The Politics of Measurement and Action

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ABSTRACT

Contemporary decisions about the management of populations, public services, security, and the environment are increasingly made through knowledge gleaned from 'big data' and its attendant infrastructures and algorithms. Though often described as 'raw,' this data is produced by techniques of measurement that are imbued with judgments and values that dictate what is counted and what is not, what is considered the best unit of measurement, and how different things are grouped together and "made" into a measureable entity. In this paper, we analyze these politics of measurement and how they relate to action through two case studies involving high stake public health measurements where experts intentionally leverage measurement to change definitions of harm and health. That is, they use measurement for activism. The case studies offer a framework for thinking about of how the *politics* of measurement are present in user interfaces. It is usually assumed that the human element has been scrubbed from the database and that significant political and subjective interventions come from the analysis or use of data *after* the fact. Instead, we argue that human-computer interactions start *before* the data reaches the computer because various *measurement interfaces* are the invisible premise of data and databases, and these measurements are political.

Author Keywords

Measurement; science and technology studies; quantification; data; evaluation; politics

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION

In the 21st century, the capacity of big data to capture massive volumes of increasingly fine-grained information, and the ability for algorithms to pull patterns from that data, is being deployed to make large-scale decisions about the management of populations, economies, the environment, security, and public services. "Big Data" and its algorithms are popularly thought to change knowledge practices and make connections in all domains, providing an informational "planetary nervous system" [53]. Databases have come to shape the very contours of our knowledge and decision-making, and thus hold the potential to shift how we know the world and act in it. Given this link between data and action, recent years have seen an intensification of interest in data, data infrastructures, and algorithms as well as other information infrastructures both within the CHI community and without, particularly in terms of how the organization of information exerts an oft-invisible hand in shaping human action, power, and culture [2, 3, 4, 7, 8, 24, 46, 60, 61].

This rich body of work, which often draws deeply from Science & Technology Studies (STS) dating back to Suchman's quintessential work [61], critically interrogates what David Ribes and Steven Edwards refer to as the "commodity fictions" of data [53: 147]. Based on Foucault's commodity fiction of power [19], the commodity fiction of data is the belief that data and context are separate-able, making data a free-floating, harvestable entity. This belief assumes data are given-in-advance of discovery, are "natural" objects—even natural resources—that can circulate and aggregate irrespective of their origins. However Ribes and Edwards point out that research consistently shows that data is never actually "raw" but is instead always socially and culturally situated [24]. Data – and its attendant processes of measurement, database production, stabilization, curation, maintenance and use – reproduce power dynamics, knowledge systems, and culturally-based assumptions [6, 16, 17, 24, 25, 41, 51, 54]. Thus, scholarship on the politics of data has expanded to include studies of data infrastructures as complex sociotechnical entities with a recent interest in algorithms as the artifacts that "make [datasets] intelligible [13: 10]" [see also 3, 33, 46, 51].

Yet data are not the deepest layer of analysis in this debate. Beneath this are the practices and premises of data creation that populate datasets themselves, shaping human-computer interactions even before data reaches the computer. Our research focuses on measurements, the artifacts and practices that form some of the smallest units of quantification underlying data, algorithms, and other

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vectors of representation. To this end, we present an analytical framework for thinking about measurement as a vector for political action through two cases of high stakes measurements drawn from medicine and environmental health. The first case follows the measurement of severe maternal morbidity via units of blood transfused in maternity wards, a measurement that is under development today; and the second case looks at the measurement of water quality during cholera epidemics in the nineteenth century. These cases allow an analysis of the politics of information by highlighting how the characteristics of measurement are used *intentionally* by experts to redefine indicators of health and harm. In each case, we assert that advocates use measurement to make a previously invisible form of harm visible, then focus on metrics that promote affective visions of crisis—what we call *charismatic data*—to spur specific managerial actions can address the newly visible problem. The intentional leveraging of measurements by activists for specific action-oriented goals is a unique contribution to the existing literature.

RELATED WORK

We will review the complete range of how different literatures have recognized the politics of measurement, then narrow things down to the specific genre of politics our study engages in. At its core, measurement entails categorization and the judgment of characteristics through abstracted descriptions of entities. While measurement does not necessarily have to be quantitative, we are focused in this paper on quantitative descriptions. Measurement is "the delimitation and fixation of our ideas of things, so that the determination of what it is to be a man or a circle is a case of measurement" [44: 313]. Morgan Robertson, a scholar who works for the US Environmental Protection Agency and thus is deeply invested in adjudicating measurements, calls measurements "coherent abstracts" resulting from "a process of creating socially-necessary abstractions that are adequate to bear value…The construction of abstract spaces, the definition of boundaries between types of things that allow nature to be segregated out in a typology, are matters of measure" [56: 2-3]. These judgments, delimitations, abstractions, and constructions are political.

Human computer interaction literature on the politics of artifacts has pointed out that all technology is inherently political; that is, technologies are built in particular politically-infused social systems for particular political ends whether intentional or not [31, 64, 65]. For example, by embedding certain types of tasks but not others in the design of collaborative workflow technologies for nurses, such technologies enable certain practices and constrain others, thus becoming a device for social control [4, 61]. Our work illuminates the politics of measurements as key artifacts shaping the design and management of information technology. Since computing technologies such as databases, algorithms, and information entry interfaces, are designed around measurements; the development of measurements and the politics they embody can shape HCI design before it has even begun.

Thus, measurements are political artifacts that cannot only launch action, but are actions in and of themselves. Margaret Morrison's study of mathematical and engineering models highlights the interventionist aspects of measurement in her definition of measurement, which "involves some type of causal interaction with the material world via instruments" [41: 35]. Measurement is causal because when the quantitative descriptions of a thing such as size, number, or temperature are recorded, these measurements simultaneously determine and affirm the boundaries and characteristics of the thing being measured, judging it to be one thing and not another, measurable in some terms and not others. Measurement always involves the enactment and re-enactment of ontologies through what appears to be merely description (see more in the section *Measurements Make Things* below).

To investigate the ramifications of measurement, we are going to start by reviewing some of the literature mentioned above in more detail. This review occurs in three related sections: politics and power; how measurements make, rather than merely describe, the world; and how value and moral judgments are part of measurement. We will then use two case studies to see how these concepts play out in situations of health and harm. Finally, in the discussion, we create a framework for thinking through the links between measurement and action, particularly in terms of *charismatic* measurements consciously designed to resonate with certain values and morals, and thus launch specific actions. Since major decisions in the 21st century are based on big data and the proliferation of measurement, investigating the qualitative work of quantitative measurements is crucial for understanding how decisions at the "end" of data analysis have already begun before data collection, during measurement, even when they are not intentional.

Politics and Power

Studies of the politics of measurement have a long legacy. In *Seeing Like a State*, historian James Scott states that "legibility has [long been] a central problem in statecraft," and modern bureaucracies are characterized by the development of "a measure, a metric, that would allow it to 'translate' what [the state] knew into a common standard necessary for a synoptic view," the top-down view required to govern populations [57: 3-4]. Likewise, in *The Politics of Large Numbers*, statistician and sociologist Alain Desrosières writes that modern statistics is the "recombining of scientific and administrative practices" [17: 9]. As such, citizens, trees, hospitals, and other entities of interest have long been measured, counted, aggregated, organized, judged, and archived in a calculus of governance. Measurement and its manipulation as central techniques in governance and control has been a strong theme in research that lays bare the political work of

quantification [5, 7, 17, 18, 25, 51, 56, 57]. In line with this work, our case studies are about politics proper: the use of measurement by a governing body or its agents to affect change within its jurisdiction.

Measurements are not just political in the sense that they are used in governance; they are also political in that they exercise covert political power by bringing certain things into spreadsheets and data infrastructures, and thus into management and policy, while leaving other things out. Sociologist Stephen Lukes [in Scott, 58] refers to this latent power to shape political agendas as a mobilization of bias, or the ability to shape agendas before overt political conflict even emerges. This view is summed up in the truism, "You can't manage what you can't measure" an its inverse, "you can only manage what you do measure."

One of the main themes in research on power, politics and data is how certain things, particularly things that are not of interest to the state or other institutions designing and collecting data, are systematically left out of data infrastructures, and thus left out of the political sphere. Case studies in the literature include the early European state not counting any qualities of trees that were not amenable to units of lumber, a choice that made for a sickly forest over the long term [57]; un-charismatic flora and fauna such as seaweed being left out of ecological evaluations and thus out of environmental policies and protection [6]; and through a seemingly rational use of normal statistical methods, the City of New York removing people of color and women from post-Hurricane Sandy survivor surveys [39]. In each case, certain entities are *unintentionally* excluded from measurement, and thus from circulation in science, policy, and management in the pursuit of other interests and values.

Measurements Make Things

The power and politics of measurement via leaving things out is further complicated by how the interplay of inclusion and exclusion *makes* things. Measurements create certain possibilities for action and exclude other possibilities; this is why it is crucial to examine not only the politics underpinning the design of measurements, but how measurements are linked to action, carrying the interests of their designers into the world.

Science and technology studies theorist Geoffrey Bowker writes, "the database itself will ultimately shape the world in its image: it will be performative. If we are only saving what we are counting, and if our counts are skewed in many different ways [such as what gets counted and what does not], then we are creating a new world in which those counts become more and more normalized" [5: 675]. It becomes normal, natural even, that some entities and qualities are measured and some are not. Soon it becomes normal to think of trees as lumber, and soon instead of "nature" they are called "natural resources" [57: 13]. Certain measurements become the norm, are taken for granted, and eventually we do not recall how those measurements were chosen over others in the first place. Our daily lives are full of seemingly natural measurements, from the caloric content of food [43] to the miles per gallon performance of our vehicles [36], despite their constructed and even contested nature, demonstrating how measurements enter into vernacular usage and are accepted as legitimate, unquestioned descriptions of the things being represented.

Not only do measurements make certain things normal, they also make new things entirely. For example, in "The Making and Molding of Child Abuse," Ian Hacking describes how the concept of "child abuse" was invented in Denver in 1961 by pediatricians after their publication of "The Battered-Child Syndrome" [26]. Once "child abuse" was on the books as something to be counted—it became a medical category by 1965—the counting began in earnest until it seemed there was an epidemic in America: 7000 in 1967, 1.1 million in 1982, doubling to 2.4 million in 1989. Child abuse became a concrete social problem via measurement. Like our case studies, "child abuse" is a category that made a previously "invisible" form of harm manifest. Once "recognized," it became a national crisis.

Moral Measurements, Judgment, and Qualculation

When measurements make things, the practice of measurement also encapsulates moral judgments about these things. To understand how measurement is linked with action, it is necessary to understand measurement as a moral act, one that embodies a particular set of values and principles of conduct.

STS scholars [10, 11, 42] link calculation and judgment in their term 'qualculation.' Qualculation is the act through which judgment and calculation, and their vested values, are stabilized into standardized things. The term qualculation denotes that quantitative calculation always already involves qualitative judgment. The results of a popular algorithm ranking hotels, for example, is inseparable from the practices of qualitative assessment that users engage in concert with the particular design of a tripadvisor interface which provides a certain scale structure and specific categories for reviewers to exercise judgment on (location, sleep quality, rooms, cleanliness, etc.) [11, 45]. Ingunn Moser and John Law explain:

"Judgment and calculation […] have much in common. This is because each makes relations between elements that are materially heterogeneous and different in kind. Each needs to simplify those heterogeneities and order – perhaps homogenise – them. Each, therefore, works by setting limits to what will count as "information". Each does this by setting boundaries to what is taken to be important and what is not. In short, we are arguing that judgment and calculation both work by arraying and manipulating entities within a single spatio-temporal frame. In this way they achieve what we will call qualculability [42: 59]."

For Moser & Law, measurement is one of a number of highly impactful descriptive practices along with classification, counting, and naming that make groups of diverse things into one kind of thing. Messy realities are framed and stabilized so that they may circulate in the world as homogenous units. These choices are value-based judgments. To return to the case of child abuse, a number of different behaviors were grouped together into one kind. It was judged that battery, willful neglect, sexual abuse, and incest against children were all one kind of thing. Through measuring these behaviors and grouping them under the term 'child abuse,' they were deemed morally wrong, thus identification of these actions was linked to a moral imperative for society to address and mitigate these behaviors.

The following case studies highlight how measurement makes something in the world that was not there before, even as they may aim to "merely" describe the thing under measurement. We have multiple aims. The first is to demonstrate how measurement makes certain things visible, and others invisible, thus creates and delimits certain spaces for action and closes off other possibilities. As noted above, other scholars have also looked at qualculation through this framework; we are extending this analysis by focusing on how this process occurs in high stake situations of health and harm. Second, in each case study we show how the qualitative, value-based aspects of measurement have be used intentionally for positive ends, rather than following most research on the topic that highlights how unreflective use of measurement and other forms of qualculation can lead to negative politics. In our cases, measurement is employed to make visible what was invisible in an attempt to intervene in a system with the aim of promoting health and well-being. If all measurements are political, we argue for both critical reflexivity in their construction and deployment, and an ethical stance that foregrounds their use for good.

CASES

We present two case studies: one on measures of maternal health for healthcare provision for hospitals, and one on measures of environmental health through sewage contamination of drinking water. These are chosen because in both cases, scientists and health professionals used their profession to intentionally advocate for change through measurement. The cases are overt in how change makers link quantitative measurement to qualitative action, thereby making the mechanics of the practice explicit to analysis and research for cases where the politics are less explicit: they are extreme but quintessential examples.

Case study 1: Measuring Severe Maternal Morbidity

Introduction

Our first case is drawn from Pine's ongoing ethnographic work on information practices in maternal and child healthcare [47, 48, 49], and specifically current development of a measurement of severe maternal morbidity. The severe maternal morbidity measure is directly linked to efforts from medicine, public health, and social justice groups to impact the high incidence of maternal mortality in the U.S., the number of women dying directly of pregnancy or childbirth related causes. In recent years maternal health has been adopted as an indicator of a country's health, development, and economic progress more broadly; improving maternal health through reducing maternal mortality was adopted as one of the United Nation's eight Millennium Development Goals in 2000. Maternal mortality received significant media attention in the United States in 2010, when the World Health Organization published a report revealing that the incidence of maternal mortality had decreased globally in the past 20 years but had doubled in the United States, ranking the U.S. number one among developed countries for maternal mortality, and even worse than some developing countries [66]. The data also revealed deep ethnic disparities in outcomes as African American women had a rate of death four times higher than other ethnic groups.

Invisible Harm

However, obtaining the precise U.S. maternal mortality rate has proven quite difficult in practice. A number of difficulties have been encountered. Bowker and Starr [7] have described the difficulty of accurately recording cause of death in general, and maternal death data is of notoriously low quality [15]. Even where pregnancy or childbirth are directly responsible for mortality, cause of death is often listed differently, such as "cardiac arrest" [23]. Further, the gross number of deaths is quite low, even if the rate is high compared to other countries. Maternal mortality is measured as a ratio of the number of deaths per 100,000 pregnancies. There is a perceptual issue in that while the ratio has risen dramatically over the past two decades, the fact that the gross number is low has lead to a tendency to discount maternal mortality as a true social problem by both medical professionals and the general public. In particular, infant mortality has received much more attention in quality improvement efforts than maternal mortality. Human rights and feminist activists point out that this may be exacerbated by pervasive underlying discrimination that places fetal rights above those of women exemplified by the ongoing abortion debate and legal cases that pit fetal rights to healthcare against those of their mothers.

Additionally, hospital culture has proven challenging for highlighting the severity of material mortality as a medical problem. There is a common belief in hospitals that obstetrical emergencies are lightweight and less pressing than other kinds of emergencies. For example, a blood bank manager interviewed during fieldwork explained that she feels efforts to improve operational and system responses to obstetrical hemorrhage are a waste of effort because

"gunshot wounds to the chest are the real emergencies" for blood banks, while obstetrical hemorrhage is not, though both require blood. As a result of this culture and the interpretation of the ratio, activists from a number of realms have found it difficult to both impact the maternal mortality rate and impress the importance of the issue on both professionals and the general public.

In trying to affect maternal health more broadly, a recent strategy has been to develop a measure of maternal morbidity rather than mortality – that is, on maternal health and wellbeing rather than death rates. Maternal health activists and quality improvement advocates argue that maternal mortality represents only "the tip of the iceberg" in terms of severe maternal health events, and the number of women who experience severe morbidity (resulting in both short and long term impairment) is estimated to occur at a rate 50 times higher than mortality. Focusing on severe maternal morbidity additionally creates a much larger pool of data and thus a larger dataset with greater statistical power from which to measure structures, processes, and outcomes related to maternal health and harm. The thought is that if morbidity can be impacted, the more elusive mortality rate will be affected as well. Thus, making maternal morbidity visible via measurement is an explicit effort to draw attention to substandard material conditions of healthcare in both medical and public spheres.

In 2008, the American Center for Disease Control (CDC) [14] proposed a potential algorithm for identification and classification of severe maternal morbidity cases based on algorithms developed by Callaghan, Creanga, & Kuklina [9] and Kuklina et al [35]. Each of these potential algorithms encapsulates a number of measurements, including a number of pieces of administrative information such as length of stay in hospital, unit of admission, along with 25 diagnosis and procedure codes that may be related to maternal health events (i.e. acute myocardial infarction, aneurism) drawn from International Classification of Disease (ICD) data applied by medical coders after a stay in the hospital. At present, some states are working to implement this measure although it is not yet required by law or by the hospital accreditation body.

The Activist Measurement

A state-funded quality improvement collaborative has recently decided to focus on data related to blood transfusions as a primary indicator of maternal morbidity in Pine's hospital and data center field sites. Obstetric hemorrhage is the leading cause of preventable maternal mortality. This is not simply a medical move, but an attempt to make obstetric emergency visible in very visceral terms: blood. The severe maternal morbidity measurement is based on the number people who receive four or more blood products, and total number of blood products each person in this sample received. Describing morbidity in terms of blood evokes an image of crisis. Moreover, in the hospital, blood is a precious resource that is expensive in both fiscal terms and in human resources required to acquire (from direct donors and larger regional blood banks), store, manage, and coordinate fragile and limited blood supplies. Further, accurate blood transfusion data can only be collected with the explicit buy-in of hospital blood banks. The current construction of the blood unit-based severe morbidity measure shapes a need for collaboration between obstetrical units, quality improvement units, and blood banks, which the statewide quality improvement agency hopes will naturally create increased dialogue between these units thus increasing the salience of obstetric hemorrhage as an urgent priority for blood banks, one of the most important departments within the hospital.

Measuring blood loss and replacement is now being materialized in the design of hospital information systems. Blood loss constitutes a substantial design challenge for both clinicians and designers of computer interfaces for obstetrical work. This is because accurately quantifying blood loss is difficult to do in practice. In some hospitals, a new pop-up calculating scale has been introduced in the Electronic Health Records (EHR) that helps clinicians accurately quantify blood loss. When a hemorrhage is documented, clinicians access a calculator that automatically subtracts the weight in grams of blood- soiled items from the pre-programmed tare weight of sheets, towels, and gauze, and produces a running tally of quantified blood loss. As the SMM measure is further developed around number of blood products transfused, designers are grappling with a way to develop calculators in the EHR interface which will depict both quantified blood loss and also the total number of products transfused, further shaping information entry into the computer system in ways that shift organizational behavior and shape it around a blood-based notion of health and harm. In short, these user interfaces will naturalize the measure of blood designed to address high material mortality and morbidity rates.

Conclusion

The blood measurement involves counting the number of blood units given to patients who receive 4 or more units of blood from an obstetrical hemorrhage. This measurement is an active local effort to label and count blood in order to stabilize "severe maternal morbidity" as a problem. When multiple sites use this measurement, they will make maternal morbidity visible and comparable, thus creating a new artifact—a coherent abstraction of 'maternal morbidity'— where there was previously none. The design of the calculator in the EHR system materializes the loss of blood of hemorrhaging patients in a way that requires weighing blood soaked items—gone are the days of estimating blood loss visually. Thus the development of the Severe Maternal Morbidity measure centered around blood loss and transfusion, and subsequent design of the calculator, requires a change in observation practices and new attention to blood loss. Our case study also shows how

this calculator and its subsequent iterations, which might appear to be a benign design element, is the result of advocacy.

This measurement is an explicit attempt at intervention on many fronts. Blood loss is not only scary in the wider social imaginary, but units of blood given are understood in the social order of the hospital as denoting "dire emergencies." Making blood loss visible via measurement thus explicitly makes "harm" by denoting that there is an acceptable amount of blood loss and an atypical, pathological amount of blood loss. Maternal health is materialized as an emergency involving the potential for massive pathological bleeding, thus presents a moral imperative for action on the part of the medical establishment to stop blood loss and on the public to pay attention to a deadly crisis in the United States.

Case study 2: Previous Sewage Contamination (PSC)

Introduction

In the mid-nineteenth century, increased industrial activity and urbanization in Britain and the United States lead to the contamination of waterways used for public water supplies by industrial chemicals and sewage. In addition to sewage, effluents of inner-city tanneries, slaughterhouses, reduction plants, breweries, paper milling and textile manufacturing compounded the "filth problem" by dumping their waste into the public water sources from which drinking water came. Cholera epidemics increased in number rather than decreasing after the industrial revolution in Britain and the United States. Governments in both countries agreed something had to be done. In Britain, the 1887 *Rivers Pollution Prevention Act* decreed

There is no such thing as absolutely pure water in nature, and the waters met with in our springs, lakes, rivers, and sewers, form a series gradually increasing in dirtiness; there is actually no definite line of demarcation separating the purest spring water from the filthiest sewage.... It is, therefore, obvious that, for the purposes of efficient legislation, an arbitrary line must be drawn between waters which are to be deemed polluting and [those deemed non-polluting]. [Rivers Pollution Commission]

Scientists were asked to determine this "arbitrary line" to say whether a waterway was fit for consumption. In London, this line was often whether or not the water had been filtered in new state-of-the-art filtration systems.

Invisible Harm

While the norm for safe drinking water metrics became whether water had been filtered and if a specific number bacteria were found in a sample (the number varied by jurisdiction), in the professional opinion of Edward Frankland, a British water chemist for the British Royal Institution, science was not up to the task [20, 21, 22]. Frankland believed that water analysis could not define the safety of water, chiefly because the presence and habits of germs, a new concept in the field, were still largely unknown. Frankland believed germs could potentially withstand filtration, chemical reagents, dilution, condensation, and other popular purification methods. Thus, even if a bacteriological test found no living germs in a sample, Frankland reasoned that a few germs may have survived purification and were just not present in the sample taken. These resilient germs could start an epidemic. Between 1831 and the time of Frankland's first writing on the topic, over 43,000 people in London had died of cholera [63].

The Activist Measurement

Thus, in 1867, Frankland introduced the concept of "previous sewage contamination," or PSC, in London's water quality metrics. PSC was meant to represent the amount of sewage a river had received upstream [22]. It was a number obtained by measuring the total amount of nitrogen compounds in a water sample, which in turn indicated the amount of organic material that had been in the water. This organic material could come from sewage or peat or other sources; science could not differentiate between them, and Frankland maintained the differentiation was "hygienically irrelevant" [22: 113-17]. PSC was meant to indicate whether there had ever potentially been sewage in the water, and thus indicated a health danger regardless of whether the water had been purified.

In effect, PSC was a measurement used to advocate for a definition of safety that differed substantially from the status quo. At the time, post-purification was the preferred standard for measurement of safety. Thus, In contrast to post-purification, PSC was an activist measurement, one that sought to link measurement to a particular mode of action [28, 29]. As a member of several Royal commissions on water quality, Frankland had the ability to instate PSC in water analysis reports received by Londoners, materializing the measurement as a commonplace information artifact used by citizens to understand water quality. His idea was that citizens and other stakeholders would understand the measurement to mean they were drinking feces—not urine, because disease-causing germs such as cholera and yellow fever had been explicitly linked to solid sewage—and become disgusted, fearful, or enraged to the point of demanding better water quality from their government. PSC would be present in any purified water since all local waterways were used as extensions of sewers (and had other organic materials in them besides), meaning the PSC metric effectively made sewage contamination an intractable problem of urban planning. Affecting change toward "better water" via this measurement would entail either changing the source of London's water supply, or the legislated cessation of all sewage disposal into waterways. The latter was Frankland's goal.

Conclusion

PSC was an explicitly, intentionally political measurement that sought the complete revolution of sewage disposal

practices. It aimed to make danger visible where people had previously seen safe drinking water, an intervention premised on the notion that science was not yet capable of making judgments of safe drinking water, and that any amount of organic matter (nitrates) indicated a possible germ, and therefore the single seed of an epidemic. It grouped together all indicators of organic contaminants, effectively homogenizing them as "previous sewage contaminant" even if they had been from peat or textile manufacturers, and these homogenized units circulated through bureaucracies and into the public sphere. In effect, PSC was a lever for banning raw sewage disposal into local waterways; it was action-by-measurement.

If you work monitoring water quality at a water treatment plant today, you would measure and log nitrates among other common contaminants. But there is no category for PSC. As a consumer of water, your yearly water quality report does not contain an entry for PSC. Again, you might see a numerical value beside "nitrates," but this number does not indicate harm or even potential harm. Despite Frankland's best efforts, PSC did not change practices of dumping sewage into waterways, nor did the measurement itself endure in water quality monitoring infrastructures. This is partly because science became able to detect safe or unsafe water and epidemics of cholera and yellow fever become less common. Yet, even today, the presence of water-borne endocrine disruptors in the form of pesticide runoff, plastic leachates, and flushed synthetic hormones are thought to cause forms of harm that science is unable to track definitively [37], but there is no indicator for these contaminants in day-to-day data collection practices. The absence of an interface that can receive these measurements makes their invisibility all the more concrete and likely to continue. It is a sort of ignorance by design [34, 52] where it becomes impossible to see certain harms because the tools and interfaces that would detect and receive them look for other things, and so they remain out of scientific, political, and public consciousness. What the interface doesn't include shapes action. Thus, Frankland's fight remains relevant to contemporary issues of measurement and how it endures in information systems with ramifications for interventions around health and contamination.

DISCUSSION

Other researchers have shown how qualculations create "things," or ontologies, which are then programmed into databases, ICTs, and management structures (i.e. see [1, 2]). Our research adds nuance to this discussion by looking at how activist and advocate groups have recognized this and leveraged it for social change in the realm of health. In particular, we show how measurements are linked to actions in the broader world by redefining harm and health and their attendant crises. Our two main assertions are:

1) Some data is more "charismatic" than others, meaning it inspires action more than other forms of evidence, because of both pre-existing social and cultural values and affective modes of representing crisis.

2) All data is already interested and value-laden, and some groups of people are using this explicitly for social change, but the value-laden nature of measurement and thus of data is true in all cases.

Charismatic Measurements

It is no coincidence that the agents in our examples chose blood and feces as their objects of measurement, for both are *charismatic*. We use charisma to mean the characteristic of inspiring devotion so strong that it moves an audience to action [50]. Measurements get their power to move people to action from qualculation—the values, judgments, and fears that are already salient in a culture, which are then "baked into" the measurement. Blood already signals fear and crisis, both in the popular imagination and in the hospital emergency hierarchy. Feces are already disgusting and dangerous, particularly in the nineteenth century, and must be segregated from human consumption at all costs. Returning to Hacking's example, child abuse is already morally abhorrent at the moment of its inception as a category of violence. All these measurements have a terrifying charisma.

Elsewhere, the second author has discussed "charismatic data" [37], information that is simultaneously scientific evidence and proof of a moral imperative, and thus has the potential to launch action the way other data may not. Blood-based maternal morbidity rates and Previous Sewage Contamination (PSC) are charismatic measurements in this way. By purposefully choosing blood as the measure of maternal morbidity and presence of feces as the measure of dangerous water, the agents in our case studies were attempting to make a problem manifest that had heretofore been invisible, and thus introduce solutions that may not have been viable before. Their efforts to make a type of harm apparent through measurement made a new entity. That entity was crafted in such a way that it was actionable.

For example, crafting the measure of maternal morbidity through blood transfusions made the problem of maternal morbidity a certain sort of crisis, which then has specific attendant solutions. Harm is constructed and made visceral in the measurement. Further, harm is tied to a specific material resource: blood. 'Making' morbidity through a measurement of transfused blood units casts maternal morbidity as an organizational problem. The measurement itself affords certain solutions to the problem; adequate treatment of morbidity involves first staunching blood loss, and second transferring blood supplies from the blood bank to the site of care, rapidly and effectively replacing blood that is lost to prevent grave harm and perhaps even impending death. At a macro level, the crisis involves prioritization at the administrative level as a consumer of valuable resources. The measurement itself, which is being built into algorithms and schemes for healthcare systems

management and quality improvement [49], lends itself to evaluations of medical practice and organizational performance, particularly inter-unit coordination. Now maternal morbidity, and by extension, maternal mortality, can be managed. Likewise, calling all organic matter Previous Sewage Contamination made any suspicious material a dangerous entity that had to be completely absent, rather than present in small numbers, to achieve safe drinking water. Now the urban water supply had to be managed differently.

Measurement and Action

In both cases, the measurements leveraged action by mapping into preexisting values. Measurements are a "technique of definition" that distills something amorphous into something essential [37], and by doing so, "having exposed its true nature, [one can] skillfully excise its root causes" [55: 159]. In the making and remaking of things and establishment of what is usual and average, normal and pathological, countable and measurable, entities and their attendant problems are presented in certain ways. Hacking [26] describes the link between measurement and action via labeling theory: "people act and decide under descriptions, and as new possibilities for description emerge, so do new kinds of action [p. 255]." When child abuse became something to be measured, it allowed policy to work in places it could not before. When blood is the measure of harm, the problem of maternal health rises in importance within the hospital and public sphere, allowing more resources and attention, and ideally fewer maternal deaths in the United States. When there is sewage rather than "organic matter" in the water, a municipality may shift from filtration to the regulation of dumping in waterways. Thus, qualculation delimits the kinds of actions towards that entity that make sense, and those which do not, determining the types of action that are likely to take place in both expert communities and policy circles. As such, measurement is always linked to action.

However, we do not want to let the charisma of blood and feces obfuscate the point that while our examples might be extreme, they are also quintessential. All qualculations are inherently political; they make the things they are describing, are infused with values and judgment, and are intimately tied to action. Using charismatic examples based in activism and advocacy makes the implicit explicit and, most importantly, available for action.

CONCLUSION

Returning to Bowker's [5] point that "the database will shape the world in its image," we are at a key moment in which to excavate the sociocultural and sociopolitical underpinnings of measurement. If successful, measurements and their modes of action are interred in data structures [1], which are increasingly woven into almost all aspects of our daily activities. Nigel Thrift [62] calls for attention to how the increasingly qualculated world is shaping the "background hum of thinking," our invisible cognitive processes, and how they will be changed by current developments in database capacity and attendant information and communication structures. This background hum includes, often invisibly, the judgments, assumptions, and values of various decisions that have been interred in information infrastructures through measurement. This is political. This is as true of overt and intentional qualculations like blood-based maternal morbidity measures or Previous Sewage Contamination as it is for every other form of data and measurement. As we seek more things to measure to meet the capacities of Big Data, and as we come to use this data to make decisions on grander and grander scales, we need to be aware of these underlying structures and our own role in shaping them as interventions in the world. Our case studies of maternal mortality metrics and Previous Sewage Contamination add to the wider conversation about the politics of information by highlighting cases where these characteristics of measurement are used intentionally by advocates and activists to redefine, via measurement, the indicators of health and harm.

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