Chapter 6: Health Risks 1968–1969*

THE ENVIRONMENTAL CONSEQUENCES of post-war industrialization and commercialization did not turn out to be biologically neutral, as had initially been generally assumed. Instead, many agents added to the environment as consequences of economic development proved to be capable of impacting human and animal physiology, thereby creating a central problem of modernity — health risks caused by side-effects arising from man-made agents in the human environment. Occurrence of the health risks, both consensual and non-consensual, posed challenges to Handler at multiple levels. He seemed unable to offer any practical solution; instead, he offered only rhapsodic praise for biochemical research and ritual promises of progress that never developed. His carefully nurtured image as a credible source of advice concerning national science policy was jeopardized by his inability to frame a solution to the health-risk problem, which was only one of many science-related problems that had developed during the post-war years. Worst of all for Handler, the ideas of epistemological specialness of biochemistry and, more generally, the putative role of science as an independent estate in society, were palpably receding. The ideas had originated in his head when he was a sixteen-year old socially backward schoolboy, and they metastasized to the parts of his brain that controlled imagination, ambition, and desire, and determined what occurred thereafter in his professional life. In the latter part of the 1960s, as the public-health consequences of the development of industrialization and commercialization became progressively more apparent, Handler's edifice concept of science comported less and less with reality. He continued to fight tenuously to make reality conform to his vision of what it should be, but he was no longer respected as a man with pertinent policy answers or someone who could continue to tap the public treasury on behalf of biochemists.

Handler's reaction to the onset of the national problem of health risks was presaged a decade earlier, when the first substantive indications that an agent thought to be harmless might not be so emerged from epidemiolocal studies that linked smoking to cancer. The evidence prompted federal officials to warn the public about the health risks of smoking; Handler was the only presidential science advisor who opposed the warning. He said the evidence was insufficient because it was not biochemically based and therefore unscientific. Handler argued against proposals to ban smoking and demonstrated his sincerity by declaring his intention to personally continue smoking until a biochemical mechanism linking smoking and cancer was proven. He used his influence at the Institutes to prevent funding of studies of cancer causation whether from smoking or otherwise. Instead, they supported only studies based on the theory that cancer was a breakdown in the body's biochemical mechanisms, like a faulty gear or a leak in a cylinder, phenomena not directly related to environmental factors. When the question of the nature and extent of the impact of environmental agents on human health gained status as a national problem, Handler took the same position he had taken earlier with respect to tobacco. According to him, all government-supported biomedical research should be based on the theory of biochemical reductionism, and no regulatory action was warranted until the biochemical mechanism that linked a specific agent to a specific disease or

* This is a preprint of a manuscript that will undergo copyediting and review before publication in final form.

adverse condition was conclusively proven. As an example of the successful implementation of his advice, he explained why people who drank polluted water sometimes turned blue; nitrites in the water reacted with the iron atoms in blood hemoglobin rendering them unable to carry oxygen, resulting in methemoglobinemia — blue skin. Handler promised that basic biochemical research, if adequately funded, would similarly explain all other environmental dangers.

At about the same time Handler began forcefully denying the reliability of epidemiological studies and proselytizing for a test-tube approach to the problem of health risks, another scientific method of biological experimentation developed whose probative power was superior to that of epidemiology — gold-standard studies. The studies employed animals as human surrogates for the purpose of discovering evidence concerning a potential causal relationship between a man-made environmental agent and a change in a physiological parameter measured in the animal, a so-called biological effect. Investigators who undertook gold-standard studies, mostly working in government-agency research laboratories, did so because the agencies recognized that some kind of protection for the public was needed, but that relying solely on biochemical experiments of the type favored by Handler was financially and scientifically impossible for purposes of evaluating the threats to public health from the hundreds of thousands of man-made agents being added annually to the human environment. Gold-standard studies, in contrast, provided reliable and verifiable information that could serve as a rational basis for regulators to set reasonably safe levels for emission of and exposure to potentially harmful environmental agents. The studies were similarly useful for establishing safe levels for chemical contamination of food and water and for determining side-effects of drugs. The absence of a reductive experimental approach to the problem of evaluating health risks was reason alone for Handler to develop his enduring enmity toward reliance on gold-standard studies, and he deemed them as no more acceptable than epidemiology. Handler abjured gold-standard studies for an even more fundamental reason. The use of data from such studies to evaluate the scope and dimension of health risks was inherently a value-based judgement, because data never speaks for itself. In other words, the data had no intrinsic meaning with respect to human health but rather depended on the desired degree of public safety deemed appropriate as a matter of government policy. The notion of subjectivity formally entering the edifice of science was something Handler despised even more than the entry of conflicts-of-interest, bias, falsified data, and industry, military, or government control, all of which had begun to occur.

The issue of health risks insidiously undermined Handler's stature because it continually highlighted his inability to fulfill his promises about what biochemistry could accomplish. He was a biochemist by training and temperament but sometimes called himself a "biologist," always evading the problem of incommensurability between biology and chemistry when he did so. Properly produced data from chemists, like that from physicists, was characteristically certain and exactly reproducible; in stark contrast, properly produced data from biologists was characteristically neither — no biologist ever placed a foot in the same stream twice. Biology was an independent science and its experimental branch was primarily based on gold-standard studies; chemistry was a dependent reductionist subspeciality governed by rules extracted from physics and had no conceptual or practical link with gold-standard studies. Although related, biology and biochemistry were on different planes. Every biological experiment involved biochemistry because every living thing

depended on the occurrence of biochemical reactions. On the other hand, no biochemical experiment directly involved biology because life didn't exist at the organizational level where biochemical reactions occurred. When the issue of health risks due to environmental agents arose, Handler tried to move one of his feet from biochemistry to biology so that he could claim legitimacy for his ideas about health risks but, in truth, he was no more a biologist than he was a physicist or a mathematician. He never seemed comfortable calling himself a biologist, as if he were worried that the audience could see his nose grow a little longer each time he did so. And even assuming, counterfactually, that Handler was a biologist, his core idea — that if the Congress provided unlimited funds to biochemists they would discover biochemical-based knowledge of the biological effects of each man-made agent in the environment — was a double impossibility because the cost would be enormous and the possibility of success was nil. Even children could see that his blue-people story was only a rare exception to the norm that biochemical reductionism was a thoroughly inadequate scientific basis to address the looming massive biological problem of assessing the consequences of industrialization and commercialization on human health. Handler was not so foolish as to think that his science policy could solve the problem anytime soon, so he tried to shift the national attention from health risks to overpopulation, which he believed was eminently amenable to a solution based on biochemical research in the areas of birth control, genetic modification, and eugenics. However, the process of making meaning from animal data was well underway across a spectrum of federal agencies as Handler continued to search for a strategy to deal with the multifaceted problems of health risks, which were interfering with his plans for a national science policy that promoted scientism. In the meantime, like someone treading water, Handler persevered in the face of his difficulties even though he had little or no prospect of success when he argued that until biochemically-based knowledge regarding health risks was obtained, there should be no laws or regulations regarding protection of the public health from environmental agents produced by industrialization and commercialization, except for proven hazards.

Despite Handler's opposition, Congress approved the first federal law aimed at controlling air pollution and authorized research aimed at mitigating it. He lobbied against the law because it envisioned gold-standard studies and contained no provision for basic biochemical research. Shortly thereafter, again notwithstanding Handler's objection, the President's other science advisors issued a report about the deterioration of the quality of the environment which included a warning about global warming and a recommendation for "further research," by which they plainly did not mean basic biochemical research. Even the parent government agency of the Institutes warned about health risks when it called attention to exposure of workers to noxious agents in various occupational settings — a warning Handler considered unnecessarily alarmist because, he said, the alleged risks were based solely on epidemiological evidence.

Handler's emphasis of the notion of epistemological specialness of science was undercut by a new development — a rapidly developing reality that the meaning of the results of scientific studies depended on who paid the investigator to perform the research and interpret the results. The state of affairs developed after industry began hiring biochemists and contracting with university biochemists to conduct gold-standard studies whose results the researchers interpreted to mean that the polluting agents produced by their clients had no associated health risks. The tobacco industry

hired scientists who said tobacco didn't cause cancer, scientists working for the gasoline industry said the lead in gasoline was harmless, and the food-additive industry soon followed, and they further impeded Handler's attempt to portray the health risks as a purely scientific matter that should be resolved by basic biochemical research. Progressively, research regarding health risks was undertaken by a diverse array of scientists, some who had an honest purpose, some who did not, and confusion soon developed in the press regarding what was or was not a health risk. Various government agencies, some regulatory and some health-related, such as the agency that employed Becker and me, became the main providers of scientific evidence relevant to health risks. The Institutes remained firmly on the sidelines, with their metaphorical nose in the air so as to avoid the stink of real scientific problems while a dichotomy of objectives crystallized among those engaged in producing research data pertinent to health risks — the federal agencies sought to provide a rational basis for regulation and industry sought to produce doubt regarding the existence of health risks. There had been no source of funds for university biochemists to systematically study health risks; consequently, they were irrelevant regarding the health-risk issue. Soon, however, needing to support their families like workers in any other profession, they began leaving the universities in favor of employment in manufacturing industries and in a new industry — companies that could be hired to provide any desired form of research. The displaced biochemists also served in significant numbers as industry consultants and experts on blue-ribbon committees that were empaneled by various state and local governments to evaluate environmental health risks, and to testify as expert witnesses after civil litigation regarding health risks developed.

HANDLER WAS SURPRISED and rattled by the national controversy that developed concerning side-effects and pollution produced as a consequence of technological advancements. He initially viewed the issue as a commotion over an insignificant matter and perhaps even a good thing if congressional interest led to larger budgets for biochemical research. The competition of the Institutes and the Foundation with other federal agencies for government funds was becoming ever more fierce, which Handler recognized with characteristic rhetorical flair: "The problems encompassed by the cities, or the environment, or pollution can soak up vast sums from the federal coffer. Therefore, we'll have to be very persuasive, indeed, to compete for money with such programs." What once seemed to be unlimited public and congressional respect for science had eroded and, increasingly, science progressively became seen as a problem as well as a potential solution, and conflicting public views of the scientific enterprise developed. Some critics, pointing to the problems of pollution and side-effects, charged that science was harmful and that scientific activities should be cut back. Science supporters argued that it was merely a tool, and that no sane worker would throw away a tool because it wasn't used properly. The public was skeptical and no consensus developed whether the nation needed more or less science. What was clear, however, was that the age when scientists were revered as men who knew all the answers was over, and Handler's reputation was no exception. Handler promised the Administration and the Congress that basic biochemical research would eventually yield the requisite knowledge to resolve all the problems that seemed to be endangering public health. The deteriorating public attitude about science, however, consistently resulted in skepticism and questions about his credibility. Nevertheless, he continued to

oppose anti-pollution regulations, which he said were "unwarranted intrusions by government into business affairs," and to favor a national policy that erred on the side of industry which was necessary, he believed, to avoid creation of barriers to the introduction of new technology. His recommendations for interim protection of the public were to stay away from smog, avoid eating or drinking anything that was contaminated, and see a doctor regularly.

Federal agencies outside the sphere of Handler's direct influence responded to what they determined to be, at least politically, a health emergency. The agencies tasked their researchers to produce scientific evidence that would support any needed regulations regarding emission, exposure, and contamination limits to protect public health. The researchers utilized gold-standard studies on animals, the only scientific method that could provide relevant information about health risks, and the only alternative to Handler's advice that society should fund biochemists and wait for their results. The animal studies could identify exposure, emission, and contamination levels of environmental agents that provided reasonable protection for human health, but only if the data were interpreted in accordance with rules based on values — the experiments provided the data, the rules gave the data meaning, the values determined what the meaning would be. Handler failed to recognize the value-laden nature of environmental rules for the protection of public health – oppositely, he saw them as objective scientific statements and hence properly the exclusive providence of biochemists.

The choice to err on the side of safety was a central value in the government's approach to environmental rule-making. To compensate for the limitations of assessing human vulnerabilities to harm based on animal experiments — which typically lasted only a few weeks and involved a small number of arbitrarily chosen physiological parameters — a safety factor, usually one hundred, was incorporated into the regulations to err on the side of safety. Typically, if biological effects — phenomena that evidenced the agent under study was biologically active — ceased after the exposure level was reduced to a particular level, the agent was a candidate for approval for exposure of the public at up to one percent of the no-effects level. Throughout the 1960s, Handler viewed the government's gold-standard-study regulatory process as a foolish game, and the Administration's view of Handler's proposed biochemistry-research solution was no kinder — nothing but very expensive blue sky — and the gulf between Handler's ideology and the times only widened. In 1969, however, a proposal appeared regarding how the environmental dangers from nuclear power should be regulated. Soon thereafter Handler adopted part of the proposal and used it to form a strategy for making his biochemical approach to resolving the health-risk issue more palatable to the Administration and the Congress.

The federal government had embarked on a major program designed to encourage use of nuclear energy rather than fossil fuels for generating electricity, but gold-standard studies were unsuitable for estimating the risk because pertinent engineering and biological details about the pollution that would be produced were unknown. Attempts to develop safety regulations were further complicated by the innate ability of the electromagnetic energy emitted by radioactive atoms in nuclear pollution to cause genetic defects. They could occur not only in humans who were exposed to the pollution but, since the defects were heritable, they could be manifested in future generations, individuals who did not exist when the exposure occurred. Leaders of the burgeoning

nuclear industry devised a radical plan for overcoming the public's fears of the risks of nuclear power, the basis of which was the reconceptualization of all forms of risk as business uncertainties that were quantifiable in dollars by management experts. The plan's decisional methodology was the element that appealed to Handler. He saw the method as a solution to his problem of quieting the health-risk controversy while still preserving a privileged place in federal spending for biochemical research. The gist of what Handler took away from the nuclear planners was to switch the focus from the seriousness of the health risk to the approval process itself.

To allay public fears of nuclear pollution and meltdown, and gain acceptance of nuclear plants for generating electromagnetic energy as well as for a grid of suspended wires that transported the energy throughout the nation, industry leaders devised a managerial strategy in which the risks and benefits entailed by their ambitions were characterized in dollars, and then balanced against each other to rationalize their decisions. Industry engineers, using what they considered to be basic principles of engineering in conjunction with a jimmied analysis of recorded public data, devised mathematical equations that yielded numbers which arguably supported the industry's position. By means of the equations, numerical probabilities from zero to one —zero meaning impossible to occur and one meaning certain to occur — were attached to the risk of death from disease caused by the nuclear industry — the only risk recognized by the industry in its calculations. The calculations showed that the risk of nuclear power was defined by industry management as "acceptable" for the reason that it was smaller than the risk of being hit by a meteor, which was said to be a risk everyone accepted. In a similar fashion, using dollars to quantify benefit, according to the industry engineers, the equations predicted that the benefits resulting from construction of nuclear generating plants and a powerlines grid would be financially enormous. The industry's approach to problem of nuclear pollution, which was called "risk-benefit analysis" by engineers and "systems analysis" by management specialists, gained industry-wide support because it was seen as mathematically precise and free from the limitations of laboratory research. From the industry perspective, since the risks were acceptable, they should be considered voluntary, and therefore the industry was not engaged in a form of involuntary human experimentation.

Handler regarded the mathematically fabricated "risk" and "benefit" entities as absurd, and he rejected the idea that the environmental dangers posed by nuclear pollution were business uncertainties. His position remained that what was called a "health risk "was actually a corrupted notion of a "health hazard" — a biochemical reaction demonstrable in the laboratory. Handler also criticized the obvious conceptual flaw in the industry's weighing process: "Risks and benefits are incommensurable because they are assigned to different population groups," he said. Even so, the crafty Handler saw the persuasive power of the metaphor in which undefined fictional entities called "risk" and "benefit" were used to describe a weighing process employed to form decisional judgements regarding the design and construction of nuclear facilities. Similar "risk-benefit" language soon appeared in Handler's speeches with regard to side-effects and pollution from any source. He reconceptualized that the problem of side-effects and pollution was a biochemical uncertainty caused by a governmental uncertainty — its failure to fund the biochemical research needed to provide reliable knowledge of conditions and circumstances that were truly hazardous. Handler recommended that federal agency regulators "learn to make judgments by weighing risks

versus benefits“ before promulgating safety regulations but studiously avoided explaining what the two terms meant or how they would be compared. Essentially, he adopted the nuclear industry's analytical methodology but omitted explicit reference to the gears that made it work — the concocted engineering and management quantifiers called “risk” and “benefit” used to form judgements about nuclear safety.

Handler apparently had no actual science policy regarding how risk-benefit analysis would yield decisions concerning health risks from side-effects and pollution, how the causal role of the environmental agent would be determined, or how financial responsibility for injuries that resulted from faulty decisions that occurred would be assessed. Instead, he confined his speculations to a higher plane of social policy and described what he envisioned as a kind of third-party contract arrangement in which the industry that created the side-effect or pollution was the risk-giver, individuals who were actually exposed to an environmental agent were the risk-takers, and society in general was a third-party beneficiary. The nature of Handler's imagined contract was such that the risk-taker had no meaningful recourse if the risk-giver failed in its contractual duty to act safely resulting in injury to the risk-taker. Unlike the case where the risk-taker does so voluntarily — like a smoker who chooses to continue smoking despite government advice that smoking caused cancer — the overwhelming majority of risk-takers in Handler's scheme would do so in the absence of informed consent. Nevertheless, Handler explicitly endorsed the policy of shielding the public from information concerning possible risks and urging regulators to err on the side of protecting industry — which he stoutly denied was a position that made ordinary citizens guinea pigs for the industry's theory of safety.

Handler's motivation for nominally adopting risk-benefit analysis was part of his effort to defuse the health-risk issue, to impede the government's reliance on gold-standard studies, and especially to buy time for biochemists to perform basic biochemical research. But the Congress was uncooperative. Not only did it consistently refuse to provide the increased funding Handler sought, it began systemically decreasing annual appropriations for biochemical research. Nevertheless, Handler persisted in his efforts to secure what he regarded as adequative federal funding for basic research to resolve what he characterized as the “scientific uncertainties” that arose from side-effects and pollution. He advised the Administration that the uncertainties would be acceptable to the public if presented as only temporary — conditions that would last only as long as it took for the requisite research to be performed that would create a danger-free world. Handler further argued that even without the research, the public would accept some side-effects and pollution to maintain the present standard of living. Handler's position toward the problem of health risks was opposite to that of almost every other science-policy advisor in the Administration and to the scientists who worked for the federal regulatory agencies; he was supported mainly by university biochemists and those who worked for the chemical industry.

Handler accused the government of perpetuating the problem of side-effects and pollution because, according to him, in most instances, it had insufficiently supported biochemical research, and consequently lacked the knowledge to set safety and antipollution rules based on science rather than emotion. He called regulations rationalized by the gold-standard studies unnecessary burdens on industry with the further drawback of feeding what he said were “unwarranted fears and paranoia

in a gullible public." According to Handler, "It will take coordinated biochemical research efforts in the laboratory and in the field to obtain the knowledge needed to establish truly appropriate regulations concerning pollution." In the meantime, the public had to be patient because "We need time to acquire the understanding upon which to base such regulations." Handler promised, "The automobile exhaust emission problem, the water pollution and the radioactive fallout problem can be managed in a few years, probably." He said, "What I wish also to convey is that we yet have the time, that the way to a better tomorrow is more technology." But he was unsuccessful in persuading the public or the Congress that scientific-based solutions were on the horizon. As Handler's nose grew longer almost day by day, a general anti-science mood developed in the country — that science itself was the problem.

During his continuing search for a winning rationale or policy position, Handler began advocating policy positions he had previously scorned. The fountainhead of Handler's philosophy of science policy was his belief that biochemical research would yield a scientific understanding of all biology, including but not limited to human health and whatever endangered it. Throughout his career, he had little use for the social sciences, which he regarded as primitive activities that were incapable of producing true knowledge. His attitude softened, however, during the period when he confronted the problems of side-effects and pollution and saw that the solution he piped wasn't attracting followers. "In part, these problems arise because technology has been so successful," he said, but "the degree of understanding of man as a social creature is not yet adequate to solve our problems." Handler argued that technology gave mankind the ability to do almost anything, including to destroy itself, but it hasn't learned to manage technology because of a lack of social understanding. The solution, he advised, was to foster a cooperative relationship that would correct what he said was an artificial division between the humanities, social sciences and natural sciences — "three areas that work separately instead of together." He said, "One of the greatest present needs is to bring together the scientific and humanistic enterprises so that scientific discovery in the future will take place within the context of humanistic thought about how best to use the discoveries that are being made in the sciences." Biochemists and humanists, working together with mutual understanding, could solve many of humanity's problems, Handler said. He proposed that the government establish a new agency, a Department of Science, which would include all the social sciences as well as biochemistry and physics, and would be responsible for funding and overseeing all advanced studies and research supported by the federal government. However, given Handler's history of derogatory comments regarding the epistemological content of the humanities, he was probably the least likely person to catalyze a union of the humanities and physical sciences. Unsurprisingly, his proposal gathered no political support, which he interpreted as further government inaction that contributed to the decreasing status of science in society. He complained that government officials were "disenchanted and disheartened with science and technology, which have made the lives of at least three fourths of us richer, easier, longer, healthier and more comfortable than in any previous experience of mankind." Handler said the government had joined youth in holding the scientific community responsible for the "threats posed by nuclear, chemical and biological weapons, for all forms of environmental pollution, for contamination of air, earth, food and water."

Handler publicly identified two factors he considered primarily responsible for inflaming public concern regarding side-effects and pollution. The acute, superficial factor was the rhetorical behavior of misguided biochemists, and the deeper, more chronic factor was the public itself, which was not properly controlling itself and instead was reproducing far too much. Handler commenced a series of ad hominem attacks against the biochemists, mostly university professors, who directly warned the public about side-effects and pollution. For the most part, he didn't deny the existence of side-effects and pollution; rather, he claimed the biochemists — who invariably knew more about the scientific basis of the threat from the environmental pollutant than did he did — lacked understanding and perspective regarding the problems. Handler argued that scientists who spoke publicly were exaggerating the seriousness of the problems, and were misleading the public when they warned of unseen or unproven dangers. "The current wave of public concern has been aroused in large measure by scientists who have occasionally exaggerated the all-too-genuine deterioration of the environment," he said. According to Handler, "Their way of calling attention to environmental problems has turned much of the general public, many decision-makers, and a yet larger fraction of our youth against science." He warned ominously, "The nations of the world may yet pay a dreadful price for the public behavior of scientists who depart from established fact to indulge themselves in hyperbole." Handler blamed the activities of the scientists as the cause of the generally recognized public loss of popularity and respect for science: "The currently overly emotional worldwide awakening to the undesirable side effects of some facets of our technological civilization has led to diminution in public support for science."

His criticism of the scientists was coupled with general praise for technology, and a naked, hurtful claim that the objecting scientists actually weren't opposed to the manner in which some technology was being used., but rather were opposed to technology itself and favored a return to a pre-technology era. Handler's unprecedented attacks on scientists had a tone of desperation. Scientists had a long history of stridently criticizing one another, but what Handler did was particularly ominous because of his powerful position in the governmental hierarchy of science advisors, and the influence he exerted over the distribution of research funding. Handler had career-long affiliations with the Institutes, Foundation, and the Veterans Administration — all major government research-funding agencies, and he was not shy about using his power to punish scientists who disagreed with him.

Handler made sweeping accusations that scientists and others who warned about the dangers of side-effects and pollution were alarmists, and that they had no basis for what he said were their predictions of disaster, imminent doom, and the probable collapse of our civilization. But Handler himself did exactly what he accused others of doing; he began warning the public of his apocalyptic vision of the future caused by overpopulation, as if to encourage the public to put aside its fear of side-effects and pollution and adopt his fear. He said: "The greatest threat to the human race is man's own procreation. Hunger; pollution; crime; overlarge, dirty cities — even the seething unrest that leads to international conflict and war — all derive from the unbridled growth of human populations. It is imperative that we begin a research campaign in human reproductive physiology. Our present knowledge is very primitive." His thesis, advanced without any rational analysis of pertinent factors, was that the goals and institutions of society were unsustainable because of the

rate of population increase. The salient question was the nature of the limits that gave rise to the growth ceiling. The possibilities included limits of arable land, the supply of clean water and minerals, the unanticipated consequences of technology that can blunt and sometimes obviate its benefits, the threat of nuclear war, and the staggering inequality in the international distribution of wealth. But Handler blamed only overpopulation, like a sentry who sees wolves on a far distant hill but not the lions behind nearby bushes.

Handler's passion about overpopulation was entirely biochemically-based and motivated by his perennial objective of increased funding for biochemists. According to him, overpopulation was caused by lack of knowledge concerning birth control and by genetic defects, both of which could be remedied if the public supported biochemical research. Inexplicably, he believed people whom he considered too dumb to refrain from having babies the world couldn't support could nevertheless be intellectually persuaded of the importance of biochemical research. He lacked the understanding that mobilization of an attitude to bring about social action required something more than biochemical-based argumentation. Although Handler repeatedly delivered his message, it never gained acceptance. The opposite. Handler was scorned by social scientists, economists, and political scientists for the amateurishness of his foray into their areas of expertise.

Undaunted, Handler made still further attempts to deemphasize the health and environmental significance of pollution. He argued that pollution was nothing new, but rather had existed ever since civilization and urban life began. Further, he claimed that today's cities were cleaner than ever before, and that the presence of pollution was known only because technology permitted its detection and measurement.

DURING 1966 AND 1967, HANDLER labored assiduously on the biology project, which was the most expensive and complex effort in analysis of science policy and provision of expert advice ever undertaken by the Academy. His goal was nothing less than a description of everything known about what he considered to be biology, an elaboration of a plan for the research needed to increase biological knowledge, and a prediction of what would ultimately happen depending on whether or not the plan were followed. Handler brought to Washington several hundred members of his two dozen subcommittees, some as often as three times a year, to manage draft reports from the subcommittees. Handler attended subcommittee meetings, edited their drafts, supervised his staff's statistical analysis of the replies to the questions posed in thousands of questionnaires he sent, and responded to innumerable questions he received from individuals associated with the project. But even though Handler worked fifteen-hour days on the project and on managing the Foundation, he was unable to complete the project within two years, as planned. Early in 1968, frustrated because the project was only half done, Handler decided to resign as the project head and so informed Seitz. The bureaucratic structure of the Academy and Handler's authoritarian manner probably accounted for most of the difficulties he encountered, but from his perspective the problem was his lack of institutional authority and the uncooperative attitude of the Academy staff.

Unknown to Handler, Seitz had decided to resign as president of the Academy and become the head of a major university in July. Seitz intended the biology project to provide a basis for reshaping the government's policies regarding financial support of biology, which would be the

capstone achievement of his career in government service. But he had no credible replacement for Handler; there were exceeding few biochemists in the Academy, and none who had Handler's rapport with the Congress — a critical consideration for Seitz because the goal of the project was to raise money for basic research. Absent acceptable options, Seitz made Handler an offer he couldn't refuse —the Academy presidency.

Many years later, Seitz confessed that he respected Handler's managerial and fundraising abilities, and his ability to talk science at the layman's level, but that from the beginning of their relationship he had doubts about Handler's motives. Seitz said he had suspected Handler might try to use the Academy as a platform to espouse his own views and had consistently tried to impress on him the importance of its historical role as advisor to the government. But Seitz never understood Handler's deep motivations or the dimensions of his ideology, so he never realized that there was a scant likelihood of influencing Handler, whose mind about what was important had been made up ever since he had read *Arrowsmith*. Despite his concerns, Seitz promised to take the steps necessary for Handler to become the next Academy president and to provide all the support he needed to complete the biology project if he remained as its head. Handler desperately wanted to be president but felt he could not complete the biology project and manage the Academy at the same time he was serving as the head of the Foundation. Additionally, the appointment would raise significant adjustment issues for Handler that included resigning from Duke, terminating his research grants from the Institutes, selling the home he built in Durham, and making suitable living arrangements in Washington DC for his wife, who was wheelchair-bound and could not live in the Academy's presidential mansion. Seitz closed the deal by promising to technically postpone his retirement from the Academy for a year after he commenced working for the university. Under their arrangement, Seitz remained the official president but all major decisions would be cleared with Handler, who was granted the authority to resolve the project-related difficulties he experienced with the Academy bureaucracy. Immediately after the parties agreed, however, Handler committed what Seitz regarded as a serious blunder. When President Johnson declined to run for president, Handler urged his vice-president, Hubert Humphrey, to become a candidate, and Handler offered his services as an organizer of a scientists-for-Humphrey committee. Handler believed Humphrey was the candidate most likely to end the Vietnam War and restore the government's cuts in funding for scientific research. Seitz strongly disapproved of Handler's political activities and threatened to cancel their arrangement unless he disavowed his planned partisan activity on behalf of Humphrey. Handler capitulated. He publicly dissimulated his actual attitude concerning the role of politics in science by publicly proclaiming that politics has a damaging effect on the purity and professionalism of scientists:

> I have become increasingly aware that the organization of partisan groups of scientists supporting individual candidates for high political office threatens to generate serious rifts in the scientific community, 'dividing the house' as it were, whereas the issues which separate them are entirely external to science itself and indeed external to the application of scientific solutions to the problems of our nation.

> Accordingly, I now consider the formation of such groups to be ill-advised and, potentially, a disservice to our society. Scientists, like all other citizens, are free to engage in political campaigns. But they should do so as citizens, with other citizens, not as scientists. Should political campaigns continue to include such organized groups of partisan scientists, it is inevitable that national attitudes and federal support for science must also come to involve political considerations. Appointments of scientists to administrative posts in science-using agencies and appropriations for federal support of science will surely be influenced by the political activities of those concerned and our nation will suffer.

Handler's about-face satisfied Seitz; after he announced his approval of Handler as his successor, all credible potential opponents disavowed their candidacy, and his was the only name on the ballot in an election in which only a tiny fraction of the membership participated. Seitz's ability to deliver the presidency to Handler revealed the hollowness that was at the heart of the Academy. There were complaints the process resembled elections in Communist countries, but the reality was that the political power in the Academy rested in the president and derivatively in the board of directors, neither of which answered in any meaningful way to membership.

BETWEEN HANDLER'S ELECTION AND INAUGURATION, he used his authority as de facto president to do much more than just remove bureaucratic barriers to completion of the biology project. He reshaped its objectives to align with the changes in his views that had occurred since the project began two years earlier, and he took primary responsibility for editing and shaping each subcommittee draft report, like an architect supervising construction of a building to ensure it conforms to the design. Handler negotiated contract extensions with the federal agencies that funded the project and issued directives for the use of Academy funds and staff to support services and activities not budgeted in the contracts. His emphasis during the period, however, was to explain the importance of science to society and his plans for changing the mission of the Academy, which he did by means of a peripatetic schedule of a dozen speeches, interviews, articles, and congressional testimonies.

Feelings about science were ambivalent in all intellectual and economic strata of society; science was credited with glories but also criticized for producing terrors that dehumanized mankind. In a speech, Handler said one of the objectives of the Academy was to provide advice to the government that would help it identify policies which increased the glories and decreased the terrors of science. He said the result of the biology project would be one of the Academy's first steps in that direction, a roadmap for the government that would explain what biology was and rationalize institutionalizing expanded support for basic biochemical research. Handler believed the ever-growing scientific knowledge imposed a responsibility on politicians and the public to embrace science and plan for its beneficial use, but that both were doing neither. Handler's effort to bring about a respected position for science in society and sufficient and stable financial support by the government was a blend of legerdemain and showmanship.

Handler reconceptualized humans as simple linear machines animated by food and sunlight, like the gears in a watch that were made to move by the energy stored in a spring. In the scientific culture, calling a human being a "machine" was just a manner of speaking about the scientist's faith

in a universe ordered by natural law. Except for the occasional fanatic, the entire culture shared the view that the laws of physics applied to humans and nonliving matter alike. During his time as a leader in the Institutes and the Foundation, Handler obfuscated the way "machine" was actually used in physics to facilitate his plan to lead biology down the road of biochemistry. Using his sharp tongue to usurp the meaning of "machine" as applied to man to mean the simplest kind of machine possible, a linear machine, like the gears in a watch, he misled his audience — biochemists, the Congress, and the public. Having done so, Handler made the even more misleading argument that scientists who claimed his linear machine concept was insufficient for explaining biology were effectively saying that there were mysteries about human beings — health, growth, disease, behavior — that were, in principle, beyond the reach of scientific investigation. No responsible scientist ever made that claim. Nevertheless, Handler's successful instantiation at the Institutes and Foundation of the linear machine metaphor permitted him to regard the problems that beset humanity as, at base, problems in biochemistry that could be solved by means of biochemical research. And still worse, he eliminated the possibility of funding for scientific inquiries designed to challenge his linear-machine model. Ironically, at the same time Handler played his game with the meaning of "machine," several lines of scientific investigation by physicists were proving that the Laplace determinism reflected in a simple linear machine did not apply in complex systems, and there was nothing in the universe more complicated than a human being. The developments meant it was theoretically impossible to simply mix chemicals in a test-tube and create life, which Handler believed was possible. Handler's fundamental misconception of what human beings were was behind everything he had done at the Institutes and the Foundation, and would be behind everything he would do at the Academy.

When interviewed for an Academy news publication, Handler described values and principles he said would guide how he intended to lead science. According to him, truth about the world was the exclusive domain of physics and biochemistry, which respectively explained the inanimate and living world. The government had a solemn obligation to support the discovery of truth by training scientists in universities and then paying them to perform basic research. He said the values of scientists, not the government, should be the principles that determine the specific objectives of the research; the government's values were expressed by the size of the budget it provided. And further, according to him, the government should not impose any constraints on the principles of scientists as manifested in the work they do "If the research results can have evil application," he said, "it's the government's responsibility to block the application, not the elucidation of the knowledge that made it possible," reiterating his principle that even though the government pays for the research, scientists should control what is done.

Handler's example of a possible evil application of basic-research results involved the knowledge discovered by biochemists funded by the Institutes regarding how to create a genetic twin of an adult animal. "The obvious next step was to clone a human," Handler said, "and I hope that day never comes. I can't imagine any more dangerous tool in the hands of an autocratic, dictatorial, authoritarian government. It would be the most powerful mechanism ever devised — the ultimate despoliation of the human race, degradation of the worst order. We could create an ant-like society that is utterly repugnant. And yet I think there is no alternative but to go down this trail and do the biochemical experimentation that, one day, may offer this kind of a capability. The idea that

since we can see this possibility, the government should mandate, 'Thou shalt not in thy laboratory do any experiment which leads down that trail,' is an equally repugnant thought. That kind of censorship is as repugnant as censorship of literature and is as potentially damaging."

Handler also sounded a note he had previously sounded many times, that the search for truth was man's noblest pursuit and that historically has resulted in revelations that were shocking when they occurred but that ultimately transformed and elevated mankind. He said, "The Copernican revolution converted the earth from the center of the universe to a tiny planet around a sun that is only a little star in the cosmos, and evolution traced humans from nothingness and in the process destroyed man's image of himself as something created in the image of God." Mankind accommodated these scientific developments, Handler said, "and will do so in response to any future scientific development." Handler never rationalized his ideology or defended it against his critics; instead he simply asserted it as if its truth was self-apparent and therefore a good and proper basis for the Academy to provide advice to the government regarding the science policies it ought to adopt and implement.

He told an audience of high administration officials that biochemists had already made the seminal discovery in biology — genes — and that "everything else is spinach." He said, "genes make proteins which make cells which make tissues which make humans" and that each step is "an automatic and obligatory consequence of the information encoded in the genes," as if the seed determined the future and the soil had no material influence. Handler promised that biochemists would uncover the mechanism by which the first cell of an organism becomes specialized into different kinds of cells capable of making different kinds of tissues. Then, he said, explaining cancer would be possible because it is uncontrolled growth, which is the opposite of specialization. Handler expressed a belief that man had come to the moment in time when he had the power to biochemically control his future by manipulating genes. The possible applications included altering genes that caused undesirable behaviors that the government decided on a policy basis to eliminate. He said uncovering the biochemical basis for human behavior would provide "a powerful tool for tampering with human behavior and for altering the course of history."

Handler had a dark and sinister view of an undemocratic future planned by biochemists, implemented by the government in accordance with the advice of the Academy. In a newspaper article, he described his vision and why it should be embraced. Essentially, he expressed a belief that the age of physics was over and there was nothing further physicists could discover which would affect the lives of people; the only aspects of science that could do so, he maintained, were basic research in biochemistry and technological development. He predicted breeder reactors would soon be perfected and become commonplace, and that the resulting abundance of power would permit recycling of water which "will be available in infinite supply, and society will have the ability to restore our physical environment almost to that which our ancestors found on this continent." Handler believed technology would be developed to allow humanity to manage the weather and other aspects of the environment that dramatically impact people. In his view, however, the situation regarding biology differed profoundly from that in either physics or technology because most problems in biology, especially those applicable to human affairs, were not amenable to solution by physics or technology but rather required as yet undiscovered biochemical knowledge.

Hander asserted his belief that foremost among the problems in biology was overpopulation. He wrote: "The greatest threat to the future of the human race is man's own procreation. Hunger, pollution, crime, despoliation of the natural beauty of the planet, extermination of countless species of plants and animals, dirty, over-crowded cities, continual erosion of limited natural resources, and the unrest which creates the political instability that leads to international conflict and war all derive from the unbridled growth of human populations." Handler promised that studies of the functioning of enzymes, the regulation of metabolism, the operation of the genetic apparatus, and "other basic research vistas almost without end" were the "wave of the future." He asserted that answers to myriad oncogenic, infectious, degenerative, and psychiatric diseases and disorders that afflict mankind, as well as resolution of social problems, can come only from biochemists.

Handler declared there were hundreds of known genetically transmitted diseases, and many more waiting to be discovered for which cures were possible by means of genetic modifications discoverable by biochemists. But he warned about the social consequences of increasing the success of medical procedures. When man intentionally modifies his own evolution by reducing the historical power of natural selection, he assures acceleration of the spread of harmful genes through the population. He suggested that breeding by means of artificial insemination using sperm from distinguished men was a possible mitigation strategy. Handler reported that biochemists were also closing in on understanding the biochemical processes in the brain that were responsible for human behavior. He envisioned "unlimited possible consequences" from such discoveries including the ability to design biochemical agents that will alter human behavior in defined ways.

Handler acknowledged that basic research of biochemists would pose complex and challenging ethical questions. Nevertheless, he planned to use the Academy to advise further expanding the research and allowing the resulting ethical problems to be controlled by political and social processes. Even though the curiosity and intellectual appetite of biochemists would create "unparalleled new stress on the fiber of the social structure," society could "no more tolerate censorship in the laboratory than in speech." Handler demanded that the biochemists educated and paid by the government "must be free to think, to seek, to explore." Handler summed up the view he intended to advocate as Academy president: "What biochemists find may not always be comfortable, but surely we can tolerate understanding ourselves. To be sure, we have not always managed our science and technology with foresight and wisdom. Tomorrow we must, if we are to survive, and surrender a decent world to succeeding generations. Meanwhile, let no one frame constraints delimiting which segments of the endless frontiers of science may be explored. No one has the requisite wisdom and foresight to make such decisions and to do so most assuredly would imperil the national future."

Handler believed science was the twentieth century's cultural hallmark, and society's tool for shaping the future and making mankind better than it had ever been; he agonized over the seeming inability of the Congress and the citizenry to see science as he did. During testimony to a congressional budget committee he said, "I personally might wish that we could justify the fundamental scientific endeavor exclusively on its cultural merits, but I am well aware that the American people won't support science on that basis alone." In a series of canards, he defended the proposition that they would support science if they understood it was the only solution to all of

society's problems. He said, "Today our nation is stronger, healthier, and wealthier than it ever has been before, very largely because we have learned how to apply the findings of chemistry and physics to enrich all aspects of American life." It was misleading to suggest that the invention of biochemistry and development of technology was responsible for the enrichment of American life, even assuming he could define enrichment or show that it had occurred, but that was the way he routinely spoke. He continued, "Biochemical knowledge has always increased every year and always will." But his implication — that the increase was something good — was deceptive because the overwhelming preponderant part of what he called knowledge were pointillist observations that didn't sum to anything meaningful. So, arguably, the increase in useless knowledge was something bad, not good. Handler's rhetoric sounded authoritative, like a priest in front of the laity but didn't have the same impact on the congressmen as it had a decade earlier, when they were unsophisticated about science and easily impressed, and lacked a technical staff that could decode Handler's verbiage.

Handler maintained that modernity was a collection of simultaneous sociological, political, economic, medical, environmental, and technical problems that had one factor in common — their solutions depended on more science, and he described how it could bring about the solutions. He asked the congressmen to understand that even though good medical care was widely available, "our best of medical care still leaves much to be desired because physicians lack the necessary knowledge," which could be but hasn't been provided by biochemists because of a lack of government funding of basic biochemical research. As a consequence, Handler said, "Our degree of ignorance is profound." Regarding environmental problems, Handler said, "All of us are constantly aware of water and air pollution as problems. It is true that the air of our major cities is probably cleaner today than it was 50 years ago, but it is also true that we have much to do." Presently, he said, the scientific aspects of what happens in air pollution are not very well understood, and the biological processes that occur when rivers are polluted are also not understood.

Handler advocated for the development of technology to ensure that the personal lives of people were not limited by the availability of electrical power. He said, "The breeding reactor gives every sign of becoming available in the relatively near future and could indeed solve that problem for us." Looking farther into the future, Handler said: "It is clear that our demands for water are quite likely to limit the kind of civilization we can have and enjoy in the next century and centuries to come. We simply must learn how to make available relatively cheap pure water on a vast scale if life is to be as good in the future as it has been in the past." Improved technology that allows radioactive minerals to be extracted from low-grade ores "will remove the limits from our civilization now imposed by the availability of power from nuclear fission."

Handler said, "Population control is surely the largest single issue facing mankind, but our knowledge of reproductive physiology is pitifully scanty." He acknowledged the serious political problems that would ensue if the government passed laws designed to restrict the ability of some individuals to reproduce, and offered the option of basic research into reproduction and manipulation of genes. Second to the problem of having too many people, according to Handler, was the problem of feeding them. Doing so, he said, "will require a markedly enhanced agricultural capability."

Handler told the congressmen, "There is another class of unsolved problems. These are the social problems of our society. On the surface, the problems belong to the social sciences" but, according to Handler, they lacked the scientific sophistication to deal with those problems. He said, "Its concepts, thoughts, understanding, facts if facts there are," are presently quite unequal to the task, but offered some hope for the future. "I think the social sciences are getting better. They have learned how to think quantitatively, how to gather quantitative data; they have sharpened their analytical tools, which are quite different from the analytical tools of biochemistry and physics, and now these are available." He opined, "Government support for the social sciences is now appropriate," but cautioned that "the problems of society can't be handled by social sciences alone in the same manner that biomedical problems can be treated by biochemistry alone."

He intended to use the NAS to advocate for the government to fund projects that would achieve his objectives.

In an interview a few days before his inauguration, Handler said knowledge produced by biochemical research had brought mankind to the threshold of a biological revolution that would be as profound and fundamental as the industrial revolution, but only if biochemists received the requisite financial support from the government. He identified overpopulation, disease, and pollution as the great biological problems of the time and said he intended to use the prestige and public esteem of the Academy to help bring about solutions. In his telling, unbridled population growth caused pollution, environmental destruction, and crime, and research into human reproductive physiology and genetic diseases was needed to help manage the quality as well as the size of the population. He said, "The genetic pool of mankind is deteriorating because modern medical care kept alive individuals with genetic defects who reproduced." Handler recommended development of a clinical method for inserting good genes to replace the bad genes, and promotion of social policies that encouraged only people with good genes to breed; he predicted that future Academy reports would support the advice. He also recommended increased agricultural research to feed the ever-increasing population and prevent famine. He saw a need for crash government programs to systematically investigate hundreds of thousands of plants and assess whether some could be bred into new crops, and other programs to develop methods for large-scale harvesting of food from the sea.

Government investment in biochemical research was needed to overcome the diseases that were the major killers and incapacitating disorders. He believed knowledge of the causes of many diseases, including cancer, was not possible as far into the future as he could see in what he called his "crystal ball," but that curing early cancer was possible, if appropriate research were undertaken. Even death itself was amenable to biochemical research, he said: "Conceivably it could permit life like Shangri-la, where people would stay physically young until the age of a hundred, and then die."

Handler expressed concern that civilization was not ready to accept the consequences of technology and the new values it would impose. He said technology accounted for "the comfort enjoyed by eighty percent of our population," by which he appeared to mean that technology produced a benefit and its associated risk from side-effects and pollution was trifling and far outweighed by the benefit. He predicted new technology would allow the twenty percent who experienced greater risks, ultimately, to live at the lower risk level of the majority of the population.

Handler suggested the concerns of those who believed side-effects and pollution were health risks was a social problem, and hence in the domain of the social sciences, not biochemistry or physics. Unfortunately, he said, "the degree of understanding of man as a social creature is inadequate because the social sciences are relatively primitive," and consequently "our lack of social understanding limits us badly." He said a sophisticated blend of social and behavioral understanding with modern technology could yield a new era for mankind "where fear of health risks from technology was no longer a popular issue."

In his last pre-inauguration interview, Handler described what the Academy's role would be. He declared that the Academy would continue to serve its traditional purpose of providing technical advice to the government, but would also "state why we believe continued public support of science truly is in the national interest. In the past, according to Handler, the Academy gave advice only in response to requests from the government rather than on its own initiative. But in the future, he announced, the Academy would become more aggressive and expand its mission; he observed, "the Academy charter does not say that, if not requested, be silent." He said that the Policy Committee report on overpopulation was the first example of the Academy taking the initiative and expressing its opinion regarding needed changes, and that he had his own agenda regarding needed changes. "We must be as persuasive as possible — not as a way to put something over on the American people — but because we truly do believe that basic research is the leverage our civilization has invented to give shape to its own future," he said.

For the first time he announced an intention to steer the Academy's advice, both solicited and unsolicited, in the direction of reforming urban life. He said, "The Academy will take leadership in those major problem areas plaguing mankind. It should help arrange to get a description of the kind of community human beings can thrive in, and what a proper human society should be. The sad consequences of ignorance and unplanned growth are all about us." Handler's staff told him that such advice coming from a biochemist was not credible, but he believed he had thought about the problem enough and he intended to press the point. In the interview, he asserted that present-day society was poorly adapted to the urban life it had created, a notion he exemplified using a story about a bear in a cage. He said, "Take the stereotyped pacing movements of a bear in a zoo. Bears in the wild don't behave anything like that. That's the response of the genetic potential of a bear to a hostile, non-bearlike environment. Some of the ills of our society are due to the fact that our technological capabilities have created an environment which is really not very human. I hope that, in time, the Academy would learn how to give leadership to this quest for a sense of direction, for the nature of future American society."

Handler's plan for countering the public's lack of appreciation for basic biochemical research and the government's lack of stable funding was the creation of a Department of Science that would be responsible for the welfare of American science. He said the new agency would include many existing agencies packaged in a way that facilitated rational planning of science programs, and that permitted the Congress and the President to appreciate the nature and importance of basic research, as well as the leadership potential of scientists in the creation of science policy. Handler said that during the next decade, he was convinced the government would make an overt declaration of intent to be the principal patron of basic biochemical research and science in general, and to that end

would create Department of Science. Handler said President Nixon "will support the requests of the scientific community for funds. He shares the values and aspirations of the scientific community with respect to the future of American science and, perhaps, is even more sanguine than are scientists as to what science can do."