Chapter 3: Academy Panels*

Claims that electromagnetic energy from two military antennas will be completely safe are consensed by rigged Academy panels to be scientific facts, and a national science policy based on a distorted meaning of "health risk" is established by the Academy, revealing that reliable science advice that serves the public interest requires an open and fair adversarial system. 1969–1980.

First Academy Panel

Despite the strategies employed by the power companies to counter what they perceived to be threats to their interests arising from Becker's work, the forces he set in motion led to a decision by the New York commission to require power companies to take specific steps to mitigate the risk to public health posed by powerline electromagnetic energy. From a procedural perspective, the reason Becker and I had a positive effect on the outcome of the hearing was that it was an open process governed by established rules. The commission's adherence to due process afforded Becker and me an opportunity to be heard in an unbiased forum, and to reply to arguments of the company experts, who expressed decidedly contrary views. But then the National Academy of Sciences became involved in the public-health issue of man-made electromagnetic energy, and the nature of the inquiry process changed dramatically.

THE ACADEMY'S INVOLVEMENT began after the Navy decided to build the world's largest transmitting antenna, Project Sanguine. The Navy had conceived the antenna idea in the late 1950s and developed what it regarded as a suitable design by the late 1960s. Sanguine was intended as a fail-safe method for signaling submerged missile-firing submarines even after ordinary radio transmissions became impossible because of atmospheric disturbances resulting from a nuclear attack. Essentially, the antenna was intended to ensure massive retaliation, like the doomsday machine in *Dr. Strangelove* that destroys the world in a final vengeful act. To produce a signal with the desired electrical characteristics, basic engineering considerations required the antenna be prodigiously large and located deep below the earth's surface to withstand nuclear attack. The Navy chose Wisconsin as the location for the antenna and designed an underground grid of wires that extended over 23,000 square miles, about 32% of the state.

THE NAVY HELD local meetings to inform Wisconsin residents of the scale of the antenna and to convince them that it was a technical achievement and a military necessity. They were told that the antenna's electromagnetic energy would cause flickering lights, shocks from touching metal fences, and interference with cable TV and telephones, and

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solutions to the problems were promised. Navy spokesmen also said there would be no adverse environmental effects, and that the antenna would be completely safe, just like the powerlines of all sorts and sizes that crisscrossed the nation and obviously caused no environmental or health hazards. To emphasize this point, the spokesmen told the residents that Navy experts had concluded there was no mechanism known to science by which the antenna's electromagnetic energy could harm people or animals.

AFTER SECURING CONGRESSIONAL approval of a test version of the antenna to be located in a national forest near Clam Lake, Wisconsin, the Navy announced plans for construction of the main antenna within five years. But resistance to Project Sanguine developed and grew despite the Navy's best efforts to assuage the concerns of the residents and help them see the antenna as an economic boon and national-defense necessity. The project was opposed by the governor, both senators, and most of the state's congressional delegation. The political situation for the Navy became even more complicated after enactment of the National Environmental Policy Act, which required an environmental impact statement prior to any federal construction project. The law forced the Navy to undertake gold-standard studies to provide scientific evidence of safety rather than to rely solely on Schwan's biophysical principles and analogies with powerlines. The ensuing research by the Navy was the first systematic study of the effects of man-made electromagnetic energy ever performed in the U.S., something the power companies did not do because the environmental law did not apply to them.

IN CONGRESS, WISCONSIN senator Gaylord Nelson introduced two reports by university engineering experts that questioned the environmental compatibility and functional capabilities of the proposed antenna. Based partly on the reports, he questioned the cost, need, and desirability of the proposed antenna, and called it a potential billion-dollar boondoggle. He asked the Navy to undertake a review of the issues he had raised, to be carried out by a panel of independent experts. The Navy turned to the Academy, which after the end of the second world war had progressively acquired a national reputation as the nation's science brain-bank.

Under its new president, Philip Handler, the Academy had accelerated its attempts to capitalize on the prestige associated with its name. He authorized the formation of numerous *ad hoc* panels of scientific experts that provided science advice for federal agencies, an activity that was the major source of funding for the Academy. Handler controlled the process by which science advice was formed and disclosed by the Academy panels; he personally chose each panel member and his staff researched and wrote the final report of each panel. At the time he was approached by the Navy, Handler had already approved more than a hundred contracts for providing advice, and each member of the respective panels that he appointed served *pro bono*, paid solely by the prestige of association with the Academy, important currency to the panelists because Handler rarely appointed an actual member of the Academy to an Academy panel.

There were no meaningful conflict-of-interest rules that restricted whom Handler could appoint to a panel, but there were strict rules governing how panel business was conducted. All panel deliberations took place in secret, and panel opinions were formed by consensus of the panel members, with the assistance of Handler's staff, and sometimes Handler himself. Panelists were prohibited from publicly disclosing any details of the opinion-forming process, or even whether they agreed with the panel's conclusions. The law provided that the panel members alone were responsible for the advice offered, but it was published under what the Academy called its "aegis," a kind of license that allowed the advice-seeker to claim that the final report was "issued by the National Academy of Sciences."

Booker Panel

Handler appointed seven engineers to a panel that was given the contractual task of evaluating the validity of the engineering reports Nelson had published in the Congressional Record. All of Handler's appointees were economically bonded to the Navy, none more so than his choice as chairman, Henry Booker, whose research on Sanguine-type electromagnetic energy had been funded by the Navy and whose opinions regarding the antenna's engineering were no mystery. During the panel's deliberations, a panelist who objected to Booker's opinions resigned and wrote his own report in which he concluded that Sanguine would not work.

The final report of the panel contradicted all three earlier reports and concluded that the data supplied by the Navy contractors "strongly suggest that the Sanguine system contemplated by the Navy would work substantially as they anticipate." The panel report criticized the authors of the earlier reports for having the temerity to question the Navy's judgment regarding the design of the antenna, characterizing them as "a small number of interested citizens" who made only "part-time efforts" and could not validly criticize "a project that has occupied many man-years of work" by Navy contractors. With Booker the judge of his own work, as Handler clearly expected, the Navy got what it wanted, a conclusion that supported its position and was published under the "aegis" of the Academy.

THE SAME MONTH the Booker panel issued its report, the Navy published its environmental impact statement, and for the first time the potential environmental and health hazards produced by the antenna's electromagnetic energy became serious issues in Wisconsin. The statement, a huge rambling document written in technical jargon concluded, "...there would be no probable environmental impact." The applicable law required the Navy to assess the possibility of "probable" impacts. The statement had no acknowledged human authors, only the "Navy," and offered no supporting evidence for the conclusion. The Navy construed the law to mean that "probable impacts" meant only impacts evidenced by their past occurrence under relevant simulated conditions, and did not include public-health or environmental risks, which are related to events that could "possibly"

occur, as evidenced by gold-standard studies. In other words, the Navy took the legal position that it had no obligation to consider the issue of risks to human health—which are inferential as opposed to observable facts—in its environmental impact statement.

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To help you understand what empowered and licensed the Navy to consider only "probable" impacts on human health and ignore "possible" impacts—in other words, "health risks"—I must explain how biology got to be the way it was when the environmental impact statement was written.

Physics began when humans conceived the straightforward idea of mass and the more abstract idea of energy and used the concepts to create a small set of equations that explained why inanimate nature behaved as it did. The equations were linear, meaning that they had the intrinsic mathematical property of allowing the activity they governed to be conceptually divided into parts that could be analyzed individually, a method called "reductionism." Using the equations and reductionism, physicists achieved their goal of understanding the behavior of inanimate nature. Nothing important happened there that could not be explained and predicted.

Biology, the study of animate nature, mankind's second great science, began after René Descartes defined a human being as a machine energized by a soul. The notion of a soul was discarded as unscientific, but for hundreds of years no serious explanations were offered for what made the living machine move. During the last half of the nineteenth century, men interested in learning how chemical processes gave rise to life, the Fathers of experimental biology, motivated by profound respect for the achievements of physicists, adopted their cognitive structure as the canonical basis for explaining the phenomena manifested by living systems. In this manner mathematical law became implicitly recognized as the principle that that moved the machine, Descartes' soul.

The Fathers' decision to ape the thought system of physics charted a treacherous course for biology. Although they were uneducated in mathematics, the sublime language of physics, they had naïve faith that somehow, someday, the mathematical laws of biology would be discovered. But the laws of physics were linear and so could govern only machines, predictable things composed of parts. In stark contrast, the laws that governed biological phenomena like development, growth, healing, memory, consciousness, health, or the occurrence or progress of chronic diseases, phenomena that emerged only at a high level of structural organization, could not possibly be linear—even children could see that such phenomena did not have the characteristics of machines. Consequently the laws governing the phenomena were inherently insusceptible of discovery using reductionism, the experimental method imported from physics. If physicists had formally recognized the existence of emergent phenomena in inanimate nature, the weather for example, the conceptual foundation of biology might have been different, but they didn't. So, at the birth of experimental biology, emergent biological phenomena were outliers that lacked a conceptual foundation—they had no parts and there was no accepted method for studying them.

The Fathers, who were primarily interested in the chemical reactions that occurred in living systems, focused on the role of chemical energy in explaining the phenomena exhibited by living systems. But some Fathers went too far and adopted chemical energy as the sole energy of life, ignoring even the possibility that other forms of energy could be important. For them, electromagnetic, mechanical, kinetic, gravitational, and thermal energy were mostly unnecessary for explaining the behavior of living systems, notwithstanding that physicists had found them crucial for explaining the behavior of inanimate nature.

During the twentieth century, biology separated into subspecialties, each with its own creed, sphere of interest, canonical method for producing knowledge, and societal significance. Some subspecialties relaxed or eliminated one or more of the tenets in the original creed of the Fathers. Biological subspecialists emerged who allowed inclusion of non-chemical forms of energy, or who embraced non-reductionist experimental designs as valid forms of the scientific method. Some biologists adopted the use of mathematics for more than just taking averages, and some eliminated a requirement the Fathers held most dear, that measured biological parameters must be linearly related to the strength of the cause (what they called the "dose-response effect") for the effect to be accepted as valid. Mid-way through the century, "biochemists," the name for biologists who maintained the strongest doctrinal purity of the Fathers, emerged as the alpha dog of subspecialists.

The biochemists learned how to explain the contraction of muscle, the conversion of food into chemical energy, the operation of genes, how proteins are made, and the role of hormones and vitamins, all processes governed by simple linear laws. But biochemists were inherently incapable of rationalizing claims of knowledge regarding system-level phenomena because the cognitive structure of biochemistry did not incorporate a method by which the governing laws could be discovered, and it is axiomatic in science that knowledge is the product of method. The ironic result was that biochemists ceased studying biology and concentrated on molecules, a level of reality at which the concept of life has no meaning.

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Becker was a physician, and system biology had always been what concerned him. He was particularly interested in how coordination was achieved among the growth-mediating biochemical reactions that occur simultaneously throughout the body. His proposed answer was a system-wide flow of electromagnetic energy, and that theory led him to suggest the possibility that perturbations in this natural flow caused by man-made electromagnetic energy in the environment might result in adverse consequences. The supporting experimental evidence he offered was that the energy caused biological effects in laboratory animals, living organisms that were used as surrogates for humans which ethically, morally, and legally could not be forced to be subjects of experiments. In Becker's perspective, the evidence from the animal studies warranted the inference that the energy was a "probable risk," an early warning of a potential health problem that required further study. But biochemists were not physicians, hence were interested primarily in pure science rather

than human welfare. Their creed encouraged the mindset evinced by Schwan, for whom only the occurrence of dead or diseased human beings whose suffering had been conclusively proved to have been caused by Sanguine energy could sustain a conclusion that the energy would probably affect health. In the world of the biochemists, Becker's reasoning wasn't scientific because the idea of "health risk" was a sociological or political concept, not a scientific concept.

THE NAVY'S MOST efficient strategy for obtaining approval of Sanguine obviously was to consider only "probable" impacts on health, because there were none—a choice consistent with orthodox biochemistry and engineering, and highly conducive to the Navy's interests. The residents of Wisconsin thought they had the "right" to be told whether they would be exposed to "possible effects," but where that right came from was a thorny problem. Becker believed that it was one of the bundle of rights that comes with being human. On the other hand, the duty to recognize that "right" was not part of the Navy's mission. Especially so, since the possibility of risks due to man-made electromagnetic energy had just entered mainstream scientific dialog for the first time, during a speech Becker gave at a convention of engineers only a month before the environmental impact statement was published and in a paper he wrote soon thereafter. So the Navy had focused exclusively on "probable" impacts on human health when it wrote the environmental impact statement and ignored "possible" impacts, which was one of its "rights" as a department of the government, thereby putting its "rights" in first place, as the power companies had tried to do.

Second Academy Panel

The Navy's environmental impact statement consisted of technical and legal jargon relating only to what was "probable" and ignored what was "possible," the condition that gives rise to health risks. But the people in Wisconsin were concerned not only with what was probable but also with what was possible, as their state and federal representatives pointedly asserted. The environmental impact statement was viciously criticized by the governor's review panel, which concluded that the statement contained shallow investigations, factual errors, inadequate data, poor review of the scientific literature, scientifically meaningless statements, unscientific reasoning, and invalid conclusions. Publication of the opinions of the governor's panel further stoked public resentment in Wisconsin against Sanguine. After the U.S. secretary of defense, who was from Wisconsin, ordered the Navy to look somewhere else as a site for the antenna, the Navy proposed to locate it in Texas near President Johnson's ranch. But budget requests to develop the Texas site were blocked, so the Navy chose a site in a state forest in the Upper Peninsula of Michigan.

Schwan Panel

In the wake of increased public-relations difficulties that followed publication of the environmental impact statement, the Navy again turned to the Academy and contracted

with Handler to appoint a panel that would decide whether the Navy research program involving the biological effects of man-made electromagnetic energy had yielded "clear evidence of a harmful human effect"—a classic straw-man objective because the program obviously had not done so. Handler appointed Herman Schwan and Sol Michaelson to the panel. His choices were made four years prior to the events in the New York hearing where both men were taken behind the woodshed when they testified that man-made electromagnetic energy was completely safe. But his choices were made after Schwan and Michaelson had repeatedly published that opinion for more than ten years. The other three panelists were strangers to the area of research: a career Navy officer, an Admiral, and a former Naval officer. Unsurprisingly, based only on Schwan's mathematical lard and Michaelson's inveterate name-calling, the panel concluded that the Navy had no clear evidence of harmful human effects, and it strenuously supported the propriety of the Navy's hygienic practices regarding all forms of man-made electromagnetic energy, including that produced by the Sanguine antenna.

Handler knew or should have known of the zealotry of Schwan and Michaelson, and he appointed three other panelists who were quite ignorant of the subject under study, choices quite inconsistent with the Academy's claim that its panels had special expertise for providing scientific advice. Further, Handler had entered into a contract for which performance amounted to affirming what was obvious but further and much more seriously, a contract that could enhance that affirmation by giving it a false meaning of safety and publishing the result under the "aegis" of the Academy as if the result were a scientific fact. Handler's phony-baloney panel woke me from my idealistic presumption that the advice of an Academy panel was always valid and reliable.

Tyler Committee

Becker continued his work dealing with the role of electromagnetic energy in animal and human biology. One evening, after a lecture he gave at an international meeting, he was asked by Captain Paul Tyler, a Navy physician, to serve on a committee that would review the interim results of the Navy's Sanguine bioeffects program. Tyler knew Becker, and Tyler knew how Becker was disposed to interpret evidence from animal gold-standard studies. From the way the two men spoke, I surmised that Tyler was doing his due diligence as the leader of the Sanguine biological-studies program, attempting to ensure that the Navy would not be embarrassed if it relied on the advice of the Schwan panel. Observing how Becker fared when he faced the other committee members would be a good test of Becker's mettle.

Tyler's committee met four months later in Washington DC. It included an engineer, a microbiologist, an anatomist, an internist, and Don Justesen, a psychologist who worked at the VA hospital in Missouri. The committee listened to presentations by Navy officials and consultants regarding about forty animal and human studies. According to Becker, Tyler began the meeting by saying that the program was a hazards survey, and thus

that the focus should be on evaluating the validity of the positive effects in the gold-standard studies which, he soon revealed, had occurred in about 10%, 40%, and 90% of the studies conducted by commercial research organizations, Navy laboratories, and university scientists, respectively. Tyler asked the committee to assess whether the effects should rightly be attributed to Sanguine electromagnetic energy or could have been due to artifacts. If the effects were valid, he said, the committee should give its opinion regarding why and how they occurred and should suggest priorities for future studies.

IN BECKER'S RECOUNTING of the meeting Navy spokesmen described the studies one by one, progressively revealing a wide range of biological effects caused by low levels of electromagnetic energy. Becker regarded the state of affairs as a double blessing with respect to his opinions—support for his ideas about the biological activity of man-made electromagnetic energy as well as confirmation of some of the specific bioeffects we had previously published. He was particularly impressed by the research of the neuroscientist Ross Adey who worked at a VA hospital in California, and who had reported in the literature that electromagnetic energy altered brain electrical activity in monkeys, effects similar to those Becker had found in salamanders. Another project that stood out was that of Joseph Noval, who worked at a Navy laboratory in Pennsylvania and found decreased growth rates in rats and increased levels of stress hormones, exactly the same effects Becker and I had reported. The most important results from a health standpoint, in Becker's view, were those of Deitrich Beischer. Becker learned that a test version of the Sanguine antenna in Wisconsin had been operating for more than three years, and routine blood tests of sailors who worked at the facility had uncovered elevated levels of some biochemicals related to stress and digestion. The observations had prompted Beischer to conduct a gold-standard human experiment at the Navy's Pensacola laboratory in which sailors were exposed continuously for several days to simulated antenna energy. He found differences in the same biochemicals in the blood of the exposed sailors, compared with the levels in the blood of sailors who weren't exposed to the energy.

The committee members did not identify any of the reported positive effects as artifacts; realistically they could not do so because it was unlikely that they could detect subtle procedural errors that had escaped recognition by the original investigators, all of whom were acknowledged experts in the kind of animal model they used. Despite the absence of conspicuous shortcomings, an attitude of skepticism occurred among the Navy presenters and some committee members because the Sanguine energy levels were so low—more than a million times lower than the energy levels from powerlines, someone at the meeting pointed out.

There was little in the background or experience of the committee members that led them to anticipate or even feel comfortable with the results they had heard. They expressed their surprise using inexact or inappropriate criticisms of various studies, a list of which Becker had noted: "Not all the animals reacted the same;" "not all the tests were statistically significant;" "the thresholds for the effects weren't established;" "there were no

mechanisms that could explain the results;" "there may have been deficiencies in experimental design;" "the results were somewhat inconclusive;" "more studies with larger number of animals are needed;" "there were inconsistencies among the studies." The only overtly negative criticism Becker remembered came from Justesen who called all the reported effects "improbable," even though each was a gold-standard study and therefore greater than 95% certain.

Everyone on the committee had a graduate degree and a familiarity with the methods of science, so their opinions had some evidentiary value in the legal sense. If offered in court, the weight afforded the opinions would be tested under cross-examination, but in the setting of a committee meeting there was only discussion and consensus, nothing remotely as rigorous as cross-examination. Overall, the committee recommended that much more research was needed, which they identified and prioritized, as Tyler requested. Studies involving the effects of electromagnetic energy on triglyceride elevation, blood pressure, brain electrical activity in humans, and studies of the effects of growth rates in rats were labeled "urgent and absolutely necessary." Priority-two research encompassed specific studies deemed essential for evaluating other specific biomedical effects. Priority-three studies were those desirable for a complete evaluation of phenomena of particular interest. Fourth priority was assigned to work necessary for scientific understanding of basic mechanisms.

After listening to Becker talk about the meeting, I was even more convinced that Tyler's main purpose was to assess the gravitas of Becker's concern about health risks due to Sanguine energy. Tyler and the other Navy officials at the meeting saw how Becker defended his ideas, and how ordinary scientists reacted. The Navy had hired a contractor who created a written record of what occurred, so others not at the meeting could make independent judgments. I supposed Becker's views had essentially passed muster, because otherwise the consensus recommendations of the committee would have made no sense. But the signs I saw in the period following the meeting were progressively discouraging. Becker's attempts to obtain updated information from Tyler about the research studies were unsuccessful. Then, unexpectedly, the Navy labeled a contractor's report of the meeting Becker had been given, "For official use only," and did not publicly disclose its existence. Becker asked me if I thought it would be illegal for him to release the report. I told him I couldn't find any law against it, but he remained concerned about the propriety of doing so and for two years did not mention the report to anyone outside our laboratory. During that period the Navy systematically terminated its human triglyceride studies, rat studies, and all its studies conducted in university laboratories, exactly opposite to what the Tyler committee had recommended.

ON THE TWO-YEAR anniversary of the meeting of the Tyler committee, Senator Nelson released the contractor's report at a press conference and said:

> "The Navy studies produced adequate evidence that the biological effect of a Sanguine-type system would be considerable.... It appears that the Navy kept the wraps on the existence of this report because it contains the very first scientific evidence that Sanguine indeed would have an adverse environmental impact. Up to this moment this was a matter of concern and conjecture. Now there is hard evidence that must be pursued."

Third Academy Panel

Following the press conference, a firestorm of protest occurred in the Upper Peninsula of Michigan, the location the Navy had chosen for full-scale construction of the Sanguine antenna. Nelson again asked the Navy to undertake a scientific review of the safety of the antenna by independent experts, and the Navy again turned to Philip Handler. He agreed to appoint a panel that would be charged to opine whether the electromagnetic energy from the Sanguine antenna would be completely safe.

Hastings Panel

From my perspective, and that of Becker, Handler's choice of panelists was reprehensible. His primary appointees were the imperious Herman Schwan, the sophist Sol Michaelson, and the battery-sucking Morton Miller. Handler appointed only one other worker in the area of biological effects due to man-made electromagnetic energy, Ross Adey, a Svengali-like character with roots in the area going back to a secret government research project in the 1960s on the effects of microwaves on humans. As panel chairman, Handler picked a biochemist named Woodland Hastings who, like every other panelist except the power-company experts and Adey, had not published any animal or human research on the biological effects of electromagnetic energy or done any work whatever in the area. The other eleven panelists were a soil physicist, two occupational-health physicians employed by Navy contractors, a zoologist, a horticulturist, an epidemiologist, a geneticist, a cognitive psychologist, an engineer, a nuclear physicist, and a zoologist who was the only member of the panel with sufficient status in his field, in the opinion of the members of the Academy, to be elected as a member of the Academy. All the panelists were experts in the legal sense because they each had a graduate degree, but not even one panelist matched Handler's rhetoric that the people he appointed to Academy panels were unbiassed experts in the area where the government sought scientific advice.

HASTINGS WROTE TO Becker and me and asked for "contact and consultation" regarding his panel's task, and I spoke with Hastings about a dozen times concerning his request. At first, he was friendly and receptive; he told me Handler had personally asked him to chair the committee and had overcome his reluctance by promising that the Academy staff would do all the necessary investigative work. I wasted no time in telling Hastings that the presence of Schwan, Michaelson, and Miller on the panel would corrupt its deliberations. They had already testified under oath that powerline electromagnetic energy,

which was vastly stronger than that from the antenna, would be completely safe, so what their opinions would be regarding the antenna were obvious. I went further and told Hastings about the details of their cross-examinations, things I had actually seen: Schwan saying he reads only papers that failed to find effects because he knew any paper that found an effect must be wrong; Michaelson saying that his experiments on cooking dogs in microwave ovens showed levels that didn't cook were safe; Miller saying he took money to do research on the effects of electromagnetic energy even though he believed there were no effects because "He who has the gold makes the rules." I also gave Hastings an earful about Adey, whom I identified as the only other panel member who had any experience in the area of health risks from electromagnetic energy, and explained why he had serious conflicts-of-interest stemming from his long history of contractual relationships with multiple military and civilian federal agencies that disfavored recognition of health risks.

Hastings told me he was shocked by what I said because he had assumed everybody on the panel was an unbiased expert. He said that no actual or possible conflicts had been disclosed by any of the appointees on their conflict-of-interest forms. He promised me that if all that I had said were true, "then either Schwan, Michaelson, and Miller are off the committee and Becker is on it, or I'll resign." During subsequent conversations, however, Hastings told me Handler had refused to remove Schwan, Michaelson, and Miller and refused to appoint Becker, and Hastings did not resign.

BECKER AND I sent Hastings and Handler a public letter, the gist of which was that the composition of the committee was inimical to the pursuit of truth, that electromagnetic energy from the antenna may cause biological and ecological effects, and that a great deal more research was needed. In June 1976 a reporter for the journal *Science* wrote an article about the letter. Handler was not specifically mentioned in the article, which said, "Hastings' committee had been hit with charges that it is 'rigged' and 'biased.'" Hastings was quoted as saying that some members of the committee "indignantly" denied the charges, and that they accused Becker of bias. The reporter said some panel members believed there were "serious flaws" in the way the panel was formed, but that Hastings thought the conflict-of-interest charge Becker had made against Schwan, Michaelson, and Miller was "ridiculous." According to the reporter, Hastings said he had considered adding Becker to the panel but that his letter had disqualified him. Schwan said that the letter Becker and I sent "intimidates my freedom of expression," and Miller said it was "slanderous to my integrity."

BECKER WAS INTERVIEWED about the Sanguine antenna and his letter to Hastings by Dan Rather for the CBS television show "*60 Minutes*." They had a discussion in our laboratory before the taping began:

"You seem to have raised quite a ruckus, Dr. Becker," Rather said.

"Seems that way," Becker replied.

"It looks like everything began with that 1973 report by the committee you were on."

"That's when my involvement began."

"It minced no words regarding what the committee thought the Navy should do," Rather said, and reading from his notes he continued, "Under the heading 'Urgent and Absolutely Necessary,' the committee recommended further animal and human studies."

"Yes."

"Did that happen?"

"No."

"Why not?"

"You will have to ask the Navy."

"Do you think the Navy is trying to hide the truth about the health risks of the antenna?"

"I think their efforts to publicize it have been unnecessarily weak."

"Are you telling me there's a possibility that what comes out of the antenna could cause human disease?"

"Yes."

"Like heart disease or stroke?"

"Yes."

"You do know that's a mind-blowing thought for a lot of people?"

"I'm aware of that."

"Come on, Dr. Becker, the Navy says that a housewife is exposed to more electromagnetic energy in the course of doing her day-to-day chores than she would be from the Navy's antenna."

"How does the Navy know that the housewife is safe? We can't have it both ways. I and other physicians use very small amounts of electromagnetic energy to treat bone diseases. We apply that energy under very carefully controlled conditions. In my studies it's mostly done in the hospital and I see the patient every day. But it's a double-edged sword. If carefully controlled electromagnetic treatments can heal bones, why can't uncontrolled exposures from household appliances produce bad effects?"

"Do they?"

"We don't know. That's the point. We should look."

"At the energy from the antenna?"

"That's right," Dr. Becker said. "I was a member of the first panel to evaluate the biological studies that were performed for Project Sanguine. And I most certainly sat there and listened to several studies that had very definite effects. Animals that are exposed grow at a slower rate than control animals. A number of projects have shown this to be true. The second area in which definite effects do appear is that exposure to this type of energy seems to produce stress. That possibility emerged from their human studies in Clam Lake and Pensacola."

"Won't all this come out when the National Academy of Sciences panel looks at the facts?"

"It's unlikely."

"Why?"

"Because the panel was pre-loaded with men who have already made up their minds."

"Dr. Becker, are you telling me that a National Academy of Sciences panel is rigged?"

"That's exactly what I'm saying."

"Are you willing to say that on the air?"

"Yes."

WITH THE CAMERAS running Rather asked Becker about the Tyler panel report Senator Nelson had publicized: "Is it true that the Navy repressed that report for better than two years?"

Becker replied, "The Navy did not disseminate the report widely."

When Rather asked about how the Navy dealt with positive reports its research had uncovered, Dr. Becker replied, "We know of, I believe it's five specific projects in which positive results were obtained, when the projects were terminated, and the money just disappeared."

RATHER SPOKE DIRECTLY to the television audience and summarized what Becker had told him earlier about the Academy panel:

> "Meanwhile, the Navy has called in the National Academy of Sciences to oversee and evaluate further experiments. And the Academy panel has issued a one-sentence interim report saying that, so far, they think [Sanguine] is safe. But Dr. Becker isn't impressed. Some members of that Academy panel have previously testified publicly that radiation, similar to that of [Sanguine], isn't harmful. And Becker maintains it would be awkward for them to change their minds in public."

On camera, Dr. Becker expressed the sentiments that Rather had just summarized: "For example, if a person has already publicly gone on record that the Sanguine antenna is harmless, then obviously he cannot do an about-face and say the Sanguine antenna may be harmful. So that a number of people on this panel, I would feel, have a pre-bias."

"Is what you're trying to say that we're playing with a stacked deck?" Rather asked.

"I think so, yes," Dr. Becker replied.

Becker Punished

Handler had remained in the background regarding Project Sanguine ever since his involvement began when he appointed the Booker panel, working exclusively through subordinates in the contract-fulfillment arm of the Academy. But immediately after the telecast

of Becker's interview, the scope and nature of his involvement changed. Handler wrote to the president of CBS, "I was shocked to hear Dan Rather suggest that a committee of the National Academy of Sciences is, in his words, 'a stacked deck.'" Handler protested, "The 'stacked deck' to which Mr. Rather referred is a committee appointed by me in response to a request from the U.S. Navy," and Handler labeled the assertion "quite intolerable." He wrote, "The notion that this committee is 'stacked' would be laughable were it not for the tragedy that the integrity of the committee and that of the Academy were impugned so casually—or deliberately—by CBS News." Handler did not deny that Schwan, Michelson, and Miller were biased, but rather suggested it didn't make any difference because they "gain nothing from having taken their position," ignoring the powerful career boost the "aegis" of the Academy confers, like made men in the mafia. Handler complained that *60 Minutes* "had raised the public's level of anxiety far beyond the magnitude of any foreseeable hazard," and asserted the panel would approve the antenna when it issued its final report, apparently blind to the fact that his confident prediction confirmed Becker's "stacked deck" characterization of the panel, and he demanded an apology and a corrective statement.

DON JUSTESEN, who had served with Becker on Tyler's committee, wrote me in support of the Sanguine antenna and urged that I testify before the Hastings panel. Justesen said my appearance would be in the national interest and my professional interest. His letter was mailed from Washington DC in an Academy-franked envelope, which I took as some confirmation of the rumor that he had become a consultant to Handler. Justesen had a history of secret research that involved rats pressing a bar in a Skinner box inside a microwave oven. Unlike Michaelson, Justesen didn't heat the rats to death, only to the point of convulsions. He rarely made *ad hominem* attacks against those who held opposite opinions but had a penchant for pretentious flourishes in his writings that he frequently used to the same effect. He was 100% as Svengali-like as Ross Adey but only 10% as smart and as good a scientist. Justesen told me the Sanguine signal was "warrantedly without physical effects," and that anxiety concerning it "is far more destructive of psyche and soma than the agent itself." He predicted that people who lived near the antenna who had "ingested negative propaganda" would become sick only because of the "Voodoo Principle that wishing will make it so." He said he admired my concern for the public health, but that I should adopt his "Epicurean outlook that too much of anything bodes for insult." I saw Justesen only as someone hired by Handler to help craft a cosmetic defense of the Sanguine antenna which was less crude than the defense of Schwan and Michaelson and Miller was certain to be, and I told Justesen that my decision not to testify before them was final.

Without any formal explanation, soon after his appearance on *60 Minutes*, Becker was notified that a National Institutes of Health research grant he had held for more than a decade had been terminated. The grant had been funded by an institute Handler was instrumental in creating, and where he retained influence on funding decisions. Becker was severely disappointed, but not surprised. He interpreted the loss of the grant as revenge

insinuated by Handler, who was politically powerful but whom Becker regarded as a weak man because he had no ethical mooring and feared open debate. Becker pointed to Handler's treatment of Albert Szent-Gyorgyi, a Nobel Prize winner and member of the Academy who was highly knowledgeable about the role of electromagnetic energy in biology. Handler didn't appoint Szent-Gyorgyi to the Hastings panel because he was afraid of what Szent Gyorgyi would say. Becker recognized that scientific truth emerges through consensus but, unlike Handler, believed that consensus emerges through intellectual conflict, something Handler did not permit on his Sanguine panels.

Less than a month later, Becker lost a second grant from the same Institute, funds that supported his experimental studies regarding the biological basis of acupuncture, an ancient form of medicine founded on principles of energy flow rather than biochemistry. The loss of this support was particularly undeserved because the Institute's review committee had praised his work and recommended continuing funding, indicating that the decision had been made at the Institute's policy level, when he was regarded as a father of the Institute and retained significant influence. Nevertheless the funds were gone and the lab was further weakened. Then, two months after he lost the acupuncture grant, Becker suffered a third and especially devastating blow. He was notified by Marguerite Hays, a VA program manager and sycophantic friend of Handler, that Becker's VA appointment as a Medical Investigator would be terminated. The appointment provided funds for research and time protected from clinical duties to allow him to perform research. Its planned elimination was the death knell for our laboratory. Becker told the staff that our jobs were safe for a while because he had secured temporary funding from a sympathetic VA program director, but he advised us to begin seeking new jobs.

Final Report

Publication of the Hastings panel's final report was promised and then delayed several times because of wrangling between Handler and Ross Adey regarding a suitable narrative. When the report was finally released, proof of Becker's charge that the panel was rigged was plain to see. The seminal argument in the report was that physical theory predicted all bioeffects due to environmental-strength electromagnetic energy, whether naturally occurring or man-made, were theoretically impossible, and therefore that the antenna could be nothing other than safe. Schwan supported the argument in a signed chapter containing the biophysical calculations he had offered for many years, except that now he extended their application beyond servicemen to the general public. In the culture of Academy panels, a signed chapter presented the opinion of only its author and was not consensed by the panel, which was particularly reasonable for the Hastings panel because Schwan's mathematical mumbo-jumbo was not a natural language for more than two-thirds of the panel members. The presence of Schwan's chapter in the report, however, unmistakably signaled that Handler regarded the chapter as authoritative. which was ironic considering that Handler was a biochemist who eschewed physical theory. Nevertheless, he knew that

Schwan's shtick could not only deliver for the Navy but also blunt Becker's biological initiative, which I think was Handler's ultimate objective.

ALL RIGHT-THINKING scientists accept the principle that valid observations always trump theory, so Handler knew or should have known that his panel could not creditably support the Navy's position unless the extant literature that contradicted the report's seminal argument—Schwan's opinion—was explicitly negated. That negation entailed acceptance of the argument that all reported bioeffects arose from inconspicuous experimental errors, faulty experimental or statistical design, or misinterpretation of data. Let's say that again. All. Reported. Bioeffects. The validity of even one bioeffect caused by man-made electromagnetic energy experiment would impeach Schwan and vitiate the seminal argument in the report. This negation task was accomplished by importing into the report, *en masse,* the testimonies that Schwan, Michaelson, and Miller gave in the New York powerlines case—that was what Handler expected when he appointed them to the panel and that was exactly what they did.

IN THE PANEL report, the trio first presented the experiments that reported no effects and praised them as well executed and reliable, without any justification for those assertions. In contrast, the gold-standard studies that reported biological effects in animals were intensely lambasted, using their oft-employed pejorative language. They said McElhaney "reported spurious results," and that Giarola used "faulty experimental cage design." They concluded that Durfee's research "must be viewed with considerable skepticism," Yates' work contained "internal inconsistencies," and that Hamer's work "provided no valid statistical treatment of the data." They said Konig's work was not "statistically significant" and Blanchi's work had "faulty experimental design." They said there was an "unlikelihood" that Altman observed the effects he reported and that Lang's work "may well be simple eyeball" estimates. Referring to the works of Mamantov and Gann, they said, "These two studies provide very simple uncomplicated examples of poor experimental design." They dismissed the work of Solovev because "artifacts were likely in the experiment." Describing Moos' experiments, they said, "The results of the various experiments were inconsistent." Concerning Wever's work, they said it "certainly suffered from internal inconsistency." They said the results published by Warnke, Spittka, Hilmer, Watson, Southern, Graue, and Lott, were each due to artifacts. The strident criticisms of studies by Becker, Beischer, *and* Adey, which the power-company trio imported directly from their New York testimony, had a tone and tenor never previously seen in an Academy report, and were offered with no account of the results of the cross-examination of the trio or any cognizance of the decision by the New York Commission that the criticisms were unreliable.

A common rhetorical strategy of the trio when they attacked the biological literature was to make the perfect the enemy of the good, a strategy with which the Navy's science policy was complicit. Triglycerides were affected among sailors exposed to Sanguine

energy in both the Clam Lake and Pensacola studies—good evidence that the energy affected humans, even if not perfect. But then the Navy stopped funding triglyceride studies, thereby permanently freezing the evidence as only "good." It was the same story with Noval's effects on growth in rats, among many other examples in the Navy's bioeffects research program. The termination of research funds froze all work at the "good" level, so when Handler set the bar at the near-perfect level, which is what he meant by "conclusive," he effectively warranted Schwan, Michaelson, and Miller to trash the published research of Beischer, Noval, and numerous non-Navy investigators that, without any exception I knew about, was done by researchers far more knowledgeable about the experiments than were the trio.

Although even small children could figure out who was responsible for the disparaging language regarding the gold-standard studies, the work was unsigned and therefore consensable by the panel. But Ross Adey, who despised Schwan's theory-based approach to risk analysis and was contemptuous of the scientific expertise of both Michaelson and Miller, flatly refused to consense the trio's language because it was devastatingly critical of his life's work, thereby posing a serious problem for Handler.

ADEY HAD BEGUN his career as a research physician and protégé of a scientist who had developed a method for extracting diagnostic information from measurements of the brain's electrical activity. Adey's interests in the bioeffects produced by man-made electromagnetic energy began when the Central Intelligence Agency funded secret research in his laboratory designed to uncover the effect on the brain caused by the so-called "Moscow Signal," a WiFi-level microwave beam aimed by the Soviet government at the U.S. embassy building in Moscow. To test the Central Intelligence Agency's theory that the purpose of the Signal was to alter the thinking processes of the embassy workers, Adey performed classic gold-standard experiments to determine whether a simulated version of the Signal altered the electroencephalogram of monkeys or impaired their ability to react to a stimulus, and he found both effects. These studies led to a career in which he performed numerous human, animal, and cell studies, and consistently found that levels of electromagnetic energy pervasively present in the human environment affected brain electrical activity and altered the movement of calcium ions in the brain. All of Adey's research was funded by the U.S. government and published in world-class journals. He prevailed as a career government investigator of the biological effects of electromagnetic energy, notwithstanding that his results were diametrically opposite to what the power-company trio claimed were possible, because he never talked openly about the public-health implications of his research. On several occasions, Adey told me that he had no obligation to explain the health implications of his research to ordinary people; he said his responsibility was to do "good science," not talk to laymen about science. He called Becker's actions to the contrary a "mistake." Adey was the perfect instantiation of what Handler often described as the ideal scientist—someone who does his research but keeps his mouth shut regarding

its implications for public health, except when speaking through official organs such as the Academy.

ULTIMATELY, HANDLER SOLVED his problem and secured Adey's cooperation by agreeing to allow him to write a signed chapter describing his research, including that on the behavioral effects of man-made electromagnetic energy on monkeys, which Adey regarded as singularly important because he felt it showed that electrical changes in the brain caused by electromagnetic energy had actual consequences in the world. Adey's deal with Handler countered the excoriations leveled by Schwan, Michaelson, and Miller, but it was strongly opposed by Don Justesen, the most influential consultant on Handler's staff regarding electromagnetic energy. Justesen, who also had performed secret behavioral research on the Moscow Signal but had failed to find effects, argued against including laudatory language of Adey's behavior studies in his signed chapter. Handler resolved the issue by allowing inclusion of a third signed chapter in the final report which defended Adey's behavioral research, but was signed by one of his students, not Adey himself.

THE THREE SIGNED CHAPTERS and the literature analysis by the power-company trio were the plot of the panel report, but it was Handler who crafted its narrative structure—the gist of which was what the public would learn when they read newspaper and magazine articles concerning the Academy's "aegis" judgment. Handler's primary goal was to reinforce a principle he had promoted with varying degrees of intensity in other Academy reports. He believed that "probable" health effects were a condition precedent for alerting or warning people who were involuntarily exposed to man-made environmental factors. Mere "possible" effects," in other words, "probable risks," was not a sufficient standard when balanced against the economic costs to society. In the next chapter, I will have more to say about the nature and origin of Handler's personal views concerning the nature of health risks and how they should be revealed to the public. Here, it is sufficient for the reader to recognize that his views regarding what health risks were, and how they were related to risk/benefit analysis, were fully formed by the time he puppeteered the Hastings panel and constructed the report's narrative concerning the health risks of electromagnetic energy.

The principle Handler believed and promoted was essentially legal in nature, as Robert Harvey had recognized in his brief on behalf of the power companies in the New York hearing. Handler was no lawyer, and even if he were, an Academy panel would be the wrong forum in which to plead his case. Even if the panel were appropriate for advocating in favor of risk/benefit analysis and against probable risk as the standard for protecting public health, doing so explicitly would be politically poisonous and lead to the kind of unwanted publicity that had resulted in the creation of the Hastings panel in the first place. The clever Handler skirted these obstacles to his goal by hiding it in plain sight in the report. First, in the preface, the objective of the report was ambiguously described: "To respond to a request from the United States Navy for a study of the possibility that humans and animals would be harmed by the electromagnetic energy emitted by the Sanguine

antenna," language that could be understood to refer to either effects or risks, depending on how "possibility" and "harm" were construed, two loaded terms that he left undefined in the report. The subsequent text in the body of the report was an infinite regress—exactly what biological condition was being discussed, in relation to what particular causative factor, on the basis of what authority, according to what standard of proof, were all thoroughly obscured by incoherently prolix syntax. Then, in the last pages, after almost four hundred pages of unmoored sciency terminology, the panel concluded that "it cannot identify with certainty any specific biologic effects that will definitely result from exposure to the proposed Sanguine energy," and proceeded to declare that the antenna would be safe. In actuality, the opinion was a legal assertion that the residents of Wisconsin and Michigan had no right to protection against "possible effects," or in other words, "probable risks."

Handler knew from experience that the technical language in the report would largely be ignored by journalists in favor of an overarching theme of safety, which would be the bottom line in their articles. In this manner, Handler did furtively throughout the narrative what he could not do openly. The harsh import of his legal claim was masked and touted as if it were a scientific fact. He tried to maintain all details regarding construction of the plot and narrative in strict secrecy, and took specific contractual steps to prevent disclosures by individual panel members; they were required to sign contracts that forbade them from revealing anything about how the report was produced and from taking any public position inconsistent with any conclusions in the report.

Grant Politics

The research projects of the PhDs and MDs on Becker's staff involved some aspect of his overall scientific concept—that electromagnetic energy was the basic language of life and was ultimately responsible for both health and disease. He supported us all, salary, equipment, and supplies, by means of the grants he received from the VA and the National Institutes of Health, all of which were awarded for mechanistic studies. Becker sheltered me after I switched my research focus from mechanistic to gold-standard studies, and he encouraged me to proceed in that direction because he believed they were a necessary part of the overall picture regarding electromagnetic energy—in the contexts of both environmental pollution and medical devices. He continued to steadfastly support me despite Handler's intimidation.

I HOPED THAT the results of my gold-standard studies would matter in a post-Handler world, but prospects for continuing the research using funds that were directly awarded to me were bleak because there were no likely funding sources for doing the kind of experiments that I believed were necessary to help evaluate the health risks of electromagnetic energy. As a matter of institute policy, gold-standard studies to explore side-effects of toxins were not funded by the National Institutes of Health, which regarded such studies as a low-level research activity appropriate only for industry. An additional and more

significant hurdle involved how the purpose of biological research was construed by biochemists, who were almost exclusively the decision-makers at the institutes. Congress had initially created them to fund research that advanced scientific knowledge related to human health. In the 1950s, and particularly after Handler became a politically powerful leader at the National Institutes of Health, administrators of the institutes interpreted their congressional mandate to mean "seek mechanistic knowledge" regarding health and disease—the concept of experimental biology created by biochemists. With nil exceptions, the institutes awarded grants only to applicants who promised to do so, although some non-mechanistic studies were done because every grantee had the legal right to change the planned experiments, as Becker had done. In the eyes of the institutes, which essentially were Handler's eyes because he remade them according to his lights, Becker sinned twice when he supported my research, because it was not necessarily mechanistic and because it involved electromagnetic energy.

DESPITE THE BLEAK OUTLOOK, I applied to the institutes for my own grant, hoping to continue my research at the VA or at a university when Becker's laboratory closed. The application was reviewed by the Institute for Environmental Health Sciences, which typically funded mechanistic studies of known toxin-induced environmental phenomena with the rationale that mechanistic knowledge would point the way to a biochemical method which would reduce or eliminate the environmental consequences. It came as no shock when the review committee criticized my research plan because it was not based on a mechanistic theory for how electromagnetic energy could cause stress or growth defects in the animals, and because the biological endpoints I proposed to measure were not known to occur in the general environment as a result of exposure to electromagnetic energy. The gist of the review was that I could be funded only to study *how* known environmental effects occurred, and I had not shown that there were any. Anticipating that point-of-view, I had argued in my proposal that the seminal scientific issue was *whether* biological effects caused by electromagnetic energy actually occurred, not *how* they occurred, and that the *whether* question was logically prior to the *how* question because non-existent effects have no mechanisms. I also argued that it was not in the public interest to wait until there was conclusive evidence that people actually developed chronic diseases from exposure to environmental electromagnetic energy, because there was no scientific method for obtaining conclusive evidence. Consequently, the results of gold-standard studies such as I proposed were the only possible basis for evaluating human risks based on experiments.

The review committee approved my experimental design but made clear they didn't like the kind of experiments I proposed, calling them "not mechanistic but merely data-collection exercises," and assigned it a score that was below the funding level. Even so, the committee's approval meant that the experiments I proposed were scientifically acceptable, and thus could be funded by *any* government agency that had different priorities and wanted the work to proceed and was willing to spend its own money. The Environmental

Protection Agency had the requisite priority, so by means of a federal budgetary process called pass-through funding, my rat and mice studies were funded.

Fourth Academy Panel

Handler had shown no awareness that rigging the Hastings panel, championing the opinions of impeached experts, and making Faustian bargains with Adey had actually legitimized a scientifically and ethically flawed national science policy regarding health risks from electromagnetic energy. The opposite. Handler was presented with another opportunity to reinforce his policies: he doubled down on his belief that 'risk' was an economic concept to be assessed by biochemists, and that the appropriate method to resolve public-health questions involving electromagnetic energy was his version of risk/benefit analysis.

THE AIR FORCE ANNOUNCED plans to build a system of radar antennas in Cape Cod, Massachusetts to detect Soviet missiles before they impacted North America. The Air Force unabashedly conceded that its basic policy concerning biohazards was "concerned only with practical problems in dealing with agents that have immediate and well-recognized deleterious effects." In its Environmental Impact Statement, unnamed experts argued that tissue heating was the only immediate and well-recognized deleterious effect caused by the electromagnetic energy from the radars, and that the heating they caused had not been proven hazardous. A handful of gold-standard studies that had contrary implications were mentioned but dismissed as being "curious," "unclear," of "no demonstrated relevance," of having "no medical or general health significance," or were discounted to zero because the mechanism of action of the electromagnetic energy in the study was not known. Unlike the Navy, the Air Force had done no relevant research and therefore had no unexpected results to explain away. The Statement concluded there were no immediate and well-recognized deleterious effects and therefore no hazards to the public who would be exposed to the antennas' electromagnetic energy.

Adey-Justesen Panel

Following demands by residents and politicians in Massachusetts that an independent unbiased panel of experts be appointed to evaluate the risks to health and the environment posed by the radars, the Air Force turned to Handler and he appointed an Academy panel to form and publish its opinion under the Academy's "aegis." From the moment Handler announced the composition of the panel, its opinion and reasoning regarding the safety of the radars was dead certain. He chose Ross Adey, Don Justesen, and six others, all of whom had serious conflicts of interest as a contractor, consultant or employee of the military or the companies that were building the radars. The panelists were experts in the legal sense because each had a degree in science, but none were both unbiased and knowledgeable, which was what Handler had incessantly maintained was the defining characteristic of an Academy panel, and the reason that its judgments deserved public acquiescence.

HISTORICALLY, THE OPINIONS of Adey and Justesen regarding public-health aspects of electromagnetic energy were mutually compatible—they both conceded the existence of biological effects but denied the existence of risks on the basis of their risk/benefit evaluations of the type that Handler had developed. To the casual observer they seemed indistinguishable, but actually they were quite different. Adey was a credible scientist and a chronic irritant to Handler, whereas Justesen was only a tool used by Handler. Adey disdained Justesen's methodology—studies of rats in a Skinner box in a microwave oven—and Justesen resented the respect Adey enjoyed among government agencies, something that largely eluded Justesen.

IN RESPONSE TO REQUESTS for comments, Becker and I expressed our views of the Air Force's Environmental Impact Statement in a letter to Massachusetts politicians, using the letterhead of the medical school, where we were on the faculty, in hopes of blunting the blow-back we anticipated from Handler. We said,

> "In our view, the great weight of scientific evidence establishes that electromagnetic energy—in addition to the specific effects that they may cause—are biological stressors. As with more familiar stressors such as heat, cold, or trauma, chronic exposure to the electromagnetic energy can produce a variety of debilitating illnesses, depending on individual predisposition."

We advocated for recognition of a distinction between a "biological effect" and a "hazard" in the context of exposure to the radars' energy, and we paid particular attention to the harsh consequences entailed by the legal position the Air Force took in the Statement:

> "To urge that a biological effect induced in a subject exposed to the radars' energy is permissible until proved hazardous is the same as urging involuntary human experimentation to evaluate the degree of biological insult caused by the radar. The proper presumption is that any biological effect is potentially hazardous."

AS EXPECTED, the panel truckled to Handler's wishes and consensed a final report that was a contradictory gemisch of assertations, assumptions, and value judgments—nothing like respectable scientific advice but expectable from panelists who could pontificate without fear of contradiction. Each of the panel's conclusions was dishonest and/or misleading.

- They said, "All known or suspected biological effects due to electromagnetic energy were not associated with increased human morbidity or mortality." But it would be medically unethical and legally unprecedented to require such statistical associations as a condition precedent to accept the existence of a human health risk.
- They said, "No overt deleterious health effects have been documented to result from exposure of the public to the electromagnetic energy from the radars." But relevant studies had never been done.

- They said, "It was improbable that exposure to the electromagnetic energy from the radars will present any hazard to the public." But the salient question involved the existence of risks, not hazards, and the issue of risks was ignored.

The panel showed no sense of its limitations when it consensed its conclusions, as if Handler had given them the ring of Gyges, allowing normally just men to behave unjustly because they were invisible and would not have to account for what they said.

JUSTESEN CONTRIBUTED essentially nothing to the final report which was produced by Handler's staff, but it was a different story with Adey. His self-serving language in the report was unmistakable:

- "In view of the known sensitivity of the mammalian central nervous system to electromagnetic fields, especially those modulated at brainwave frequencies, the possibility cannot be ruled out that exposure to the radars' electromagnetic energy may have some effects on exposed people;"
- "Cell and animal exposures of nervous tissue have provided additional evidence of sensitivity to low-intensity microwave fields;"
- "Effects have been reported to occur in specific ranges ("windows") of intensity and pulse repetition rate, whose existence suggests that alterations in nervous tissue may not depend solely on exposure intensity or duration; in other words, such effects do not follow monotonic dose-response relationships;"
- "Studies showing that the mammalian central nervous system reacts to microwaves suggested that alterations in that system could be caused by the radars;"
- "Because of lack of adequate data, it is not known whether effects will be induced in humans under the anticipated exposure conditions."

No one on Handler's staff or panel had the cojones to oppose Adey, and because the panel had consensed the self-serving principles he had maneuvered into the final report, he had no reason to object to the appearance that he was consensing principles with which he profoundly disagreed.

THE REPORT was self-contradictory on its face, but Handler bet that wouldn't matter, and it didn't. The reality was that the radars would be built because, as Justesen once said to me, it didn't matter if they caused cancer in a hundred thousand people, the radars were a national security necessity. When Handler defended a putative national security necessity by falsely claiming that scientific evidence proved it would be completely safe, he sinned against both science and justice.

Consequences

Handler Speaks

The unfair treatment Becker received at the hands of Handler was only the smaller part of his evil. There existed in the real world, in contrast to what was in Handler's mind as judged by his actions, a *bona fide* issue in social policy regarding the safety of environmental electromagnetic energy. But Handler had whitewashed the issue by characterizing it as a problem in science and was succeeding in making the whitewashed version national science policy. There was no national-level criticism of his policy regarding electromagnetic energy, and consequently no need for him to publicly explain his personal opinions and objectives concerning health risks from electromagnetic energy. Late in 1979, however, an article in *Saturday Review* magazine about the Hastings panel drove Handler into an epic rage, and he came out of the shadows.

The article described the contacts Becker and I had with Hastings, including our warnings about the partisanship of Schwan, Michaelson, and Miller, and that Handler had appointed them anyway. All the major figures involved in the controversy were interviewed concerning the bias of the panel, except Handler who declined. Hastings was criticized for the "clean bill of health" his panel gave the antenna and for lying about the research Becker and I had done. The article said Hastings had "lashed out at the credibility of colleagues who differ with his benign depiction of a Navy project. "Schwan was mocked for using calculations as a basis for claiming that the man-made electromagnetic energy was completely safe. Hastings was quoted saying that he had welcomed Schwan, Michaelson, and Miller to his panel because testifying for a power company "is not a basis for removing anyone from eligibility," and saying that Becker and I were "quacks" who had not done any relevant research. Hans Selye, the originator of the theory of biological stress, was interviewed and he offered strong support for Becker's point of view regarding the link between disease and stress induced by electromagnetic energy. Selye said that Becker and I were the experts on the subject. The article concluded that "metal balls and calculations cannot determine what is or is not a dangerous assault on internal organs."

Handler had presided over many contentious science-policy issues, and his *modus operandi* had always been to remain behind the scenes, never disclosing the extent that his opinions contributed to the advice offered by his panels, his actual role in the Academy's process for producing advice about science policy, preferring instead to work through intermediaries, like the Pythia who spoke for Apollo at Delphi. When the article appeared, his staff urged him to continue projecting an image of aloofness. Dramatically, however, Handler injected himself directly into the controversy in a way he had never done. In a letter to the magazine's editor, Handler complained that the article was replete with what he said were willful and venal distortions, inaccuracies, and misrepresentations, slanderous descriptions of Hastings and Schwan. He said the article insulted both the Academy, using language that implied the Academy was pure and above criticism, and a paper he had

written, "Scientific Evidence and Public Decision Making." Handler threatened to sue the magazine to rectify "the grievous injustice done to the Academy," unless the editor agreed to publish the paper, which he said would provide "actual scientific knowledge" regarding the effects of electromagnetic energy from the antenna and from powerlines."

The paper began with language Handler had used many times in speeches and testimonies in congressional hearings, descriptions of the magnificence of science, its importance to humanity, and the stalwart role the Academy played in protecting the sanctity and independence of science. Then he described the physics of electromagnetic energy, expressed his profound regard for Hastings and Schwan, and attacked Becker's ideas and the gold-standard studies I had presented in the New York hearing, using the same words Schwan, Michaelson, and Miller had used. Immediately below, I styled Handler's pirated opinions as if they were Answers in testimony; his irrelevant comments, verbal flourishes, and redundant language were removed but otherwise the words were his. The matching Questions were extracted from those Robert Harvey had asked Schwan, Michaelson, and Miller when Handler's Answers were first elicited:

Q. What are the biological effects of man-made electromagnetic energy, if any?

A. Obtaining a reliable, definitive answer to that question turns out to be rather difficult, but we can readily provide some gross answers. While there are plentiful data, much of them are contradictory, and some are simply experimentally invalid. Efforts to search for biological effects of electromagnetic energy have been persistent, catholic, and imaginative. The examination has included searches for possible effects on the growth and development of plants and animals, for changes in physiological or molecular aspects of cellular metabolism, for genetic and chromosomal changes, and for any effects on the behavior of animals or people. The general conclusion extractable from the sum of these efforts is that if a hazard does exist it has not been demonstrated.

Q. Are you saying that you just don't know if there are hazards?

A. In the absence of any proof and in the absence of any theory that predicts such effects, we are left with the unprovable negative: that there does not exist any danger from electromagnetic energy at the level at which people are customarily exposed. And we are left also with a burden to improve the experimental methods necessary to appraise further those small effects that have been seen to ascertain whether they signal real hazards.

Q. What small effects are you referring to?

A. Many result have been inconsistent, with superficially similar experiments seemingly finding opposite results. For example, one report claimed a significantly increased human reaction time upon exposure to electromagnetic energy of 3 Hz as compared to exposure to 10 Hz, whereas another report claimed that there was an increased reaction time at 12Hz as compared to 2Hz. These results can't both be correct, and probably neither is.

Q. Can you describe other instances that in your opinion are examples of inconsistencies?

A. Two studies assessed the effect of 60-Hz energy on the growth rate of chickens; one found no effect and the second a decreased growth rate. Such inconsistencies have been obtained repeatedly in the history of science, particularly when, as in this case, the effects sought are small.

Q. In addition to inconsistencies, are there other scientific flaws in the experiments that Marino relied on?

A. In some experiments, incomplete technical information was provided, in others there was a drawing of conclusions not supported by what purportedly was measured. To illustrate, Soviet investigators reported a number of complaints—listlessness, excitability, headache, drowsiness, and fatigue attributable to exposure to electromagnetic energy. However, a nine-year study of linemen conducted by American power companies found no physical, mental, or emotional effects attributable to exposure to powerline energy. Similarly, a study in France of people working and living in proximity to powerlines found no increase either in the frequency of visits to physicians or use of medications. Studies in Canada, Germany, Sweden, and Japan have failed to show significant effects on electrical workers from the electromagnetic energy in which they intimately work.

Q. What should the ordinary person think under these circumstances?

A. The layman should be wary and recognize that conclusions from seemingly positive experiments are tentative at best, and perhaps invalid. American scientists have noted that the Russians found similar results in different working environments, which is suspicious.

Q. Do the problems you described also occur in animal studies?

A. Similar puzzles crop up in experiments with rats and mice. In an experiment conducted by the power companies, for example, there was no effect on either the growth or development of mice that were exposed to very high levels of electromagnetic energy. In contrast to this benign result, Marino asserted statistically significant decreased water consumption, food intake, and weight gain as well as increased adrenal and pituitary weights and decreased blood steroid levels in rats exposed to lower energy. These results are inconsistent.

Q. Have experiments looked for changes in the chemical composition of the blood, such as serum triglycerides?

A. In a Navy study by Deitrich Beischer in which volunteers were confined to a small room and exposed to electromagnetic energy, he reported higher triglyceride levels compared with controls. But this is slippery ground for public decision because another experiment in which humans were exposed found no differences in other blood constituents. In a related series of experiments conducted on personnel involved in the Navy's

Project Sanguine facility at Clam Lake, Wisconsin, supposedly elevated serum triglyceride levels were found in these personnel; but the control subjects lived in Illinois. The best explanation for all these results is that there were no real effects due to exposure to electromagnetic energy.

Q. Did the *Saturday Review* article (see, "Marino's testimony") adequately characterize the physics of electromagnetic energy?

A. It failed to do so and, oddly, the article even derided attempts to understand at a fundamental level the effects of electromagnetic energy. After indicating that Schwan "used a metal ball as a model of the human body, together with his own assumptions of how much heat the body can throw off," the author opined "metal balls and calculations cannot determine what is or is not a dangerous assault on internal organs." What chutzpah!

Q. Did the article make other errors regarding Dr. Schwan?

A. It made many errors:

Stating that Schwan's funding is largely from the Department of Defense when the bulk thereof derives from the National Institutes of Health;

Indicating that his research is in "electromagnetics" when it is in biophysics and biology;

Stating that Dr. Schwan used "metal balls" when he employed spheres of tissue to approximate exposures to electromagnetic energy;

Failing to note that the work referred to, done over a period of thirty years, has been rigorously reviewed and reaffirmed in the scientific literature;

Failing to note that Schwan is a member of the National Academy of Sciences and is perhaps the leading authority in the United States, if not the world, on the interactions of electromagnetic energy with living tissue.

Q. What is your opinion of the research of Andrew Marino of the Veterans Administration Medical Center at Syracuse and his colleagues, who asserted that there are quite clear effects due to electromagnetic energy?

A. He published papers claiming that fairly low-intensity energy causes "stress" in experimental animals, the consequences including stunted growth, food avoidance, and changes in physiological state, and concluded that the animals were exhibiting the classic signs of stress. A prime role of the Hastings panel (see, Schwan, Michaelson, and Miller) was to appraise the scientific validity of experimental results and determine whether they were artifacts. The members of the panel, whom I appointed to review Marino's work, found that the cages he used to house the experimental animals could have transmitted small electric shocks each time the rats ate or drank, and that he never considered the possible role of these artifacts. It seems likely that to be "buzzed" when one eats is not to eat well. Stress can be validly ascertained only by comparisons under precisely identical conditions, and that was patently not the situation in their experiments. Moreover, the data

were themselves paradoxical: they reported reduced levels of corticosteroid hormones whereas classic stress research shows that stress raises such levels. Independent analysis of their own data shows that there was no statistically significant difference in the weight of the treated versus the untreated rats! And what about their picture of the woefully stunted mouse that appeared in the article? Perhaps the growth of some mice was indeed stunted, but it must have been a very small fraction of the total. And the experimental procedures used do not unequivocally tell us why; they most surely do not provide scientifically acceptable evidence that electromagnetic energy causes such effects.

Q. Has the research of Marino been generally accepted by the scientific community?

A. His research and opinions have been rejected as valueless by the rules by which science guards against shoddy work. His results seem provocative, but they are not believable because they are not real.

In the paper Handler sent to the *Saturday Review*, he made false statements, advanced claims that were simplistic to the point of parody, and deprecated literature reports using technical arguments that didn't belong in the mouth of a biochemist. He plagiarized much of the language he used from the testimony of Schwan, Michaelson, and Miller. When Handler did that, he constructively adopted their errors and their immorality of balancing off positive effects reported by independent investigators against the result of rigged industry studies. Effectively, he blessed their rhetorical technique of making perfect studies the enemies of good studies to deny health risks. Handler did more that utilize the plagiarized language of the three scientific miscreants to connect the statement of the basic question—the safety of the Sanguine antenna—and the affirmative conclusion he had reached before he created the panel. He also added so much self-authored goopher dust that the question and answer could be connected rhetorically using only the goopher dust, irrespective of the testimonies of Schwan, Michaelson, and Miller.

FROM THE BULLY PULPIT of the Academy, Philip Handler created a *de facto* standard for determining what a health risk due to man-made electromagnetic energy in the environment was—the weighing of risks to health experienced by individuals against the financial benefits received by stakeholders and society, with the proviso that man-made electromagnetic energy in the environment should be considered to be perfectly safe until conclusively proved otherwise by biochemical evidence. It was this science policy, and his "right" to make it, that Handler was defending in the paper he sent to the magazine, a policy and a "right" that he believed in with a ferocity that could be measured by the vehemence of his language. This value-based science-policy edifice he built began operating throughout the U.S. to promote a fiction about public health—that exposure to man-made environmental electromagnetic energy was completely safe—as if it were a scientific fact.

Symposia

A group of scientists who had similar views regarding the biological role of electromagnetic energy started a scientific society devoted to advancing research in the area, and we held a symposium at the 1980 meeting of the American Association for the Advancement of Science. In the symposium, Szent-Gyorgyi and Lipinski, biochemists with open minds, described their theories and evidence for the role of electromagnetic energy in the pathogenesis of cardiovascular disease and cancer. "Pathogenesis" to a Handlerian biochemist meant identifying the biochemicals that were abnormal after disease began; to non-Handlerians, it meant identifying how disease began. Smith, a biologist who had performed the original experiments on limb regeneration that inspired Becker, described his latest results on frogs, the phylogenetically lowest species that doesn't normally regenerate missing limbs. Pilla, an electrochemist who developed a theory to explain how bone cells interacted with electromagnetic energy—useless, as later became apparent, but brimming with potential at the time—presented experimental evidence regarding his invention of a device that stimulated bone growth, which had recently been approved for sale by the government. I spoke about the problem of side-effects due to environmental electromagnetic energy. Powerlines and antennas had proliferated and historically entered the marketplace in the absence of pre-market safety evaluations, but subsequent laboratory studies on animals clearly showed that the electromagnetic energy they emitted into the human environment could be a biological stressor, thus possibly increasing the incidence of a broad range of human diseases. Although this generalized mode-of-action will surely complicate future analyses of the problem, I said, such difficulties were no valid justification for failing to address it using gold-standard studies, the only possible ethical scientific method.

In the audience I recognized Chauncey Starr, who was the head of the Electric Power Research Institute. When I went to hear him speak at his symposium, I saw Handler on one side of the room. He had always been involved in animated conversation whenever I had seen him in public. But that afternoon in early January 1980 he seemed smaller, almost lethargic, and spoke little to those around him, which included both Justesen and Adey, but never at the same time. I knew Starr was an engineer and a strong proponent of nuclear power. After I heard him speak and learned how he thought about health risks, I better understood Handler's tactics in the Academy panels. I will have more to say about Starr and Handler later. Here, it is only necessary that you see that the fundamental problem with the conclusion Handler's panels had reached—exposure to man-made environmental electromagnetic energy was completely safe—which I attacked in my talk at our symposium, was not something that could be resolved by the scientific method, and was not so resolved by the panels. The conclusion was a judgment by Handler based on his value system and was merely mouthed by his panels and published under the "aegis" of the Academy.

Becker's Exile

Becker once made the point that no one could dispute the value of research that explained what was previously unexplainable, but research that rendered unexplainable what had been previously regarded as satisfactorily explained was equally valuable. He said, "Such destruction of cherished dogma formed the basis for modern science, and we must always have a place for it—even today." His general point was that, despite the real and apparent successes that flowed from the reductionist cognitive structure of biochemistry, it alone was unable to solve any of the most important problems of medicine. He saw many disease conditions each day in his clinic where taking a pill was not a reasonable solution. He believed that new perspectives were needed that focused on real problems and what the possible solutions might be. In his research, he had concentrated on what he thought might be a solution, and he believed that his approach should be allowed and encouraged in the scientific marketplace. He deplored the extreme biochemicalization of clinical medicine, which limited initiatives in research to problems which could be solved employing the model of a human being as a chemical machine. He saw directly that many clinical problems didn't fit that model, and hence were ignored by the academics. As a physician, he naturally concentrated on the systemic level because that was where health and disease occurred, and in his research he sought instrumental scientific knowledge—benefits for patients. Becker called biochemistry "stamp-collecting" and thought it useful but less important than system-level, biocybernetic research. He regarded the biochemistry that mediated a biological process as important, but the system that controlled it as even more important. From time to time his research descended to the atomic level, seeking mechanistic explanations for his observations, but his research wasn't mired at that level. From his point-of-view, biochemicalization alone lacked even the promise of solving many important clinical problems because it did not even formally recognize their existence, and perhaps allowing a role for electromagnetic energy could fill the void. Becker wanted a fair opportunity to make his case regarding both the importance of the basic problem and his proposed answer. He was not knowledgeable regarding the deep physical laws of electromagnetic energy, but he had three PhD biophysicists on his staff to address those details.

Handler was Becker's anti-doppelganger, located at the opposite end of the spectrum regarding how and why experimental biology ought to be conducted. Handler was a biochemist disposed by training and temperament to think exclusively at the molecular level and to pursue scientific knowledge for its own sake. He was skeptical of any research in experimental biology that wasn't performed by someone educated as a biochemist because, he said, biochemistry was the only language of life. Handler saw no usefulness in Becker's systemic focus, particularly as regards electromagnetic energy, which Handler believed had no meaningful biological relevance. His views became concretized to the extent that he was unwilling to even consider the possibility that electromagnetic energy and biochemistry, taken together, were the language of life. It was as if he had a walnut-sized brain that could not simultaneously accommodate two equally fundamental concepts.

BECKER DID NOT EARN Handler's enmity overnight but rather accrued it by a lifetime of work. While Becker was still an orthopedic resident, he decided to seek an understanding of how growth was regulated, and he chose to work at a VA hospital because the VA promised to provide the resources he needed to conduct experiments on growth control. He published extensive evidence for his hypothesis that growth and healing were regulated by an electromagnetic system which was controlled by the brain and mediated by information-bearing electrical signals transmitted by nerves. He greatly antagonized orthodox biochemists by publishing research that showed artificial electromagnetic energy produced partial limb regeneration in rats, a phenomenon that contemporary biochemists believed was impossible in mammals. He further antagonized the biochemists when he published results involving the role of the energy in the processes of cellular de-differentiation, acupuncture, and biological stress. He regarded his side-effects studies as secondary to the task of elaborating the biocybernetic processes in the body, an objective that had the potential to revolutionize modern medicine and provide a true scientific medicine, not one limited to the biochemical model of life. But Becker was unprepared by training and temperament to deal with the reaction his work engendered among biochemists who opposed *bona fide* scientific facts simply because they clashed with dogma. Handler seemed hellbent on destroying not only Becker's ideas but also his career, an objective he was well-positioned to achieve.

HANDLER'S FATAL SLASH against Becker occurred soon after Becker's research on electrical control of limb regeneration unexpectedly came to the attention of two U.S. senators who controlled the VA's research budget. They read about Becker's work in the Washington Post, and after speaking with him they expressed their interest in his work directly to the head of the VA, which instantly elevated Becker to a position of influence over the VA budget for medical research. The head of the VA directed Marguerite Hays to organize a meeting to provide Becker with a forum where he could present his ideas about regeneration to a panel of experts. But Hays, after consulting with Handler, appointed a panel composed exclusively of biochemists, and they were devastatingly critical of Becker's presentation on the dogmatic grounds that limb and spinal cord regeneration were essentially impossible in any species phylogenetically higher than salamanders.

Hays argued to the head of the VA that scientists not politicians should make VA funding decisions, and recommended that the VA accept the money offered by the senators for a regeneration program, and that a panel of expert biochemists be appointed to decide who received the funds, but that Becker be excluded from consideration because he was not a biochemist. The head of the VA acquiesced, effectively ending Becker's career in research and forcing him into retirement. His career, which had begun with high praise from VA authorities, including the Middleton Award, appointment as chief of research at his hospital, and continuous national and VA funding, ended at age 56, in my judgment, the result of an act of revenge by Handler, the all-powerful president of the Academy.

BECKER WENT TO LIVE in a house he built in the Adirondacks, bloodied but unbowed, lacking Handler's political power but every bit as stubborn. He told me he had no regrets, and that if he had it all to do over, even knowing the influence that Handler would exert on his career, he would do nothing differently.

HANDLER USED HIS POWER with great effect to establish, as national science policy, his vision of what health risks were and how risk-benefit analysis should be used to measure them. By means of Academy panels, over which he had essentially total control, the science-policy questions of the health risks of military antennas were morphed into questions of scientific fact and Handler's answers were published as such under the "aegis" of the Academy. One of his included powers was the ability to create or destroy the career of any specific scientist in the U.S by means of controlling the federal funding for research received by the scientist. Handler used that power repeatedly against Becker, in the most unfair way imaginable, because he perceived, correctly, that Becker was a threat to his conception of biology. Both Becker and Handler were stubborn men, but in different ways. Handler in the pejorative sense of extreme hubris, Becker in the Sophoclean sense, willing to risk all in the pursuit of his vision of what was right.

Handler's Death

At the Advancement of Science meeting and the annual Academy meeting which took place four months later, people who knew Handler sensed an uncharacteristically low energy level, and suspected he was acutely ill. He had developed symptoms that he attributed to a common cold, but they continued for a more extended period; he developed a persistent cough and mentioned tenderness under his arms. Medical tests revealed an abnormality in the cells of his immune system, but he did nothing further to assess whether the abnormality was related to his symptoms. Instead, he began experimenting on himself, using various diet modifications and self-medicating, but his health continued to deteriorate. In early 1981, cancer specialists diagnosed Handler's condition as advanced cancer of the immune system. They recommended the orthodox treatment, toxic biochemicals and ionizing radiation, but he declined. His condition continued to worsen, and within a month after his term as president of the Academy ended in June, he was admitted to a hospital, where he finally accepted treatment with toxic biochemicals and radiation.

He understood his doctors as having said the treatments would cure him, and he began making plans to return to Duke where he intended to teach. But his doctors never expected him to recover and never told him otherwise. In October, as the treatments continued to diminish his quality of life even more than did the symptoms of the underlying disease, Handler was visited by representatives of President Reagan and presented with a medal for scientific achievement. The president praised Handler as someone who had devoted himself completely to the advancement of American science, intellectual freedom,

and human progress and well-being, and for having made significant contributions to pellagra research. Handler died in the hospital two months later.

A tribute was held for him at the Academy, with music by Schubert, Haydn, and Bach, recitation of the Kaddisch, and eulogies by seven men: four physicists, a congressman, a biochemist, and a judge. The physicists praised Handler for his strength of character, the congressmen for his political acumen, the biochemist for his laboratory skill, and the judge for his ability to make value judgments. The judge said Handler believed science was glorious, despite its occasional adverse effects on human welfare through its technological offspring, because the good outweighed the bad.