NUCLEAR POWER, RAPID TECHNOLOGICAL ADVANCEMENT, AND DEMOCRATIC VALUES

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I want to raise some large, generic questions about the compatibility of democratic society with the kinds of problems which this Symposium has addressed. In many respects the problems associated with nuclear power, while unique and dramatic in some ways, really illustrate a much more general phenomenon. Few have recognized this phenomenon, however, and neither political nor legal mechanisms have evolved to respond to it.

This phenomenon involves the nature of modern science and technology, the nature of the modern technocratic state, and the blurring of the lines between the modern state and multinational corporations with respect to that emerging technology. Its effect has been to threaten the constitutional values of individual liberty, freedom, and democracy. Our legal and political institutions, after all, developed in response to 18th century conditions. If modern forces beyond those contemplated two hundred years ago are straining those institutions, then we should all be concerned about the security of the values that these institutions were meant to protect. The problem, therefore, is precisely political, but it requires a larger understanding of what is going on and how the nuclear power controversy is symptomatic of a more general problem.

I

THE TECHNOCRATIC STATE

The development of a modern, technocratic state, including the conscious and rapid development of technology to solve particular problems, is a recent phenomenon. This phenomenon is fundamentally different from that of the Industrial Revolution of the 19th century. The Industrial Revolution did not significantly alter the political and legal institutions that developed in the 18th century to reflect the values codified in the Constitution. The modern, technocratic state, on the other hand, has already changed the way major life-affecting decisions are made and has shifted the power to make those decisions away from democratic institutions to various experts with "special" knowledge. This shift has greatly strained our institutions and has seriously threatened our traditional values.

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There are several characteristics of the modern science-state. All of them are exemplified by the development of nuclear power, but they are not unique to nuclear power.

A. Unintended Effects of Technology

The first characteristic of today's science-state is based on the notion of unintended effects. What has happened consistently over the last thirty to forty years is that we have achieved the technological capacity to produce magic potions. These magic potions do all kinds of wonderful things, but in addition they often have other, unintended effects. These magic potions are the new synthetic compounds of many kinds: plastics, pesticides, herbicides, food additives, drugs, detergents, and various industrial products. Although they have been part of our lives for some time now, we have not yet really assessed the cumulative, long-range unintended effects of many of these products.

A few among us have sounded alarms. One of the first books that brought this problem to public attention was Rachel Carson's *Silent Spring*.[1] Barry Commoner was sounding similar warnings twenty years ago.[2] But, by and large, the development of these magic potions has continued at nearly exponential rates without regard to their secondary effects; effects that consumers were unaware of and that often may be long in duration or irreversible.

As the variety and quantity of such products and technologies explode, it becomes crucial to anticipate their unintended effects before commercialization because, besides having economic and environmental effects, their development will affect democratic values. The prediction of those unintended effects is usually the province of expert scientists and technologists who attest in great numbers to the safety or to the limited side effects of a particular product. Usually other experts contest their testimony, and these rival experts often seem more worried about what is not known than assured by what is known. These disagreements arise out of fundamental, philosophical differences in approach. But as the experts contest, the rest of us sit on the sidelines, unsure whom to believe, and find it increasingly difficult to trust our own judgments and senses. That uncertainty has grave implications for the functioning of a democratic society.

But it is important to look at the record and to ask, now that a few decades of these developments have elapsed, if the assurances given by experts were right. Were the scientists and the technologists who were so good at developing magic potions also good at anticipating their secondary effects? The answer is, not always. Too often the experts failed to anticipate adequately the unintended effects of their wonders. There is also reason to

1. R. CARSON, SILENT SPRING (1962).
2. *E.g.*, B. COMMONER, SCIENCE AND SURVIVAL (1963).

believe that, in general, experts cannot predict the unintended effects of new developments with sufficient certainty. A few examples demonstrate this proposition.

In 1962 there was Project Starfish.[3] These were nuclear explosions in the stratosphere which created artificial radiation belts. All of the careful calculations about the extent and duration of those belts and about the damage that they might cause were grossly off.[4] The experiment proceeded based on "expert" assurances, but the assurances turned out to be wrong.

Synthetic chemicals provide similar examples. Industry committed itself to large-scale production and distribution of synthetic detergents before realizing that they were not biodegradable.[5] Similarly, agriculture became committed to the large-scale use of pesticides and herbicides before understanding the hazards they posed to plant life and ultimately to animal life, including human life.[6] Commercialization occurred because the "experts," those whom we thought were in the best position to know, believed that the side-effects would be negligible or not significant enough to outweigh the benefits. Those experts were wrong.

These mistakes were not merely political. Nor were these mistakes made for venal reasons of self-interest alone or by people knowingly acting as corporate apologists. These mistakes in fact reveal something important about the nature of knowledge, about the limitations of science and technology, and about the inability of analysts to predict these external effects with sufficient certainty.

The history of science demonstrates the frequent inability of even the best scientists to anticipate the effects of current developments. The Wright Brothers' flight at Kitty Hawk provides an excellent example. Shortly after that feat, reputable scientists predicted that air travel would never attain commercial significance. Those predictions were not based upon mere conjecture, but on what they considered the immutable laws of physics. This is by no means the only example of such spurious certainty.

Other examples are legion. The great British physicist Ernest Rutherford, less than a decade before scientists were able to sustain nuclear chain reactions, said that it was not possible to control atomic energy to any useful extent. Similarly, forecasts by distinguished scientists about the growth and spread of nuclear weapons have consistently underestimated the extent and rapidity of proliferation, especially during the critical, early years of development. This mistake had substantial political consequences. The myth of the secret of nuclear technology was in significant part derived from the predictions of many scientific experts that no one else could soon duplicate the technological advances that the United States had achieved. That predic-

3. *See, e.g.*, N.Y. Times, April 25, 1962, § 1, at 1, cols. 7-8.
4. *See, e.g.*, B. COMMONER, SCIENCE AND SURVIVAL 49-52 (1963).
5. *See, e.g.*, N.Y. Times, June 4, 1962, § 1, at 31, col. 1.
6. *E.g.*, R. CARSON, SILENT SPRING (1962).

tion encouraged the political witch hunts of the 1950's by supporting the belief that the Soviet Union could not have developed nuclear weapons without the aid of espionage.

The tendency of experts to underestimate the effects of technological development is inevitable, revealing a limit of human knowledge. To deal with science and technology, therefore, is to deal, at least in some degree, with the unknown. As one savant put it, "You pay your two bits to walk into a darkened room, but you don't know what's inside until you get there."

It is as if I presented you with a glass of clear liquid and told you that it might be water, but it might also be poison that would taste like water, and you could not tell for sure until you drank it. Of course, once you drink it, there is no way back. Faced with that decision, who among us would drink the liquid or be willing to rely upon the assurances of experts that the liquid was "probably" water? That is precisely the kind of risk we often face in the modern world. The reason why there is so much passion over the issue of nuclear power is that many people sense the nature of the risks and the limits of our knowledge and refuse to rely on the assurances of experts.

B. The Rapid Pace of Modern Technological Expansion

It is important to recognize that this risk-phenomenon has always existed, but that the nature of the risks involved has changed radically. Only the duration, magnitude, and irreversibility of the unanticipated effects of modern technology are new. During the Industrial Revolution, factories were opened before they were safe, boilers blew up, steamships foundered at sea; as a consequence, lives were lost. However terrible it was for the victims and their families, the effects of accidents in mines, factories, steamships, and railroads were limited in time and in magnitude. One the other hand, the unanticipated effects of much modern technology are far more dangerous. As our magic grows stronger, as our power increases, the danger from side-effects also increases. Moreover, the time frames for modern technological development have changed. The entire process has become much faster, and that decreases the ability of science to get feedback in time to respond.

At precisely the time when the danger of side-effects has dramatically increased, our capacity to learn of the danger in time has diminished. For example, in about 1830 Michael Farraday developed the theory of electromagnetic induction which laid the basis for the technological development of electric generators. But it was approximately thirty years before the first generator was built and another twenty years before the first commercial generator in New York City was actually functioning. This time span between the development of a scientific theory and the development of a corresponding technology is fairly typical. The significance of this kind of time span is that basic scientific knowledge was constantly developing dur-

ing the thirty to fifty years before the technology was committed to widespread use. Developments occurred incrementally, and there was time to change, to adjust, to become aware of side effects and to attempt to control them. That was possible because of the relatively slow rate of technological development.

But the time frames of modern technological developments are often very short. When, for example, the ozone layer is affected, it happens in a very short period of time. But meanwhile all those spray cans are out there, and nobody knows what's happening in the upper atmosphere. Everyone enjoys the convenience of using aerosols, but no one is aware of the unintended side-effects. When we become aware, it is sometimes too late to repair the damage.

It seems to me that open and vigorous democratic debate prior to the development of technologies with particularly grave potential consequences becomes especially crucial in a way that it never was before, and yet it is precisely in this context that these decisions are being withdrawn from public debate. There is secrecy, highly technical information accessible to very few, and resistance to public hearings prior to the development of certain technologies. Only the assurances of experts serve to guide public opinion. All this is very dangerous to democratic decision making. Thus, there is a need to develop some mechanism that, in effect, assures the informed consent of the potential victims of certain technologies. This is essentially true if there is a significant possibility that such victimization may be irreversible and its full extent unknown.

II

THE PARTICULAR CASE OF NUCLEAR POWER

The movement against nuclear power is a reaction reflected in a number of human myths throughout the ages: the countless genies coming out of bottles, the clay Golem of Jewish legend, and the Frankenstein monster, among others. These human myths, in one way or another, express an instinctive fear about the unintended consequences that may attend our creation of a supernatural power capable of doing wonderful things. These myths express the dark side of the wonderful image of magic, the danger inherent in the ability to create a source of unlimited power to do our bidding and to make life as it has never been before. The allure of such mechanistic slaves and their capacity to make life better, easier, less trying, is precisely the appeal of new technology. But in every one of those fearful myths, what happens? The slave turns out to be uncontrollable, it inevitably turns on its creator in an amoral way and consumes those who would have benefited from it.

This unpredictability is, in part, what troubles people about certain technological developments in general and the development of nuclear power in particular. People are worried that nuclear power may, in fact, be

our own "sorcerer's apprentice." In Goethe's *Sorcerer's Apprentice*, one may remember, the magician gives the apprentice instructions to fill up the receptacle with water and leaves. The apprentice then decides to play with the sorcerer's magic, using his broom to fill up the receptacle because the apprentice is too lazy to do it himself. Soon the vessel is filling up with water, and everything is wonderful. Then, however, it starts to overflow, and the apprentice cannot reverse the spell. That is the part of the magic that the apprentice did not know or did not worry about in advance. Just as the apprentice is about to drown the magician returns, godlike, and cancels the spell.

The *Sorcerer's Apprentice* is an interesting myth, but of course the magician may not return in real life. A more typical story, related by Norbert Wiener in his provocative book, *God and Golem, Inc.*, is W.W. Jacobs' famous horror story, "The Monkey's Paw." In that story, you may remember, an English working-class family, parents and their son, are meeting with an old friend, a soldier recently returned from India. The son, after dinner, goes to work on the night shift at the local factory, and the soldier takes out a dried monkey's paw which he says he got from an Indian magic man. He says that three people owned this paw and that the paw allowed each owner three wishes. He then tells the couple about three unintended, terrible consequences of what would appear to be a wonderful power. The soldier says that although he does not know what the first two wishes of the initial owner of the paw had been, the owner's third wish was for death. He himself was the second owner, and he says that what happened to him was too terrible to relate. He then throws the paw into the fireplace to burn.

The couple, anxious to avail themselves of the paw's wonderful power, retrieve it from the fire, and the man wishes for £200. Shortly afterwards, there is a knock at the door; it is a representative from the factory to tell them, sadly, that their son has been killed in an industrial accident and to give them £200 in compensation. Horrified by this, they make their second wish, to have their son back. There was a loud wind outside and a knock at the door, and they realize that their son is back, but not in corporeal form. They do not open the door, and their third wish is for the ghost to go away. The story ends.

The lesson, of course, is that when you play with magic you get what you ask for, not what you should have asked for, and certainly not what you intend. Jacobs' story reflects a belief that magical power is dangerous, that it is never possible to know what its unintended effects will be or what conditions one should have set upon the things desired from the outset.

III

Technocratic Responses to Technological Problems

Of course, the experts have answers for those problems. They have developed concepts like "feedback" and "fail-safe" that imply control.

Feedback is wonderful, but there must be time to feed it back if it is to be helpful. Driving a car is a perfect example of how feedback works. When you drive a car at a manageable speed, and you turn the steering wheel or step on the gas or the brake, the car reacts. That is feedback. The results of your actions are fed back to you, and if those are not desired results, you adjust; you do something else to correct the car's course. But suppose there was a new car that was guided by photoelectric feedback. If I were riding in such a car for the first time, I would want to have a mechanism available to override the photoelectric system and to regain conventional manual control in case the new device were to malfunction. But if the car went too fast, it might not be possible to regain control in time. That is potentially the situation with respect to certain technologies. If the use of a technology increases so quickly that the message that something is wrong arrives too late, the feedback has failed to work.

Therefore, dangerous technological mechanisms must include automatic override devices in case something goes wrong which either shuts down the mechanism or slows down the process. These are called fail-safe devices, and they are designed to sense critical dangers and to take over automatically. In nuclear reactors, such devices are designed to contain accidents, to limit damage, and to dampen the process.

But in order for fail-safe devices to work, they must be designed to sense the danger, and that means we must know in advance what the danger is. They cannot work if the danger is unknown or probabilistic. That is why it is so important to remember that when dealing with new technologies we do not always know what the danger is. John Barton, for example, said earlier that we are continually designing responses to the prior danger and are deficient in foreseeing the next danger.

IV

THE IMPLICATIONS FOR DEMOCRATIC VALUES

Faced with such situations, how are citizens to make judgments? What happens to a democratic society when such judgments become too complex for the average citizen to comprehend and are ceded to "experts" who claim to be in a better position to know and who often exaggerate how much they know? What happens to the basic value of democracy when we lose the ability to control our own lives and to make decisions about matters that affect our lives?

Much of the information that we need to make such judgments is kept secret, and that information which is available is often difficult for most of us to understand. The rapid development of new technologies and the commitment to large-scale use of such technologies are often not effectively subjected to prior public debate, and we are often urged to rely on experts. We stake our lives on believing those experts, but we have no basis ourselves to know how trustworthy their recommendations are. In consequence, we are forced to make decisions in these matters all the time on faith.

In fact, modern governmental and corporate technocrats are a new priestly class. They make pronouncements, and we choose which priests we like and follow them. But few of us really understand what any of these new priests are saying. What we are left with is faith, not knowledge. Paradoxically, then, the expansion of human knowledge points up the poverty of individual knowledge. The great age of science thus leads to an age of personal ignorance and eclipses personal judgment.

It may well be that the protest against full-scale development of nuclear power is an attempt to reject the assurances of experts, to reassert the importance of personal judgment, and to regain control over decisions that may affect our lives. If I am correct in assuming that nuclear power is a dramatic example of a generic problem, then it is perhaps useful to focus public attention not only on nuclear power *per se*, but also on the political culture that supports basic democratic and libertarian values. Perhaps it is useful to conclude by asking ourselves what has been happening during the past quarter of a century and to what extent have the values of liberty and democracy already been incrementally eroded by the modern state?

I believe that the erosion has been substantial and that the habits and instincts of liberty have gradually given way to the imperatives of the modern state. We have succumbed over and over again to the argument that basic liberties are no longer "practical." For instance, once there was a strong presumption in our political culture against peacetime conscription, but twenty-five years of draft laws passed routinely, and almost always without public debate, have changed all that; not even the revulsion against the war in Vietnam has re-established the public attitudes about conscription that existed until World War II. Officials now represent conscription as a necessary evil in the modern world, and those who oppose it no longer seem to represent the mainstream of our political culture.

Even those who oppose conscription in the absence of a declared war appear to accept without serious argument the legitimacy of a standing army. The authors of the Federalist Papers, on the other hand, warned of the corrosive effects of a standing army upon civil liberties. "[T]he liberties of Rome," wrote James Madison, "proved the final victim to her military triumphs, and . . . the liberties of Europe . . . have, with few exceptions been the price of her military establishments."[7] Evidence of that insight abounds in contemporary America, yet the common mistrust of a permanent standing army has given way to the imperatives of the modern state and the judgments of military "experts."

Moreover, secrecy is the norm. The right to information struggles vainly to establish itself. The classified state is now accepted, and all we fight about are the exceptions. Spying, furthermore, is routine. Everybody spies. It is nearly unthinkable to oppose peacetime spying. Indeed, national

7. THE FEDERALIST No. 41 (J. Madison) *in* THE FEDERALIST 271 (J. Cooke, ed., 1961).

security "experts" tell us that in the modern world there is no such thing as peacetime. We are now in a constant state of potential war, they argue, and so measures that once were anathema to a free society and permissible only during wartime are institutionalized as a necessary feature of the modern state.

The metaphors of war and its methods have by now infected the larger political culture. Electronic surveillance and wiretapping have become accepted practices. There was a time when civil libertarians vigorously argued that wiretapping and electronic surveillance were *per se* violations of the fourth amendment and that there was no way to narrow wiretapping consistent with the dictates of the fourth amendment. That argument is rarely heard anymore. In fact, there is nowhere to make that argument. There is no room to make it in the courts, there is no room to make it in the legislatures, and I hardly ever hear it made in any public forum. We now merely argue over the relative degree of the violation and abandon all hope of resisting the violation itself.

Further, regarding privacy, there was a time when people would not have believed that Social Security numbers would be used as universal identifiers. Indeed, people would have vigorously resisted such use. Architects of the Social Security Act provided assurances that one's Social Security number would never be used beyond the purposes for which it was intended; without those assurances, that aspect of the legislation would have been in jeopardy. Yet today the Social Security number has become a universal identifier, and there is hardly any protest.

Changes like these are fundamental, but they generally go unnoticed because they occur so gradually. Bertrand Russell used to tell a story about incremental change and its effect. He posed this philosophical problem: Suppose you were sitting in a bath of comfortable, tepid water, and somebody arranges to increase the temperature of the water by one degree every few minutes so that the change in the water temperature is imperceptible. The process continues, said Russell, unnoticed. He then posed this question: Why, at some point, do you begin to scream? Well, that is the nature of the changes which have been occurring for some time. And now we are screaming. Whether or not the scream is too late, it is certain that the water is already pretty warm. The process of change is not being contained, and it is not being slowed.

The full-scale commitment to nuclear power has caused some people to notice the change, and they have begun to yell. But nuclear power, however important in and of itself, is symptomatic of a larger problem. I believe that if we are to preserve the values codified in the Constitution and in the Bill of Rights, then we must reassert ourselves, regain confidence in our own judgment, rely less on the assurances of those who claim they know, and begin to restore our sense of liberty. The task, as always, is fundamentally political.