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ABSTRACT

Drawing from articles appearing in several national publications about the dioxin contamination found in Midland, Michigan, in 1983, a case study examined how the publications handled the phenomenon of expert disagreement concerning the natur- of dio..in. Specifically, it examined how the publications handled expert disagreement about (1) the way dioxin gets into the environment, (2) whether it causes cancer in humans, (3) whether it causes birth defects or miscarriages in humans, (4) the significance for human health of studies showing dioxin has severe and acute health effects in animals, and (5) the implications of regulation of the substance. The study discovered that some of the publications obscured the existence of disagreements among scientists or made no attempt to account for it, while others attempted to explain it by suggesting that one side or another was irrational or psychologically disturbed, that the science used by one side was incompetent, or that the science used was corrupted by politics, economic pressures, or a commitment to corporate power. The study concludes that journalists can benefit from the review of studies in disciplines other than journalism showing that expert disagreement is a normal aspect of science that can be accounted for in a number of ways. (FL)

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DIOXIN IN MIDLAND

A Case Study of Press Coverage Of Expert Disagreement

By John Palen

A paper prepared for presentation
at the
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And Mass Communication

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ABSTRACT

Dioxin contamination at Midland became a national issue in 1983, a part of the larger controversy over Agent Orange, the evacuation of Times Beach, Mo., and the resignation of Ann Burford as director of the Environmental Protection AGency. For several months, Midland shared dioxin headlines in the national press. As in the larger dioxin story, reporters who went to scientists for information about dioxin in Midland encountered the phenomenon of expert disagreement. This paper, a case study, examines how the phenomenon of expert disagreement was covered in several national newspapers and magazines. Some of the publications obscured the existence of expert disagreement or made no attempt to account for it. Others attempted to explain it within a conceptual framework in which the possible explanations were "irrationality," "poor science" or "corrupt science." By contrast, studies in the philosophy, history and sociology of science indicate that expert disagreement is a normal aspect of science which can be accounted for in a variety of ways. STudies in these disciplines offer journalists a broader conceptual framework within which to report the phenomenon of expert disagreement.

ERIC

The author wishes to note that he was the editor of the Midland Daily News, Midland, Mich., during the time the events described in this paper occurred. He also wishes to acknowledge the help of Dr. Robert Snow of Michigan State University and Potsdam College.

ERIC

The dioxin controversy was in full flower in 1983. Veterans of the Vietnam War were suing manufacturers over health problems the veterans believed to have been caused by exposure to Agent Orange, a defoliant containing the dioxin isomer 2,3,7,8-TCDD.[1] High levels of dioxin found at Times Beach, Mo., led to a proposal by the Environmental Protection Agency to buy out the town and evacuate its residents. Dioxin was found in industrial areas in Michigan and New Jersey. The EPA itself, charged with cleaning up dumps containing dioxin and other chemicals, was under fire for allegedly lax and politicized enforcement. Ann Gorsuch Burford, its first director under the Reagan presidency, was forced to resign.

For journalists, the dioxin story was multifaceted. It was a legal story as well as a political story, a health story as well as an economic story, a national story as well as -- for some journalists -- a local story. It was also a science story. What is dioxin, how did it get into the environment, what should be done about it, and, above all, is it dangerous? Journalists went to scientists for answers to these questions. Instead of clear, unambiguous answers, they often found expert disagreement, especially on the issue of human health effects from low-level, long-term exposure. This paper will examine how some major newspapers and magazines presented the phenomenon of expert disagreement on that issue to readers in connection with a small part of the overall dioxin story -- the controversy over dioxin in Midland, Mich., as covered in the national press during 1983.

The presence of dioxin in fish in the Tittabawassee River at Midland had been known for several years and had been reported in local and state media. Residents had been warned against consuming fish caught near

Dow Chemical Co.'s chemical plant at Midland.[2] The dioxin contamination of the river became a national issue, however, after testimony in a Congressional hearing in March 1983 revealed that a Dow scientist had peer-reviewed a federal research report on dioxin and that statements attributing the contamination to Dow's production processes were subsequently deleted from the report. For several months, Midland shared headlines in the national press with Times Beach and other dioxin sites. As in the larger dioxin story, reporters who went to scientists for information encountered the phenomenon of expert disagreement.

This study will not attempt to evaluate which writers came closest to the "truth" about dioxin in Midland, for to do so would require that the controversies themselves, scientific and otherwise, be resolved -- a task beyond the author's competence. Instead, the paper will describe several ways in which expert disagreement was presented and accounted for in the articles studied; examine the assumptions about expert disagreement that appear to underlie such treatment; and suggest ways in which a broader conceptual framework could help journalists more thoroughly explore expert disagreement for readers.

II

Among scientists, there are several areas of past and/or current disagreement about dioxin. It is beyond the author's competence to independently review and evaluate the voluminous literature on dioxin, which includes work in such fields as analytical chemistry, toxicology and epidemiolcgy. Fred H. Tschirley of Michigan State University has published an overview of the research in the February 1986 issue of Scientific American.[3] I have adopted his review as a baseline guide to the controversies which have divided scientists. Among them are these:

-- How does dioxin get into the environment? One "well-defined source," according to Tschirley, is the manufacture of the herbicide 2,4,5-T. But dioxin also was found in the fly ash of municipal incinerators in the Netherlands, Switzerland, Canada and Japan. These findings led researchers at Dow Chemical Co. in Midland to hypothesize that polychlorinated dibenzo-p-dioxins (of which 2,3,7,8-TCDD is one) are a product of trace chemical reactions in combustion. The hypothesis was challenged because the nature of the process by which they are formed remains obscure.[4]

-- Does dioxin cause cancer in humans? A study by Lennart Hardell of Sweden found that forestry workers exposed to dioxin developed six times the normal incidence of soft-tissue sarcoma, a rare cancer. But, according to Tschirley, "subsequent events have emphasized the difficulties in accurate diagnosis of soft-tissue sarcoma and in accurate identification of exposed individuals." In addition, Tschirley wrote, other studies on occupational exposure to dioxin "fail to support" Hardell's hypothesis.[5]

-- Does dioxin cause birth defects or miscarriages in humans? A study by the Environmental Protection Agency, known as Alsea II, reported a link between 2,4,5-T spraying and the miscarriage rate among pregnant women in Alsea, Ore. "This study has come in for much criticism," Tschirley wrote, "notably by an interdisciplinary group at Oregon State University. The group concluded that an association between herbicide spraying and spontaneous abortion could not be shown from the data relied on by the agency. Other studies -- in Australia, Hungary, New Zealand and the U.S. -- failed to find a link between the use of 2,4,5-T and birth defects."[6]

-- How significant for human health are the many studies that show dioxin to have severe acute and chronic health effects on animals? It is on the basis of these studies that dioxin has become known as "the most toxic synthetic chemical known to man." However, extrapolation from animal tests to human health effects is "neither art nor science," Tschirley notes. This is so for two reasons. First, humans may be more, less or equally sensitive to a chemical than animals. Second, there is no "simple, accurate method of determining whether and at what level TCDD occurs in the tissues of exposed individuals."[7]

-- Finally, what are the implications for regulation? Regulatory actions continue to be based on animal studies for lack of sufficient human data, Tschirley wrote, "even when the human data, although they are not definitive, may be sufficiently compelling to allow a scientific judgment that the hazard to people has been overestimated.... Investigators are in general agreement that TCDD is less toxic to humans than it is to experimental animals, but the available information is not sufficiently compelling to stimulate a change in regulatory posture toward either more or less restriction of exposure to the material."[8]

III

The phenomenon of expert disagreement in the Midland dioxin controversy was reported in a variety of ways by newspapers and magazines. One was to obscure the nature of the disagreements themselves, either by reporting consensus where there was in fact disagreement, or by reporting disagreement where there was none. Examples of the first approach are found in some of the brief "background" descriptions of dioxin. The Los Angeles Times, for example, described dioxin as "one of the most deadly of man-made substances" and said it is "classified by scientists as the most deadly compound in nature, after botulism and tetanus toxins."[9] The New York Times said dioxin is "widely considered the most potent compound known."[10] These descriptions may be capable of being construed as correct, but they beg an important question: Deadly to whom? They fail to alert readers to the substantial disagreement about the significance of animal testing which underlies the scientific consensus that dioxin, in Tschirley's phrase, is a "chemical of supreme toxicity to experimental animals."[11]

The second approach, reporting disagreement where there was none, also masked the animal test controversy. For example, Time quoted Dow President Paul F. Oreffice as saying, "'There is absolutely no evidence of dioxin doing any damage to humans, except something called chloracne. It's a rash." In the next paragraph, Time continued: "Many scientists do not take the chemical so lightly. They say that even concentrations as low as 5 parts per trillion can cause birth defects, cancer and other serious illness in laboratory animals."[12] Time thus implies that the second statement offers evidence to the contrary to Oreffice's statement. In fact, while the second statement can be construed to be the consensus view of scientists in reference to guinea pigs,[13] it again begs the question in regard to human health. The magazine does go on, however, to offer information that more logically counters the Oreffice comment, reporting that the Centers for Disease Control had found blood, liver and kidney abnormalities in the Times Beach residents and quoting Dr. Irving Selikoff of Mount Sinai Medical Center as saying: "No question about it, dioxin is harmful to humans."[14]

The unexamined assumption that appears to underlie these examples is that if a chemical is harmful to animals it is also harmful to humans. That assumption, however, is one of the key points of disagreement among scientists. In these examples, the press appears to have allowed an unexamined assumption to have shaped its coverage in a way that obscured, rather than described and accounted for, the phenomenon of expert disagreement.

Another way in which newspapers and magazines reported the phenomenon was in a "neutral" presentation -- both sides were given "side by side," as it were, with no explicit attempt to judge between them. In one instance the presentation was literally "side by side." Good Housekeeping asked Dr. James Saunders, director of biomedical research at Dow, and Dr. Samuel Epstein, professor of environmental medicine at the University of Illinois

Medical Center in Chicago, five questions about dioxin and printed their responses, Saunders' on the left and Epstein's on the right.[15] On the question of human health effects, the two disagreed sharply.

Saunders said there is no doubt that dioxin is highly toxic, as shown in animal studies. However, he said, "there have been a number of reviews, including one by the American Medical Association (AMA) and the National Academy of Science, and others by prestigious government organizations in other countries, that suggest that these same toxic effects have not occurred in man." Saunders said studies indicating a link between dioxin and soft-tissue sarcoma had been "discredited by eminent international authorities from several nations." The preponderance of the research seems to indicate that "man is less sensitive to dioxin than many of the animals tested in the lab. That's why when we talk about low-level environmental exposure, we're confident dioxin does not pose a health risk to people."[16]

Epstein said that animal tests, "from which you can draw certain conclusions to apply to humans, show that dioxin attacks nearly every organ and system in the body. Very low levels have also caused birth defects, miscarriages, a rare form of cancer called soft-tissue sarcoma ... and chloracne, a severe acne lesion." Epstein contradicted industry statements that there have been no serious health consequences for humans. "The effects studied in people exposed to dioxin either in industrial accidents, on the job, or because they lived near a hazardous waste site or industrial plant, show a remarkable -- if not exact -- correlation with the effects in animals. Examples are liver diseases, elevated blood chloresterol, anemia, soft-tissue cancers, chloracne, miscarriages, and birth defects such as cleft lip and cleft palate."[17]

Thus readers are presented with two diametrically opposed views of the health effects of dioxin. "It's too soon to tell who is right," Good

Housekeeping commented. "But it's important to know what the debate is all about."[18] The article does indicate to readers that the significance of animal tests and epidemiological studies are key issues about which scientists disagree. On the other hand, it begs an important question: Part of "what the debate is all about" is the definition of "expert." The Good Housekeeping presentation assumes that Saunders and Epstein are equally credible and that their views deserve equal weight. Yet Epstein appears to be something of an outsider as far as the dioxin research community is concerned. He is not mentioned in Tschirley's review of the field, nor is any research by him cited by presenters of papers on the human health effects of dioxin at the 1980 Rome conference on dioxin. Dow scientists, on the other hand, were cited both by Tschirley and in the Rome conference papers.[19] The fact that Epstein does not do dioxin research himself does not necessarily mean he is not an "expert." He may be skilled in evaluating research done by others, or he may not. Likewise, the quantity of Dow research on dioxin does not guarantee that its spokesmen are right on dioxin's health effects. Nevertheless, there are grounds to say that the "who-is-an-expert" issue deserved exploration. It was not explored, however, because Good Housekeeping's "neutral" presentation precluded its being raised.

Nor did Good Housekeeping examine other possible reasons for expert disagreement. Similar treatment occurred in an article in U.S. News and World Report, which pointed out a major area of disagreement: On the one hand, no human deaths have been attributed to dioxin, and epidemiological studies have not confirmed "any major human health hazards." On the other hand, "Many experts argue that widespread exposure to dioxin is too recent for them to learn its long-range effects."[20] This presentation of the controversy leaves out the fact that a few cases of exposures which have been studied epidemiologically are not recent. For example, a study of workers exposed to dioxin at Nitro, W.Va. in 1949 found "no excess deaths due to cancer," according to Tschirley.[21] Nevertheless, unlike the brief "background" statements examined earlier, the U.S. News presentation does clearly set out a major area of disagreement: How compelling is the available epidemiological evidence? What the article does not do, however, is to explain how and why such disagreements arise Thus it leaves readers without a conceptual framework within which to evaluate expert disagreement.

IV

A limited attempt to provide such a framework was made by those publications which abandoned the "neutral" posture and came down for one side or the other. Among them was the Wall Street Journal, which suggested in an editorial that those supporting the view that dioxin was a significant human health problem were irrational or perhaps even psychologically unstable. The newspaper based its opinion on its evaluation of the epidemiological studies at Seveso, Italy; at Nitro, W. Va.; and of the "Ranch Hands" who sprayed Agent Orange in Vietnam, and on the studies critical of Alsea II. The editorial, entitled "Dioxin Hysteria," concludes: "None of this means that dioxin is harmless.... But there are a lot of other threats to worry more about, such as tobacco, marijuana, drunk driving or street crime, where the evidence of threats to health is clear. The notion that dioxin is a doomsday menace is based less on medical evidence than on some kind of psychological phenomenon."[22]

Other explanations for expert disagreement about dioxin were suggested in an Audubon article by Frank Graham, "Under the Dow Volcano." One is politics: "'Dow is a victim in a political battle between the Democrats and the Republicans,' the company told its employes in a message dated March 19th. 'We appear to be a pawn in the attack on the Reagan Administration and EPA's policies. Rest assured, there is no health threat or evidence that dioxin poses a health hazard to the general population of Midland.'"[23] Another suggested explanation for expert disagreement is poor science, and a third is money. Graham quotes Dow scientist Wendell Mullison as asserting that the Alsea II research was "seriously flawed scientifically" and Dow scientist Eugene Kenaga as saying that researchers on the other side might have been economically motivated. "...The original charge may be brought by someone who is not a good scientist, the kind I call an opportunist scientist," Kenaga is quoted as saying. "What happens commonly is that a professor in a college isn't getting enough money. So he asks for a grant from somebody and gets a project started and has graduate students working on it, and then the grant ends. Well, how does he get the grant continued? He has to create enough interest in his project to get the grantor to put up more money. If you see a scientist who is in the news all the time, he is either a crusader or someone who likes to see his name in print."[24]

A similar "good science/bad science" framework is implied in a Fortune article by Jeremy Main, "Dow vs. the Dioxin Monster," which stresses Dow's scientific reputation. "Employes stand on principle, come hell or high water," Dow Chairman Robert W. Lundeen is quoted as saying. "The foundations of the company and its future success rest on scientific integrity."[25] By contrast, the federal government suspension of 2,4,5-T "was patently unsound and had no scientific merit," Lundeen is quoted as saying. Some of the research uncertainties surrounding dioxin are summarized briefly, and it is noted that the EPA "doubts Dow's theory that dioxin is a product of common combustion processes. But Dow critics most prominently mentioned are not scientists but a newspaper columnist, "local environmentalists" and a politician, Rep. James Scheuer, D-N.Y., of the House Committee on Science and Technology. Main wrote: "Scheuer wasn't quite sure whether Dow's contaminants could be measured in parts per billion or parts per trillion

-- which is a little like not noticing whether you take two aspirin or a fatal dose of 200 -- but he sure is mad."[26]

Main portrays Dow's problem as attitudinal, not scientific. Dow's critics, he wrote, "fault it not so much for the quality of its science as for its attitudes," which are described as "prickly, difficult, and arrogant."[27] The article concludes that Dow has science on its side for the most part and only needs to shape up its image and its public relations. "If Dow could get its public posture straight," Main wrote, "then it could help lead the way to solving hazardous waste problems because its policies are generally sensible and its technology advanced, though far from perfect." [28]

Charges of the corruption of science do not come only from the industry side. Keenan Peck, in a Progressive article entitled "A Company Town Makes Peace With Poison," accounts for expert disagreement by suggesting that science was corrupted for corporate purposes. "If any pattern can be detected in Midland, it is that a paycheck from Dow softens the holder's perception of risk," Peck wrote.[29] Moreover, the company's public position on dioxin is portrayed as being directly contradicted by scientific evidence known to the company. "Dow maintains that the only adverse effect of human exposure to dioxin is chloracne.... Yet Dow itself has known for years of other, more serious effects," Peck wrote. "In 1965 ... Dow convened a meeting with representatives of three other chemical companies to discuss the dangers of dioxin. One scientist at the meeting later wrote a memo about Dow's tests on rabbits: 'In addition to the skin effect, liver damage is severe, and a no-effect level based on liver response has not yet been established.'"[30] Like earlier examples in this paper, the article offers animal results as if there were no disagreement about their applicability to human health. The example goes further than the others, however, in suggesting that the company willfully disregarded the evidence of its own scientists. This same cavalier disregard for science is suggested in an image of Dow's research laboratories contrasted with the company's peer review of the EPA dioxin report -- the incident that triggered national press coverage of dioxin in Midland. "In the toxicology building," Peck wrote of a 1981 visit to Dow at Midland, "a scientist showed us exposure chambers where white mice were breathing assorted chemicals while canned music played softly in the background. It was an impressive display of 'objective' science. At the same time though, the company was suppressing damning portions of an EPA report about dioxin."[31]

To summarize, publications that attempted to account for the phenomenon of expert disagreement did so in several ways: by suggesting that the "other side" was irrational or psychologically disturbed; by suggesting that its science was less competent; or by suggesting that its science was corrupted by politics, economic pressure or a cynical commitment to corporate power. Readers attempting to evaluate the phenomenon were given a conceptual framework in which the possible explanations were "irrationality," "poor science," or "corrupt science." How well does that conceptual framework correspond with what is known about expert disagreement from the perspective of science and technology studies?

V

Studies in the philosophy, history and sociology of science indicate that expert disagreement is a normal aspect of science which can be accounted for in a variety of ways.

Expert disagreement can arise, for example, because of certain problems in the philosophical foundations of science. On the one hand, theory will always be under-supported by observation because of the problem of induction -- no matter how many white swans one sees, there is no logical guarantee that the next swan will not be black. On the other hand, observation statements are theory-dependent -- to say that a swan is white involves very complex theoretical assumptions about the definitions of swans, whiteness and "isness." In addition, even if the theoretical assumptions could somehow be made firm, the complexity of realistic scientific test situations rules out the possibility that an experiment can conclusively falsify a hypothesis. Given a complex bundle of theories, assumptions and observation statements, an anomalous experimental result only indicates that something is wrong in the bundle, not what is wrong. And an expected result may indicate mutually correcting errors somewhere in the bundle, rather than confirmation of the hypothesis.[32] Finally, on the frontier between philosophy of science and history of science, Kuhn maintains that competing paradigms are a fundamental source of expert disagreement and that, in Chalmers' words, "when one paradigm competes with another, there is no logically compelling argument that dictates that a rational scientist must abandon one for the other." The resolution of the paradigm crisis is a social decision based on achievement of consensus rather than a matter of logical choice based on the evidence. "The aim of arguments and discussions between supporters of rival paradigms should be persuasion rather than compulsion."[33]

Another historical perspective on expert disagreement is offered by Ravetz, who also suggests that scientific work is an activity deeply influenced by its social nature. Of particular interest is Ravetz' portrayal of the craft nature of scientific work. At every step in the process, Ravetz argues, scientific work is a matter not only of explicit, public knowledge but of personal, tacit knowledge.[34] For example, at the level of data collection, the decision that an apparatus is functioning "well enough" to conduct the experiment is a craft decision, and craft skills are socially learned. "It is clear that the more stable and consistent the readings, the more likely they are to be sound," according to Ravetz. "But anomalous readings always do crop up; and if one waited for them to vanish entirely, or tried to 'explain' each and every one of them, one would never get beyond this first stage of the work. In short, the scientist must be a craftsman with respect to his apparatus; and his judgment of when it is working 'well enough' must be based on his experience of that particular piece of equipment, in all its particularity."[35] The same sorts of craft decisions enter into the transformation of data into information -- for example, by fitting a curve to data points. "Very sophisticated methods have been developed for assisting in this judgement," Ravetz wrote, "but in the last resort it depends on the craft knowledge of the scientist, to decide which sort of functional relation is represented by the discrete points obtained from his readings."[36]

One important conclusion to be drawn from Ravetz is that scientists working in different disciplines or subdisciplines -- or trained at different institutions in the same subdiscipline -- will develop different craft techniques which in turn could account for expert disagreement. Another is that the transformation of craft work into "achieved scientific knowledge" is itself a complex social process.[37] The central paradox of science in Ravetz' view is that "out of a personal endeavor which is fallible, subjective, and strictly limited by its context, there emerges knowledge which is certain, objective, and universal."[38] Science, then, is not wholly social -- but it is an activity interpenetrated by the socially inculcated skills, attitudes and assumptions scientists bring to it and by the social context in which it takes place.

The social context has crucial implications for the quality of science, according to Ravetz, who believes the capital-intensive, industrialized nature of present-day science undercuts the morale and discipline that helped create the high quality of pre-war science.[39] In line with one of the explanations for expert disagreement offered in the examples in this study, Ravetz believes there is a good deal of "bad science" being done. "Shoddy work exists," he writes, "and in large quantity. References to it can be gleaned from published discussions of the state of particular fields." However, rather than seeing shoddy science as a problem of one or the other side in a scientific controversy, Ravetz sees it as a systemic disease. "... It is a truly pathological symptom of the social condition of industrialized science."[40] It might be well, in other words, for journalists to look for it on both sides.

Another possible reason for expert disagreement is inadequate information. William Lowrance in his book Of Acceptable Risk has outlined for lay readers how inadequate information introduces uncertainty into many scientific attempts to determine risk. For example, in a dose-response curve the extremes of the curve are imprecise because one is dealing with fewer data points than in the middle of the curve; but it is precisely at one extreme of the curve -- the low-dose, low-response end -- that the crucial risk questions occur.[41] A serious shortcoming in epidemiological studies, again resulting at least party from inadequate information, is their "ineffectiveness in proving that effect results from cause."[42]

Finally, studies in the sociology of science have shown how scientists working within different national, occupational and political contexts support different regulatory outcomes. In their study of the Aldrin/Dieldrin controversy in the United States and Great Britain, for example, Gillespie, Eva and Johnston found the diametrically opposed regulatory decisions of the two countries were influenced by "the uncertainty inherent in the relevant scientific field; the application of different scientific standards, motivated by different scientific and social commitments; and bureaucratic politics of the agencies with responsibility for regulating the pesticides; (and) the way in which standards are defined in particular systems of regulation."[43] Specifically, whereas "U.S. decision-making institutions depend upon, and, to some extent, generate conflicts among experts, British institutions tend to rely upon singular sources of expertise. In the A/D case, the result was the availability of an adversarial forum in the U.S., and scientists eager to enter it, whereas in Britain there was neither the forum nor, apparently, the scientists."[44] While noting that the attempt was made to justify both decisions by recourse to science, the authors question any "exclusively scientific justification" for the decisions. The British decision not to ban the pesticide is, in effect, a "decision to wait for definite evidence of harm to accumulate (and) is just as much an ethical and political choice as the decision to treat risk determination as a policy issue (the U.S. decision)."[45]

VI

Several conclusions can be drawn. Perhaps the most important is that work in the philosophy,history and sociology of science provides a conceptual framework for the understanding of expert disagreement that is considerably broader than that shown in national press coverage of the Midland dioxin incident. In that broader framework, expert disagreement can be seen as a normal, expected part of science, arising perhaps because of philosophical uncertainties, perhaps because of the different skills, attitudes and assumptions that scientists bring to their work as social creatures. Inadequate information may be a factor, as may the national, occupational and political contexts in which science interacts with regulatory decisions. In the complex story of dioxin in Midland, each of these is a plausible contributing factor to expert disagreement, yet none was examined in any depth in the examples used in this study.

Expert disagreement, of course, may indeed arise because of incompetence or the corruption of science -- but the broader framework suggests the possibility of different interpretations. For example, since science inevitably takes place in a social context that influences its outcome, the mere showing by one side that the other operates within a social context becomes relatively unimportant. Whether one takes a corporate paycheck or gets one's money from a federal grant does not, in itself, say anything definitive about the quality of one's science. Similarly, charges that one side or the other represents "good science" or is guilty of "poor science" ought to be evaluated from the dual perspective that a decline in the quality of science seems to be a systemic problem, and that in a clash of paradigms or a difference of craft skills, each side might be likely to regard the other as scientifically less competent.

Likewise, because of the philosophically uncertain and socially derived nature of scientific knowledge, claims by one side or the other to scientific certainty should be dealt with skeptically by the press. The statement that "there is absolutely no evidence of dioxin doing any damage to humans, except something called chloracne" not only is inaccurate with respect to the published literature; it also demonstrates a misunderstanding of the nature of science. This does not mean, however, that any statement is as good as any other scientifically, nor that scientific knowledge as such is meaningless -- only that it is less certain than it often is held to be.

Finally, readers have no hope of untangling the issues of expert disagreement if writers do not clearly delineate what those issues are. Journalists should avoid "neutral" presentations that obscure conflict over expertise and "background" descriptions that gloss over disagreement or create it where none exists.

It may be, after all, that corruption and incompetence explain the expert disagreement that arose in the Midland dioxin case. It was beyond the scope of this study to make that determination. The author, however, believes this to be highly unlikely. What is more likely, I believe, is that other explanations of expert disagreement were not presented and explored for readers because journalists did not ask the questions that would have disclosed them. Tneir failure to do so, I believe, stems from a simplistic, good science/bad science conceptual framework -- a framework that may also be shared by their sources in the scientific community. This study demonstrates that the presentation of expert disagreement in the examples studied is consistent with that framework, and briefly outlines a broader approach drawn from the discipline of science and technology studies. Further study might examine whether the factors in the broader approach did indeed play a role in the Midland situation in 1983, and how; and also might extend to other years and to other aspects of the national and international controversy over dioxin.

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NOTES

1. For the sake of brevity, the 2,3,7,8-TCDD isomer will be referred to as "dioxin" or "TCDD."

2. Midland Daily News, June 29, 1978, p. 1.

3. Fred H. Tschirley, "Dioxin," Scientific American, February 1986, pp. 29-35.

4. ibid, p. 29.

5. ibid, p. 33

6. ibid, pp. 33-34.

7. ibid, p. 34.

8. ibid

9. Los Angeles Times, June 17, 1983, p. 16, and May 9, 1983, p. 4.

10. New York Times, April 1, 1983, p. A13.

11. Tschirley, p. 34.

12. Time, May 2, 1983, p. 62.

13. Tschirley, p. 31.

14. Time, May 2, 1983, p. 62.

15. Good Housekeeping, September 1983, p. 273.

16. ibid

17. ibid

18. ibid

19. O. Hutzinger, R.W. Frei, E. Merian and F. Pocchiari, eds, Chlorinated Dioxins and Related Compounds: Impact on Environment. Oxford: Pergamon Press, 1982.

20. U.S. News and World Report, July 4, 1983, p. 56.

21. Tschirley, p. 33.

22. Wall Street Journal, May 31, 1983, p. 26.

23. Audubon, July 1983, p. 14.

24. ibid, p. 19.

25. Fortune, May 30, 1983, p. 84.

26. ibid, p. 85

27. ibid

28. ibid, p. 88.

29. Progressive, June 1983, p. 26.

30. ibid, p. 29.

31. ibid

32. A.F. Chalmers, *What Is This Thing Called Science*. St. Lucia: University of Queensland Press, second ed., 1982, Chapters 2, 3 and 6.

33. ibid, p. 97.

34. Jerome Ravetz, *Scientific Knowledge and Its Social Problems*, 1973, pp. 75-76.

35. ibid, p. 77.

36. ibid, p. 84.

37. ibid, pp. 71, 72.

38. ibid, p. 71.

39. ibid, pp. 32, 44.

40. ibid, p. 50.

41. William Lowrance, *Of Acceptable Risk: Science and the Determination of Safety*. Los Altos, California: William Kaufmann, Inc., 1976, p. 38.

42. ibid, p. 52.

43. Brendan Gillespie, Dave Eva and Ron Johnston, "Carcinogenic Risk Assessment in the United States and Great Britain: The Case of Aldrin/Dieldrin," *Social Studies of Science* Vol. 9. London: SAGE, 1979, p. 294.

44. ibid, pp. 293-294.

45. ibid, p. 294.