



## Epistemic Fencelines: Air Monitoring Instruments and Expert-Resident Boundaries

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# Epistemic Fencelines

## Air Monitoring Instruments and Expert-Resident Boundaries\*

Gwen Ottinger<sup>†</sup>

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Scientific instruments can help to shape and re-shape epistemic boundaries, especially those between communities of scientific researchers. But how do they function at boundaries between scientific communities and communities of non-experts? This paper examines the use of air monitoring instruments at the boundary between petrochemical facilities and nearby residential communities, asking whether a new generation of fenceline monitors shared by industry (and regulatory agency) experts and community members alter the epistemic boundary between the two groups. Arguing that epistemic communities organized around instruments are characterized, in part, by a common understanding of the evidential contexts for instrumental data, the paper shows how the evidential contexts in which experts and residents interpret monitoring data diverge. Instead of the new, shared fenceline monitors helping to reconcile differences over evidential contexts, those pre-existing contexts shape the interpretation of data from the new instruments—perpetuating epistemic boundaries between industry experts and community members.

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In Chalmette, Louisiana, a chain link fence marks the boundary between an Exxon oil refinery and a residential community. Like those at the borders of other petrochemical facilities, this fenceline also marks the boundary between epistemic communities. Within the refinery, scientists and engineers understand the environmental and health effects of chemical emissions in terms of air dispersion models and occupational health studies. In the neighboring community, residents' understanding of the refinery's effects is assembled from their experience of noxious odors, scratchy throats, and shortness of breath, as well as their informal catalog of fellow residents diagnosed with cancer, asthma, and chronic bronchitis.<sup>1</sup>

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<sup>1</sup>My characterization of the epistemic communities on either side of the refinery fenceline and my analysis of their air monitoring practices are based on research conducted in southeastern Louisiana since 2002. In addition to a year of ethnographic fieldwork on community-industry relations in New Sarpy, Louisiana, my research has

From the late 1990s until 2004, the epistemic boundary between refinery and residents was also marked, and maintained, by the scientific instruments used by the two groups. Specifically, both used air samplers to measure levels of toxic chemicals in the air surrounding the refinery. However, refinery experts, like their peers at other petrochemical facilities and in environmental regulatory agencies,<sup>2</sup> used stainless steel Summa canisters to collect samples that would then be analyzed in a laboratory. Chalmette residents used buckets—homemade, easy-to-use samplers deployed throughout the world by fenceline communities involved in environmental justice campaigns (O'Rourke and Macey 2003; Overdeest and Mayer 2008) that collected bags of air that were analyzed by the same techniques used for Summa canister samples. With Summa canisters, experts took instantaneous samples to troubleshoot problems and twenty-four hour samples to represent average air quality; with buckets, residents took three-to six minute samples during the most malodorous periods in order to represent the high levels of toxic chemicals to which they were routinely exposed. Each group regarded the other's data as irrelevant to, or at least highly limited in, the assessment of air quality. Yet the epistemic boundary was policed by regulatory standards and standardized practices, which institutionalized experts' disregard for bucket data (Ottinger 2009).

But starting in 2004, the ambient air monitoring which had been conducted on both sides of the boundary began to occur at the boundary itself. Fenceline monitoring was introduced to Chalmette by the community group St. Bernard Citizens for Environmental Quality (SBCEQ). With the assistance of a New Orleans-based environmental health and justice non-profit, the Louisiana Bucket Brigade (LABB), SBCEQ operated a high-tech open-path monitoring system, the UV Sentry, for two months

included participant-observation at the Louisiana Bucket Brigade and over fifty interviews with individuals involved in air monitoring in so-called "fenceline communities," including representatives from the Louisiana Department of Environmental Quality and the US Environmental Protection Agency; scientists and engineers from petrochemical facilities in St. Charles Parish, Louisiana; staff and volunteers of environmental justice non-profit organizations that assist communities all over the country with air monitoring; and residents of communities that use buckets and other air monitoring devices.

<sup>2</sup>Scientists and engineers working in the petrochemical industry and those working in regulatory agencies are treated as a single epistemic community for the purposes of this discussion because (although they certainly differ in myriad ways) they share their technical backgrounds, professional networks, and—as a result—understandings of what constitutes "good science," especially with respect to air quality assessment. Likewise, community members and the environmental justice professionals who support their air monitoring efforts, despite their other differences, are largely unified in their approaches to monitoring data and can be considered a single epistemic community in the context of this analysis.

in the spring of 2005 (and again in summer 2006), collecting continuous real-time data on toxic chemical concentrations near the fenceline of the Exxon refinery. Their efforts convinced local officials to call for comparable monitoring by the refinery, and in 2006, the Louisiana Department of Environmental Quality set up three real-time fenceline monitoring systems around the refinery's perimeter.

Operating at the border of community and industry and sanctioned by residents, refinery, and regulators, fenceline monitoring would seem to be a trans-boundary practice. Might it then herald the blurring of the epistemic boundary between the groups, or even the emergence of a new epistemic community that includes both experts and non-expert residents? Research on instrumentation suggests that this is a possibility: scientific instruments have been shown to play an important role in defining research communities (Galison 1997; Traweek 1988). This paper, however, argues that shared instruments for air quality monitoring are doing little to erode the epistemic boundaries between members of fenceline communities and scientists at oil refineries and regulatory agencies. Drawing on Pinch's (1985) analysis of instruments and observational practices, I argue that epistemic boundaries coincide with the boundaries of instrumental communities only when instrument users have a common understanding of the instrument's evidential contexts. In their use of Summa canisters and buckets, I show, industry experts and community members, respectively, interpreted monitoring data in quite different evidential contexts. In the more recent use of real-time fenceline monitors, their disagreements over evidential context have been reproduced, making the new instruments objects of a tug-of-war across the epistemic boundary. The case, I argue, suggests that instruments' power to bridge or shift epistemic boundaries, while well documented with respect to scientific research communities, is likely to be much more limited where those boundaries separate communities of experts and non-experts who may have divergent approaches to fundamental questions of proof and evidence.

#### I. INSTRUMENTAL AND EPISTEMIC COMMUNITIES

Research on instrumentation illustrates that scientific instruments are powerful in reconfiguring relations among research communities. Instruments bring together academic laboratories and corporate entities in collaborations that defy simple models of technology transfer or innovation (Bud and Cozzens 1992; Lenoir and Lécuyer 1997; Mody 2006). Instruments aid in the creation of new disciplines and help establish their credibility with respect to existing ones (Lenoir and Lécuyer 1997; Gölkalp 1990; Kohler 2002). Indeed, some have argued that instruments create their own communities, oriented primarily to the research technologies

themselves, which cut across institutional and disciplinary communities (Galison 1997; Joerges and Shinn 2001; Mody 2006).

But what is the relation between the boundaries fashioned and re-fashioned by instruments and epistemic boundaries? The literature points to two distinct kinds of community organized around scientific instruments. The “multi-institutional, multiregional, multidisciplinary” communities organized around “building, developing, using, selling, and popularizing” instruments themselves, dubbed “instrumental communities” by Mody (2006, 59), are relatively unmoored from specific contexts of data production. Although members of instrumental communities may be active in finding and promoting uses of their technology, forming relationships with—or even temporarily incorporating—groups of experimenters in the process, the instrumental community exists independent of these particular uses (Galison 1997; Joerges and Shinn 2001).

In contrast to instrumental communities, “epistemic communities”—potentially cross-disciplinary networks of professionals bonded by “their shared belief or faith in the verity and applicability of particular forms of knowledge or specific truths” (Haas 1992, 175)—share not only instruments, but the interpretive contexts and practices that give meaning to instrumental data. Studies of scientific practice show that common techniques for generating evidence do not automatically yield common understandings of what those techniques produce evidence of; rather, significant work is entailed in organizing an epistemic community around an instrument. Notably, Lenoir and Lecuyer (1997) show how, in creating a discipline of chemistry organized around Nuclear Magnetic Resonance (NMR), instrument manufacturers had to make NMR data interpretable to chemists. (Rasmussen 1996 offers a similar analysis.)

The work of creating shared meaning, often evident but not always thematized in studies of instrumentation, is usefully conceptualized by Pinch (1985) as the process of “black-boxing” an instrument. Instruments, Pinch argues, begin as open boxes, whose data can be linked to a variety of evidential claims. In his example, measurements from a particularly powerful telescope could be interpreted either as measurements of solar oblateness, or measurements of temperature differences between the sun’s equator and its poles. Settling the question of what an instrument can be considered to measure—or establishing its “evidential context”—is, according to Pinch, essential to the black-boxing of the instrument. Black-boxing, in turn, allows scientists to accept and rely on the instrument in particular research settings.

Epistemic communities organized around instruments then share not only the instruments themselves but also common understandings of their evidential contexts. This insight is important to analyzing whether

air monitoring instruments used at petrochemical facility fencelines have the potential to bridge epistemic boundaries or even create new epistemic communities. The instruments might well serve as “boundary objects,” permitting some coordination of activity across the fenceline (Star and Griesmer 1989). But only if parties on both sides of the epistemic boundary represented by the fenceline can agree on the instruments’ evidential contexts, or what those monitors actually measure—a level of coordination specifically not demanded by boundary objects (Fujimura 1992)—can air monitoring instruments be seen as organizing industry experts and community residents into new epistemic communities.

## II. EVIDENTIAL CONTEXTS OF AIR MONITORS

Prior to the use of real-time fenceline monitors, the epistemic communities on either side of petrochemical facility fencelines shared neither air monitoring instruments nor evidential contexts for interpreting their data. Petrochemical industry scientists and engineers, along with environmental regulators, used Summa canisters, while community members and the environmental justice support organizations that supported them used buckets. Although the two instruments produced similar data—ambient air concentrations of several dozen hazardous air pollutants—the two instrumental communities used the data in distinct evidential contexts. Experts from industry and regulatory agencies interpreted data in contexts of regulation and problem-solving; residents and their allies interpreted data in the context of systemic danger.

### *The context of regulation*

Government standards for ambient air quality provide a formalized and unavoidable context for interpreting air monitoring data. In this context, measurements of chemical concentrations show whether air pollution is within the limits set by federal and state environmental laws. The standards are health-based: regulators draw on toxicological and epidemiological research to set the standards at levels below which they believe no unacceptable health risks are incurred. In this context, monitoring data that show chemical levels are within the legal limits is said to demonstrate that air does not pose a significant threat to human health.

This evidential context was used for Summa canister data by industry representatives in Shell Chemical’s “Air Monitoring...Norco” program (URS 2003). In the wake of a community campaign that raised questions about the potential health effects of air pollution in Norco, Louisiana, Shell established an ambient air monitoring program. Summa canisters, which ordinarily fill in a matter of seconds, were used in

conjunction with pumps and flow controllers in order to produce long-term average data commensurate with regulatory standards expressed as eight hour or annual averages. When Shell presented the results to community members, they featured a graph comparing measured chemical concentrations to Louisiana's ambient air standards. Besides concluding that Shell had met the standards, scientists and engineers involved in the program implied that residents should be reassured about the effects of the air on their health. Because the standards were based on the best available health research, one scientist said, chemical concentrations that were well below the standards, like those in Norco, indicated that air quality would not negatively affect residents' health.

### *The context of problem-solving*

In the context of problem-solving, chemical concentrations measured with air monitors are taken to indicate whether or not a petrochemical facility is operating as it ought to. Monitoring data indicating high levels of chemicals suggest a malfunction at the facility. For industry and regulators, the context of problem-solving is a complement to the context of regulation: where the latter demands measurements of relatively long-term, average chemical concentrations in order to be commensurate with regulatory standards, data from very short term samples—the kind produced when Summa canisters are used without flow controllers—is taken to be meaningful as an indicator of operational problems.

Jim Hazlett, director of the Louisiana Department of Environmental Quality's air toxics monitoring program, described how his agency, together with petrochemical facilities, used Summa canister data in the context of problem-solving:

[If] there's an odour problem we'll ... take samples at fencelines ... cause maybe they're [the facility is] having a problem they don't really know is happening or something. We had an incident in Lake Charles recently, we got a real high number on our monitor and went and talked to them about it, and they started looking at their internal processes and they finally found, hey, we got a leak over here. And if we hadn't have picked it up, they may not have, it may have been a lot longer before they discovered where the problem was. (Interview with author, December 5, 2002)

Shell Chemical Norco similarly used some of the data produced in its air monitoring program to track down leaks at its facility. In both cases, the leaks were subsequently fixed. In the context of problem-solving,

monitoring data is, importantly, not only an indicator of malfunctions but also an aid to identifying and fixing them.

<b>Hydrogen Sulfide:</b> <i>Attacks the respiratory system</i> <i>Texas Screening Level: 1 ppb</i> <i>Louisiana State Standard: None</i>		<b>Carbon Disulfide:</b> <i>Attacks the respiratory system</i> <i>Texas Screening Level: 1 ppb</i> <i>Louisiana State Standard: None</i>	
January 29, 2001	5.09	August 30, 2000	40
February 21, 2001	5.75	October 1, 2000	1.4
August 31, 2001	2.17	February 21, 2001	2.4
		June 7, 2001	3.8
<b>Carbonyl Sulfide</b> <i>Attacks the nervous system</i> <i>Texas Screening Level: 1 ppb</i> <i>Louisiana State Standard: None</i>		<b>Benzene</b> <i>Known Carcinogen</i> <i>Louisiana State Standard: 3.76 pbb</i>	
August 30, 2000	22.2	August 30, 2000	14
February 21, 2001	2.3	October 1, 2000	2.4
June 7, 2001	2.58	February 21, 2001	4.3
		August 31, 2001	110

**Figure 1:** Bucket data as presented by community and environmental justice group.

### *The context of systemic danger*

In contrast to Summa canister data, bucket data was taken by community members and their allies to demonstrate the inherent threat posed to residents by petrochemical facilities. In this third evidential context, which I call the context of systemic danger, high measured levels of toxic chemicals indicate that industrial operations have routine impacts on community environmental quality that are not well understood or controlled by government regulators or industrial facilities themselves.

One report on bucket data prepared by a New Sarpy, Louisiana, community group and LABB lists the concentrations of four chemicals measured in six different samples (see Figure 1). Under the heading for each chemical, the report describes its primary health effects and lists relevant health-based standards. Noting that the state of Louisiana has no regulatory standards for three of the four chemicals, the table implies that the state is unconcerned about protecting the health of its citizens from the effects of chemicals recognized by other states to cause illness. The text that surrounds the table further casts officials at New Sarpy's oil refinery



as either deceitful or deluded in their approach to air quality. Contrasting officials' claims that fumes from a massive fire in a gasoline storage tank had no effect on air quality in New Sarpy with bucket data that showed high levels of carbon disulfide and carbonyl sulfide, the report accuses the refinery of "spin[ning] fairy tales" (Louisiana Bucket Brigade 2002).

Despite the presence of regulatory standards and industrial malfunctions in this interpretation of bucket data, the context of systemic danger it exemplifies is importantly different from the contexts of regulation and problem-solving. Bucket data is compared to regulatory standards to argue that the standards fail to protect residents from repeated exposure to high levels of chemicals. Similarly, bucket data highlights industrial accidents not to trouble-shoot fixable malfunctions, as in the context of problem-solving, but to show how residents are plagued, and their health threatened, by untoward events that facilities seem unable to eliminate.

#### *Evidential contexts and epistemic boundaries*

On one side of petrochemical facility fencelines an epistemic community composed of industry officials and environmental regulators, all Summa canister users, interprets monitoring data in the contexts of regulation and problem-solving. This community refuses to acknowledge the context of systemic danger, reinterpreting bucket results in its own evidential contexts. To the extent that they recognize bucket data at all, agency and industry scientists and engineers regard them much as they do data from short-term Summa canister samples—irrelevant to regulatory standards expressed as long-term averages but potentially useful in tracking down and fixing malfunctions at chemical plants (Ottinger 2009).

On the other side of the fenceline, an epistemic community organized around buckets, populated by community members and environmental justice activists, rejects the contexts of regulation and problem-solving as too circumscribed. For this community, because bucket results demonstrate that there are problems at petrochemical facilities, and that these problems result in chemical concentrations that exceed regulatory standards,<sup>3</sup> those results further indicate that the close proximity of industrial facilities poses systemic dangers to residential communities.

<sup>3</sup>That this claim is made despite the incommensurability of five minute bucket samples and long-term average air quality standards should suggest not the ignorance of residents and activists (a common interpretation by regulators and other experts) but their critique of standards that do not apply to the short-term spikes in pollution experienced by residents.

### III. MENDING EPISTEMIC FENCES?

Buckets and Summa canisters are black-boxed in the sense that their evidential contexts are settled, at least among their respective users: Summa canister data is interpreted within the contexts of regulation and problem-solving, while bucket data is given meaning by the context of systemic danger. These contrasting evidential contexts, moreover, make the boundary between instrumental communities an epistemic one.

Fenceline monitors, on the other hand, may still be an open box. Their instrumental community spans the epistemic boundary at the fenceline: bucket users advocate the real-time monitors for their ability to produce extensive data about chemical concentrations, and expert users of Summa canisters are increasingly deploying fenceline systems in the hopes of satisfying the environmental concerns of industry's residential neighbors. Not only do fenceline monitors enter a field where multiple evidential contexts are in play, the data that they produce could be evidence for entirely new kinds of claims. Generating a measurement of chemical concentrations—comparable to that yielded by a short-term Summa canister or bucket sample—as often as every several seconds, fenceline monitors can show how chemical concentrations vary over time and can be aggregated into average chemical concentrations over periods ranging from hours to years.

How then are the evidential contexts for fenceline monitors being negotiated? Might the boundaries between epistemic communities on either side of the fenceline be affected in the process of black-boxing the instrument that both communities share?

Despite its unprecedented scope, the data generated by fenceline monitors data have so far been interpreted in the same contexts in which Summa canister and bucket data are made meaningful. Scientists from regulatory agencies and industry continue to use the contexts of regulation and problem-solving. For example, a report by the Louisiana Department of Environmental Quality on data from fenceline monitoring in Chalmette compares average chemical concentrations to state and federal ambient air standards to show that air quality does not violate regulations (Hazlett 2006). Even where the capabilities of the monitors are being exploited to novel ends, these evidential contexts still dominate: speaking of the benefits of fenceline monitoring in a 2008 presentation, instrument developer Don Gamiles explained how monitoring data could be combined with meteorological data to help pinpoint primary sources of pollution, which may or may not be an area's largest industrial facilities. Rather than altering evidential contexts, this new use of data simply increases regulatory and industry experts' capacity within the context of problem-solving.

Community members and environmental justice activists, for their part, interpret data from fenceline monitors, like data from buckets, in the context of systemic danger. Reporting on the use of a fenceline monitor by SBCEQ and LABB in Chalmette, a press release authored by the two groups claims:

During a 24 hour period that began at 6 AM on April 28th, the monitor detected readings of sulfur dioxide—known to trigger asthma attacks—at levels that violate EPA standards. **The air is allowed to exceed the EPA limit once per year; the level was exceeded within the first week of operating the monitor.** (Louisiana Bucket Brigade 2005, emphasis in original)

Although the report makes reference to the twenty-four hour sulfur dioxide standard set as part of the federal Clean Air Act, it immediately positions the violation of the regulatory standard as evidence of a larger problem: if the community group was able to document a regulatory violation by the nearby Exxon refinery in just a week of monitoring, the press release suggests, violations of these and other health limits must be frequent occurrences.

Yet using fenceline monitoring data as evidence of petrochemical facilities' inherent dangers has been a challenge for community members and their allies. Validating and manipulating the large quantities of data that real-time monitors produce is often beyond the technical capacities of community and non-profit groups. As a result, they have struggled to find a way of representing fenceline monitoring data that clearly tells their story of systemic danger. Their strategies for presenting data have instead tended to revolve around pointing out peaks in pollution identified by fenceline monitors—peaks that industry and agency experts are quick to reinterpret in the context of problem-solving, as they do bucket data.

Fenceline monitors remain open boxes in the sense that their heterogeneous users have not agreed on their evidential contexts. Yet, within the each of the pre-existing epistemic communities whose boundary the monitors span, their evidential contexts are well established. Industry and regulatory scientists and engineers see fenceline monitors as providing evidence of regulatory compliance (or not), or of (fixable) operational problems at industrial facilities; community members and environmental justice activists see them as offering evidence of the inherent dangers of petrochemical manufacturing. Fenceline monitors, then, have not bridged epistemic boundaries; rather, epistemic boundaries that separated instrumental communities of Summa canister users and

bucket users have been reproduced in the struggle to establish the evidential contexts of the new instruments.

#### IV. CONCLUSION

Looking at how fenceline monitors operate at the boundary between residential communities and nearby petrochemical facilities extends an important finding of research on the work instruments do at the boundaries of scientific communities. Just as communities of researchers do not coalesce around instruments until their evidential contexts are settled, shared instruments do not meld industry and agency scientists with non-expert community members and activists into an epistemic community without agreement on the claims that can be made with instrumental data. But this study also suggests that scientific instruments may not have the same power to alter epistemic boundaries in cases where those boundaries divide experts from non-experts. Residents and experts' divergent evidential contexts for fenceline monitors betrayed fundamentally different understandings not only of the kinds of claims that could be supported by particular observations but also of the very nature of the problem of industry-community proximity and the shape of its potential solutions. It was questions about, for example, whether there can be "safe" levels of toxic air pollutants, or whether operational problems at facilities can ever defy technical solution, that prevented the two groups from coming to a shared understanding of monitors' evidential contexts. While it is possible that one might find similarly fundamental differences at the boundaries of research communities, especially cross-culturally (Traweek 1988), these are precisely the kinds of questions that characteristically divide "lay" from "expert" ways of knowing (Wynne 1996). The fact that instruments—even ones held in common across epistemic boundaries—cannot resolve these questions, but rather flounder in the face of them, offers yet another explanation for the intransigence of expert-lay boundaries.

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