy descend into mud-wrestling,
is how scientific experts and the public can begin a civilized, respectful discourse that can lay the foundation for trust and learning.

After directing the British Government’s investigation of the biological and medical effects of the atomic bomb at Nagasaki, Jacob Bronowski wrote,

What science has to teach us here is not its techniques, but its spirit: the irresistible need to explore. … It has created the values of our intellectual life and, with the arts, has taught them to our civilization. Science has nothing to be ashamed of even in the ruins of Nagasaki. … The shame is ours if we do not make science part of our world, intellectually as well as physically …. The values by which we are to survive are not rules for just and unjust conduct, but are those deeper illuminations in whose light justice and injustice, good and evil, means and ends are seen in fearful sharpness of outline.

Indeed without these values, all that science provides for us is, in Thoreau’s words, “improved means to an unimproved end,” On values, scientists have much to learn and we would do well to be humble in our opinions of what should be done with the scientific knowledge we have to share. As we join in the search for eternal moral truths that can guide us as we break a trail into an unknown future, we might remember the words of Gandhi:

Truth is not to be found by anybody who has not got an abundant sense of humility. …
The seeker after Truth should be humbler than the dust. The world crushes the dust under its feet, but the seeker after Truth should so humble himself that even the dust could crush him.