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The Enronization of Science

Lead . . . Hill and Knowlton. Vinyl chloride . . . Hill and Knowlton. Asbestos . . . Hill and Knowlton. Tobacco . . . Hill and Knowlton. Are we beginning to see a pattern here? Given where we are today, it is hard to believe that the cigarette manufacturers did not even have a trade association until 1953, when public relations guru John Hill warned the industry to get organized before it was too late and offered his firm's services for that dubious purpose. In 1966 Hill and Knowlton set up its Division of Scientific, Technical, and Environmental Affairs, which in later years would brag in solicitation brochures that this founding was "years before the first 'Earth Day' or the establishment of the Environmental Protection Agency."[1] Regarding the vinyl chloride story, the firm boasted that it assisted the producers of this carcinogen "to help fight and finally bring under control one of the most violent media and government regulatory firestorms ever experienced by a single industry," with the result that the final OSHA standards "were significantly less onerous than had been originally proposed."[2] When three scientists linked chlorofluorocarbon gas—Freon—to the destruction of the ozone layer[3] and users of the chemicals began to look for alternatives, Hill and Knowlton went into action. On behalf of the Freon manufacturers, the firm attacked the science as uncertain and later boasted that its work helped DuPont gain "two or three years before the government took action to ban fluorocarbons."[4] In fact, the science was of the highest quality: The three researchers subsequently won a Nobel Prize.

While Hill and Knowlton continues to provide public relations services to polluters, since the 1970s the sophistication of the "product defense industry" has grown apace with the federal regulatory apparatus established by Congress. For thirty years, therefore, it has been pretty much smooth sailing—that is, lots of lucrative work—for the key players in the new industry who specialize in helping corporations fight regulation. Ironically, more work is assured them with every advance in our ability to identify the deleterious health effects of toxic exposures. Only in the last few decades have we perfected the techniques that allow us to recognize and measure the illness and premature death toll associated with specific components of air pollution. New laboratory techniques have enabled scientists to examine the endocrine-disrupting properties of chemicals at almost unthinkably low levels of concentration. As a general rule, the more we know, the more regulation is required. Industry and free-market ideologues despise this logic, but what is the alternative? *Ignore* the health impact of these toxins? Yes, or better yet, let's debate the impact!

As the product defense work has gotten more and more specialized, the makeup of the business has changed; generic public relations operations like Hill and Knowlton have been eclipsed by product defense firms, specialty boutiques run by scientists. Having cut their teeth manufacturing uncertainty for Big Tobacco, scientists at ChemRisk, the Weinberg Group, Exponent, Inc., and other consulting firms now battle the regulatory agencies on behalf of the manufacturers of benzene, beryllium, chromium, MTBE (methyl tertiary-butyl ether), perchlorates, phthalates, and virtually every other toxic chemical in the news today. Their business model is straightforward. They profit by helping corporations minimize public health and environmental protection and fight claims of injury and illness. In field after field, year after year, this same handful of individuals and companies comes up again and again.

The range of their work is impressive. They have on their payrolls (or can bring in on a moment's notice) toxicologists, epidemiologists, biostatisticians, risk assessors, and any other professionally trained, media-savvy experts deemed necessary. They and the larger, wealthier industries for which they work go through the motions we expect of the scientific enterprise, salting the literature with their questionable reports and studies. Nevertheless, it is all a charade. The work has one overriding motivation: advocacy for the sponsor's position in civil court, the court of public opinion, and the regulatory arena. Often tailored to address issues that arise in litigation, they are more like legal pleadings than scientific papers. In the regulatory arena, the studies are useful not because they are good work that the regulatory agencies have to take seriously but because they clog the machinery and slow down the process.

Public health interests are beside the point. Follow the science wherever it leads? Not quite. This is science for hire, period, and it is extremely lucrative. Court records show that the big three U.S. auto companies paid product defense scientists $23 million between 2001 and 2006 to help defend them against disease claims by mechanics and other workers exposed to asbestos contained in automobile brakes.[5]

The coterie of consulting firms that specialize in product defense have done a great job—so great that manufacturing uncertainty has become a big business in itself. The scientific studies these firms do for their clients are like the accounting work that some Arthur Andersen Company accountants did for Enron (until both companies went bankrupt): They appear to play by the rules of the discipline, but their objective is to help corporations frustrate regulators and prevail in product liability litigation.

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Should the public lose all interest in its health, these product defense firms would be out of luck. Exponent, Inc., one of the premier firms in the product defense business, acknowledges as much in this filing with the Securities and Exchange Commission:

> Public concern over health, safety and preservation of the environment has resulted in the enactment of a broad range of environmental and/or other laws and regulations by local, state and federal lawmakers and agencies. These laws and the implementing regulations affect nearly every industry, as well as the agencies of federal, state and local governments charged with their enforcement. To the extent changes in such laws, regulations and enforcement or other factors significantly reduce the exposures of manufacturers, owners, service providers and others to liability, the demand for our services may be significantly reduced.[6]

Exponent, Inc., began its existence as an engineering firm, calling itself Failure Analysis Associates and specializing in assisting the auto industry in defending itself in lawsuits involving crashes.[7] "Failure analysis" is a standard methodology for investigating the breakdown of a system or machine, but the firm must have realized that "Failure" in its name might not work well outside the engineering world and switched to the more palatable Exponent, Inc., when it went public in 1998.[8]

Exponent's scientists are prolific writers of scientific reports and papers. While some may exist, I have yet to see an Exponent study that does not support the conclusion needed by the corporation or trade association that is paying the bill. Here are brief sketches of a few recent Exponent projects:

- The taste and smell of the gasoline additive MTBE are so foul that a tiny amount makes water undrinkable. This is bad because MTBE has contaminated drinking water sources across the country. (Moreover, it causes cancer in animals and may do so in people also, but this will be difficult to determine because the exposure levels are very low, exactly the sort of situation that epidemiology has the most difficulty addressing. The state of California has categorized MTBE as a possible human carcinogen.[9]) Communities across the country have sued the major oil companies and the MTBE manufacturers for the costs of cleaning up their water supplies. In response, a firm that provides the methanol used for making MTBE hired Exponent to produce a series of studies that concluded, not surprisingly, that MTBE is unlikely to pose a public health hazard and has not significantly impacted California's drinking water.[10] When the defendants in certain lawsuits tried to convince Congress to end the litigation by fiat and bail out the polluters, Exponent's economists produced a report for the American Petroleum Institute that concluded that the cost of the cleanup would be relatively low, which would make the proposed taxpayer bailout of the industry more acceptable to fiscal watchdogs.[11]
- An article in the *Annals of Emergency Medicine* suggested that the new generation of amusement park rides exposed thrill seekers to g-forces (a measure of acceleration) that exceed those experienced by astronauts and recommended that emergency physicians consider these rides as "a possible cause of unexplained neurologic events in healthy patients."[12] Six Flags Theme Parks, Inc., immediately commissioned Exponent to produce an "Investigation of Amusement Park Roller Coaster Injury Likelihood and Severity."[13] The press release on the report was headlined "Roller Coasters, Theme Parks Extraordinarily Safe."[14]
- Given the skyrocketing obesity rates among teenagers, many school systems and even some states have considered banning soda machines from high schools in order to discourage teenagers from consuming the empty calories. In 2005 an Exponent scientist conducted a study on behalf of the American Beverage Association that concluded that the number of beverages consumed from school vending machines "does not appear to be excessive."[15,16] In this case, however, the public just could not be convinced. The soft drink industry jettisoned these findings and in 2006 agreed to stop selling soda in schools.[17]
- Defense giant Lockheed Martin turned to Exponent when faced with the huge potential cost of cleaning up underground water sources contaminated with perchlorate, a rocket fuel component that ac-

cording to the National Academy of Sciences causes thyroid disease in infants.[18] Exponent's studies minimized the risk associated with perchlorate exposure.[19,20]

- When a study by consulting epidemiologists discovered a high rate of prostate cancer cases at a Syngenta plant that produced the pesticide atrazine,[21] Exponent's scientists produced a study that found no relationship between the chemical and the disease.[22]
- After numerous studies that linked pesticide exposure and Parkinson's disease appeared in prestigious scientific journals, Exponent's scientists produced a literature review for CropLife America, the trade association of pesticide producers, whose conclusion maintained that "the animal and epidemiologic data reviewed do not provide sufficient evidence to support a causal association between pesticide exposure and Parkinson's disease."[23]
- Exponent specializes in literature reviews that draw negative conclusions. The company's scientists have produced several reviews of the asbestos literature for use in litigation, all of which conclude that certain types of asbestos and certain types of asbestos exposure are far less dangerous than previously believed.[24–26]

Another major player is the Weinberg Group, which was founded in 1983 by Dr. Myron Weinberg, formerly of Booz, Allen, and Hamilton. "Asbestos, Tobacco, Pharmaceuticals—We're All Next!" shouts the PowerPoint presentation of one Weinberg executive. Here is his bottom line: "Without the science you cannot win, but having it carries no guarantee."[27] In one promotional brochure the firm touts its work for a company that was confronted with a Superfund problem. On behalf of this client Weinberg's scientists "analyzed existing studies to find any design flaws to support legal defense. . . . [B]y reanalyzing the raw data from this study, a biostatistician from THE WEINBERG GROUP helped to demonstrate the study's numerous design and analysis flaws."[28]

In 2003 DuPont hired the Weinberg Group to address "the threat of expanded litigation and additional regulation by the EPA" of perfluorooctanoic acid (PFOA),[29] a chemical used in the production of Teflon. (The majority of members on an EPA scientific advisory board have labeled PFOA a "likely" carcinogen.[30]) Paul Thacker, a reporter, uncovered a letter from Terry Gaffney, Weinberg's vice president for Product Defense, to a DuPont vice president, explaining that "DUPONT MUST SHAPE THE DEBATE AT ALL LEVELS." (This firm appears to favor uppercase exhortations.) Gaffney lays out a comprehensive strategy, including "analyzing existing data, and/or constructing a study to establish not only that

PFOA is safe . . . but that it offers real health benefits."[29,31] At the time, Gaffney was also running the campaign of a major manufacturer of ephedra-based dietary supplements to stop the FDA from banning ephedra, a product that the agency had already linked to 164 deaths.[32]

In my work on beryllium, I first came across the work of Dr. H. Daniel Roth. This was a reanalysis by Dr. Roth and Dr. Paul Levy on behalf of the beryllium industry, and it yielded the usual result: By changing some of the parameters, the researchers had managed to demonstrate that the statistically significant elevation of lung cancer risk was no longer statistically significant.[33] Such reanalyses are a specialty of some of the product defense firms, whereby one epidemiologist reanalyzes another's raw data in ways that almost always exonerate the chemical, toxin, or product in question. The studies are carefully designed to do just this. Statistically significant differences disappear; estimates of risk are reduced. Such alchemy is rather easily accomplished, whereas the opposite—turning insignificance into significance—is extremely difficult.

Intrigued by the work of Levy and Roth on behalf of the beryllium industry, I wanted to see whether the two had bestowed similar benefits on other industries, so I Googled them. Among the many exhibits I found were a number of tobacco documents showing how both men had worked for this industry. Dr. Levy was hired by R. J. Reynolds (RJR) to conduct a reanalysis of a study examining the link between lung cancer and workplace exposure to secondhand smoke; in 1998 he presented his findings to a National Toxicology Program panel that was considering whether to designate environmental tobacco smoke (ETS) as a carcinogen. No link existed, he concluded.[34] Dr. Roth's work with tobacco was more extensive. In 1985 he was one of the experts hired by Philip Morris to assist with its litigation, especially to develop ways to attribute lung cancer among smoking asbestos workers to asbestos rather than to smoking.[35] In 1987 he applied for the position of executive director of the Center for Indoor Air Research (CIAR), a creation of the Tobacco Institute. The evaluation of Dr. Roth by CIAR's executive search firm was very positive. "Simply put," it concluded, he "believes in the mission of the Center and in his ability to achieve its objectives."[36] The tobacco documents do not reveal whether he was offered the job, but it is clear he later played a key role in Big Tobacco's efforts to stop OSHA's proposed indoor air quality standard in 1994.[37]

The tobacco relationship did not surprise me, but the coal connection did. For the past thirty years Dr. Roth has worked for producers and users of coal, turning out reanalysis after reanalysis refuting studies of the health effects of airborne pollutants from coal-burning power plants. On behalf of the North Dakota Lignite Research Council, which represents companies that produce coal with a high mercury content, he reviewed the literature on

the effects of human exposure to mercury and, taking a page from the tobacco playbook, told the coal producers that most of the studies were "highly questionable" and that the overall picture was inconclusive. Even so, he recommended that "it would be valuable to reanalyze the raw data."[38]

In 1977 Dr. Roth produced a report for the electrical power industry that attacked the EPA's research on the relationship between exposure to fine particles in the air and the risk of asthma attacks. This reanalysis was required, he wrote, because the acceptance by the public and policy makers of the original EPA study was "making it most difficult to generate wise policy decisions on such matters as the rapid expansion of the use of coal."[39] Interestingly, both of Dr. Roth's coauthors on this study went on to become key scientists in Big Tobacco's campaign to manufacture uncertainty about the health effects of secondhand smoke. One of them, Dr. Anthony Colucci, was appointed director of RJR's Scientific Litigation Support Division.[40]

A jack of all trades within the product defense business, Dr. Roth also turned up in a book, *The Expert Witness Scam,* written by Leon Robertson, a retired professor of epidemiology from Yale and one of the two or three leading injury epidemiologists of the twentieth century. Dr. Robertson was appalled that for at least a decade Dr. Roth had been presented as an expert in vehicle rollovers although, according to Robertson, Roth had never published a research paper on any aspect of motor vehicle injuries.[7]

Dr. Roth also collaborated with Dr. Levy in refuting the risks associated with liquor; the Distilled Spirits Council of the United States hired them to critique the studies on alcohol consumption and breast cancer.[41,42]

Yet another major product defense consultant is ChemRisk, founded in the 1980s by Dennis Paustenbach, perhaps the leading figure in the field. Dr. Paustenbach has an unassailable scientific background. He is the author of two textbooks on risk assessment and hundreds of scientific articles and book chapters. At first, ChemRisk was part of a larger consulting firm, McLaren/Hart Environmental Engineering Corporation, of which Dr. Paustenbach eventually became president and chief executive officer. In 1998, when McLaren/Hart was facing bankruptcy, Dr. Paustenbach and several ChemRisk colleagues moved to Exponent, Inc.

In 2003 Dr. Paustenbach left Exponent and revived the name ChemRisk for his firm, which has prospered, quickly opening six offices around the country. He and his colleagues are important players in this book and are featured in upcoming discussions of benzene, beryllium, and chromium. In each case they have developed arguments that could have the effect of delaying or weakening public health regulation of a powerful toxin. Paustenbach is a veteran of the Love Canal and Times Beach, Missouri, catastrophes, and has been a key participant in the attempted rehabilitation of dioxin.[43] He has worked for the initiative funded by the auto industry that

attempts to show that asbestos liberated from automobile brakes does not cause disease,[44,45] and he was also among the scientists used by the tobacco industry to question the EPA's risk assessment of secondhand tobacco smoke.[46]

According to a report in the *Wall Street Journal,* Dr. Paustenbach and his colleagues at ChemRisk pulled off a particularly audacious stunt on behalf of Pacific Gas and Electric (PG&E).[47] The California utility was fighting several lawsuits, including the one portrayed in the movie *Erin Brockovich,* in which chromium-contaminated groundwater was alleged to have caused a range of illnesses. In mounting its defense, PG&E turned to ChemRisk, which had already been working for the chromium industry in New Jersey (trying to convince that state's regulators that the metal was not so dangerous as to require cleaning up a massive toxic waste dump.[48]) According to a report in the *Wall Street Journal,* ChemRisk's product defense experts, through an affiliate in Shanghai, obtained the raw data of a 1987 study that had implicated chromium-polluted water in high cancer rates.[49] This study was a major problem for the defendants. The *Wall Street Journal* reported that ChemRisk paid Dr. Zhang JianDong, the lead author, two thousand dollars, reanalyzed his data, and obtained different results that appeared to exonerate chromium. The renalysis was then published under the names of Dr. Zhang and a Chinese colleague, without any mention or acknowledgement of ChemRisk's role.[47,50,51]

This initiative was remarkably successful; for almost a decade, the fabricated study was promoted in courts and regulatory proceedings. Fortunately, the questionable history of the article is now public knowledge. After much uproar, the editor of the journal in which the paper was published withdrew the work,[52] and a California state epidemiologist has reexamined the original data and determined that Dr. Zhang's first analysis was the accurate one: Drinking chromium in your water increases your risk of stomach cancer.[53] (Paustenbach has said that his involvement in the paper was relatively minor and has defended the "underlying science." ChemRisk has also claimed that its scientists "wanted to be co-authors on the paper."[54] A year after the *Wall Street Journal* reported the story, the Chinese paper's second author claimed that the newspaper's coverage was inaccurate.[55] But the *Wall Street Journal* has not corrected or retracted its story.)

This episode was outrageous but not all that out of line with the standards of the industry. When product defense specialists cannot get the raw data required for a reanalysis, they have even been known to make them up. I learned this when I came across an abstract that described the reanalysis of the data of a study of older adults that had found reduced performance on neuropsychological tests associated with polychlorinated biphenyl (PCB) levels. The reanalysts did not have access to the raw data, so they came up

with a simulated data set based on the overall distribution of subjects in the original study. Not surprisingly, their results called into doubt the validity of the original findings.[56] My curiosity piqued, I called the author of the original study, toxicologist Susan Schantz of the University of Illinois. Dr. Schantz had never heard of the reanalysis. She had never been asked to provide her raw data, and when I read her the abstract, she laughed. Dr. Shantz told me the new work was simply wrong, as she could have explained to the reanalysts if they had asked her. (One of those reanalysts was the same scientist who would later defend the cause of selling soda in schools for the American Beverage Association.)

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Peer review is a complex issue, one that is widely misunderstood by the public and by some individuals in the regulatory and legal systems. Even rigorous peer review by honest scientists does *not* guarantee a study's accuracy or quality. Peer review is just one component of a larger quality control process through which scientific knowledge is developed and tested—a process that never ends. Nevertheless, it has been granted an important role in both the regulatory and legal systems. Some agencies, including the International Agency for Research on Cancer (IARC), will not consider using a paper in its deliberations if it has not undergone peer review.[57] Articles that have been published in peer-review journals are assumed, often mistakenly, to be of high quality. This is not necessarily so.

The credibility given peer-reviewed studies encourages product defense firms to manipulate and distort the process. They play the peer-review card beautifully. They understand that their studies and reanalyses need this imprimatur, but how do they get this seal of approval? Easy. They establish vanity journals that present themselves to the unwary as independent sources of information and science, but the peer reviewers are carefully chosen, like-minded corporate consultants sitting in friendly judgment on studies that are exquisitely structured to influence a regulatory proceeding or court case.

There is now a slew of these "captured" journals. The tobacco industry, for example, secretly financed the journal *Indoor and Built Environment* to promote (and position for legal purposes) the idea that indoor air pollution was a problem caused not by secondhand smoke but by inadequate ventilation.[58] The best-known of these publications is *Regulatory Toxicology and Pharmacology,* the official mouthpiece of the International Society for Regulatory Toxicology and Pharmacology (ISRTP)—an impressive name, but really just an association dominated by scientists who work for industry trade groups and consulting firms.[59] The sponsors of the ISRTP include many of the major tobacco, chemical, and drug manufacturing companies. Its leadership consists of corporate and product defense scientists and

attorneys, along with a small number of government scientists who have apparently bought in or who do not know better. The immediate past president was Terry Quill, an attorney who became senior vice president for product defense of the Weinberg Group.[60] Quill also has roots in the tobacco wars but not as a scientific expert. Rather, he served as outside counsel to Philip Morris in the secondhand-smoke litigation.[61]

The editor of *Regulatory Toxicology and Pharmacology* is Gio Gori, well known in the public health community as one of the tobacco industry's most prominent and long-standing defenders—after serving from 1968 to 1980 as director of the National Cancer Institute's highly regarded Smoking and Health Program. Then he changed sides and embarked on a lucrative career defending Big Tobacco on the secondhand smoke issue.[62]

Does the peer-review process at these journals play a role in improving the published papers or do studies of questionable validity move to publication unchallenged? Here is a recent story that speaks volumes. One well-known epidemiologist and corporate consultant recently conducted what is called a meta-analysis, in which several studies on the same exposure were combined into a single large study, theoretically at least more powerful than several smaller ones. The study, which was paid for by PG&E for use in the chromium-contaminated drinking water suits, concluded that, contrary to fifty years of epidemiologic studies, chromium was "only weakly carcinogenic for the lungs."[63]

Published in *Regulatory Toxicology and Pharmacology,* the study makes the most basic (and fatal) mistake of combining all types of exposure and cancer rates and treating them as comparable. Heavy exposures to airborne chromium among the workers in pigment factories were combined with light exposures among residents of towns with contaminated water. Of course, there was no increased lung cancer risk among the community residents—they were not *breathing* chromium. However, since there were several times more community residents than workers, they were weighted more heavily in the analysis, thereby diluting the effects seen in the worker study and making it appear that chromium was "only weakly carcinogenic for the lungs." That is an elementary error. The peer reviewers evidently did not mind, though, since the study achieved its product defense purpose for the industry.

Another story also illustrates how polluters use these journals-for-hire to impede public health measures. The International Agency for Research on Cancer is the branch of the World Health Organization devoted to cancer prevention. In February 2006 an IARC advisory panel met to consider whether carbon black, an important industrial chemical that is the foundation for many new "nanoproducts," should be categorized as a carcinogen. One of the papers that the panel planned to consider was a study that had

found that workers who had been exposed to carbon black had twice the expected risk of lung cancer.[64] The weekend before IARC's meeting was to start, a scientist who was working for the International Carbon Black Association (ICBA) breathlessly delivered to the IARC panel three manuscripts[65–67] that reanalyzed data from that first study. All three of these papers had been first presented at a conference sponsored by the ICBA and held less than *one month* before the IARC meeting.[68] The three new reanalyses had been put into a fast-track (two week) peer review and accepted for publication in the *Journal of Occupational and Environmental Medicine (JOEM),* whose work appears all too frequently in these pages. I should explain that peer review in a scientific journal generally takes at least several months, sometimes more than a year, and that authors generally revise articles based on reviewers' feedback. As we would surmise, the fast-track papers disputed the causal relationship between carbon black and lung cancer.

The IARC advisory panel voted that carbon black was "possibly carcinogenic" and concluded that, although sufficient evidence for carcinogenicity in animal studies existed, the human evidence was inadequate.[69] Did the three new reanalyses help shape the panel's conclusion? It is hard to say, but it is clear that most of the negative evidence from human studies was provided by the industry. No new independent studies have been undertaken, let alone fast-track peer-reviewed.

Skewed studies produced for the most mercenary of purposes are now accepted as part of the game. I saw this at the Department of Energy. Regarding the beryllium industry's advocacy briefs masquerading as scientific papers (they had been published in peer-review journals, after all), my career colleagues in the department shrugged. "It's all part of the game," they said. "We know what these papers are worth." The lack of outrage by honest scientists and regulators is distressing. The late senator Daniel Patrick Moynihan had a phase for it—he called it "defining deviancy down."[70] Conduct that was once considered unacceptable and that *should* be considered unacceptable is no longer stigmatized or even acknowledged as being corrupt. Moreover, some scientists and certainly most nonscientists (including reporters, judges, juries, and members of Congress) do *not* know what those papers are worth. They are often fooled—which is the whole idea.

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Polluters and manufacturers of dangerous products also fund think tanks and other front groups that are well known for their antagonism toward regulation and devotion to "free enterprise" and "free markets." There are dozens of these organizations working on behalf of just about every significant industry in this country. Some of the ones leading the fight on behalf of corporate interests against public health and environmental regulation are familiar: the Heritage Foundation, Washington Legal Foundation, American

Enterprise Institute for Public Policy Research, Cato Institute, Competitive Enterprise Institute, Hudson Institute, Progress and Freedom Foundation, and Citizens for a Sound Economy, to name a few. Each year these think tanks, along with a host of smaller, lesser-known ones, collect millions of dollars from regulated companies to promote campaigns that weaken public health and environmental protections.

These broad public-policy groups rarely pretend to do science themselves; they generally focus on major regulatory issues. Therefore, the polluting corporations and their trade associations have also set up a different stratum of think tanks and front groups they can rely on to churn out predictable, authoritative-looking reports that cull the friendly science commissioned by the companies themselves. These reports are aimed at legislators, the press, and the public. They always question the science regarding specific hazards (generally those created by their funders). For example, the Council on Water Quality pretends to ensure that the "best available science drives government actions on setting standards for perchlorate in water."[71] As previously mentioned, this rocket fuel additive is now contaminating groundwater supplies around the nation. Lockheed Martin and other polluters that are facing the huge cost of cleaning up contaminated aquifers provide the council's funding.[72] The group is run by staff at APCO Worldwide, the public relations giant that has done similar work for Big Tobacco, so consider the source when judging the claim that "[s]cientific research shows low levels of perchlorate are harmless."[71] In fact, an analysis by the National Academy of Sciences found that perchlorate causes thyroid damage, especially in infants, at fairly low exposure levels.[18]

The Center for Media and Democracy keeps tabs on these front groups on the web[73] and in a series of invaluable books written by Sheldon Rampton and John Stauber.[74–75] One of the groups they are following is the Center for Consumer Freedom, which uses funding from the food and restaurant industries to attack studies that link fat consumption to obesity.[76] The same group started FishScam to promote the idea that mercury in fish does not pose a danger to pregnant women.[77]

Another of these cleverly named organizations is the Foundation for Clean Air Progress. This group issues regular reports showing how pristine our environment is, questioning why anyone would want to strengthen the laws responsible for such excellent air. The organization is run by Burson-Marsteller, the PR firm, using funds provided by the petroleum, trucking, and other polluting industries.[78]

The Annapolis Center for Science-Based Policy was started by a vice president of the National Association of Manufacturers for, among other purposes, fighting the EPA's Clean Air standards.[79] It is heavily funded by ExxonMobil ($688,575 between 1998 and 2005)[80,81] and large coal-burning

utilities like the Southern Co. ($325,00 in 2003–2004).[82,83] A "key finding" of one Annapolis Center report states that "No one knows whether controlling [airborne particles] will actually yield net benefits to public health. Further regulation of PM is thus premature."[84] This has become the mantra of the big coal-burning power companies as they oppose further regulation of these particulates.[85,86] It is an indefensible assertion. While we cannot ethically set up a study in which we expose some people to high levels of these particulates (called PM, or particulate matter), the equivalent natural experiment happens all of the time. One of the most famous was studied by Arden Pope, a researcher at Brigham Young University who was conducting a long-term study of air pollution in Provo, Utah, in the 1980s. As his luck would have it, his research period covered a full year in which the big steel mill in Provo, which accounted for 80 percent of the region's airborne PM, was idled by a labor strike. In that year, the mortality rate and hospitalizations dramatically *decreased.* Once the strike was settled and the PM pollution from the steel mill resumed, mortality and hospitalization rates went back up.[87] The cause-effect relationship could not have been clearer.

So many studies have linked exposure to airborne PM levels and increased risk of death, hospitalization, and emergency room and clinic visits that the editor of the journal *Epidemiology,* Dr. Jonathan Samet, a distinguished scientist and chairman of the Department of Epidemiology at the Johns Hopkins Bloomberg School of Public Health, told scientists to stop submitting new studies on this topic. So many had already been published that new ones would add little of value to the scientific literature; the pages of Dr. Samet's journal could better be devoted to other topics.[88] We do not know everything about PM, but we know enough to be very confident that reducing the concentrations will prevent tens of thousands of deaths each year.[89–91]

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Let's face it, the work product of the product defense industry is impressive. Carefully manicured reports and reanalyses, captured journals full of "peer-reviewed" articles, and captured think tanks hiring out their ad hoc advocacy sow uncertainty across a range of issues. Perhaps the sleaziest behavior of all, though, is their practice of denigrating scientists and studies whose findings do not serve the corporate cause. Today the most prominent and effective public face and front for this component of the attack on science is the "junk science" movement, whose sole purpose is to ridicule research that threatens powerful interests, irrespective of the quality of that research. Peter Huber, based at the Manhattan Institute, is often credited with coining the term, as I mentioned in the introduction. I would like to repeat Huber's rough-and-ready description of junk science in his book *Galileo's Revenge: Junk Science in the Courtroom:* "Junk science is the mirror image of real science, with much of

the same form but none of the substance. . . . It is a hodgepodge of biased data, spurious inference, and logical legerdemain. . . . It is a catalog of every conceivable kind of error: data dredging, wishful thinking, truculent dogmatism, and, now and again, outright fraud."[92]

Orwellian indeed, as I stated in the introduction, but unquestionably the corporations and the product defense industry they fund have done a superb job in marketing the "sound science" slogan and thereby undermining the use of scientific evidence in public policy. The junkscience.com website lists a roster of "junk scientists," including six elected members of the Institute of Medicine and four recipients of the highest honor bestowed by the American College of Epidemiology, so it appears that scientists who are asked to identify *their* most outstanding colleagues do not share the opinions of the promoters of the "junk science" label.[93]

The opposite of junk science is, of course, "sound science." Rarely is the one invoked as bad without an immediate reference to the other as the ideal. The first entity to carry the official "sound science" flag was The Advancement of Sound Science Coalition (TASSC), which was "dedicated to ensuring the use of sound science in public policy decisions."[94,95] This front organization was set up by APCO Associates, one of Philip Morris's PR firms.[96] (Elisa Ong and Stanton Glantz described the founding role of tobacco in the sound science movement in the November 2001 issue of the *American Journal of Public Health*.[97]) Steven Milloy, the first executive director of TASSC, had formerly worked for Multinational Business Services, a firm run by Jim Tozzi, perhaps the premier antiregulatory tactician. Ultimately TASSC served its purpose and is now defunct, and Milloy has moved on to his own website, www.junkscience.com.

A representative "sound science" credo is this one from a TASSC press release, which quotes Dr. Margaret Maxey, director of the Clint W. Murchison Chair of Free Enterprise and professor of bioethics at the University of Texas: "More and more [science is] being used to justify preconceived agendas. Too often, public policy decisions that are based on inadequate science impose enormous economic costs and other hardships on consumers, businesses and government."[95] The usual figure provided for the annual cost of "regulations" has been in excess of $40 billion.[98] One of industry groups' favorite examples of costly policy is the Clean Air Act. Another TASSC authority, Floy Lilley, also of the University of Texas, had this to say in denouncing that regulation: "The Clean Air Act is a perfect example of laboratory science being superficially applied to reality. If it were reflective of reality, based on current government studies, medical examiners would find evidence of effects in lungs that are irreversible and life-threatening. This simply has not happened. And now we must wonder if the cost of the Clean Air Act is justified by alleged health benefits."[95]

In the fact-based world, the Clean Air Act has been one of the most successful modern public health regulations by preventing tens of thousands of illnesses and premature deaths and millions of asthma attacks.[99] Even the cost-benefit doyens of the second Bush administration, perhaps the most fervent opponents of regulation ever to occupy the White House, have estimated that its benefits outweigh its costs by somewhere between $50 billion and $400 billion.[98] But is anyone really surprised that it is subjected to ridiculous attacks? As comedian Lily Tomlin said, "No matter how cynical you become, it's never enough to keep up."[100]