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FEAR AND DESIRE IN DATABASE CREATION

Social, Behavioral and Organizational Aspects of Information Systems

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Abstract

Organizations need quality information for control and coordination of their operations. Yet, despite the resources expended on data production, data often proves to be unreliable or inadequate when used in practice. To understand this puzzle, I conducted an ethnographic study of the production of a database system within one organization. Database systems provide the scaffolding to hold the data that are to be produced and consumed on a regular basis. I find that the creation of a database is a laborious exercise fraught with tensions and entailing both fears and desires. I examine these fears and desires from three separate lenses reflecting the various purposes that people imagine for the database – efficiency (rational lens), accountability (control lens), and comparability (standardization lens). As these purposes interact in the activities of database production, the fears and desires heighten to eventually produce an oversized database system with standardized, simplified, and abstracted data that undermines its stated purpose and generates significant difficulties for its users.

Keywords: Database, data, control, enterprise systems, decision making, systems design, standardization

To stay well informed and build up its knowledge base, the intelligent organization needs to feed on a balanced diet of high quality information supplied through a varied menu of information products and services (Choo 1998, p.38).

Introduction

Organizations rely on information for decision making. Indeed, management of information is often cited as the defining characteristic of modern organization (DiMaggio 2001; Weber et al. 1958). Organizations are constantly scanning their internal and external environment for what they hope will be valuable information to contribute to future decisions.

Despite such valiant organizational efforts to collect information –- made significantly more ambitious by the use of computers – poor decisions are taken. In fact, most collected information has little decision relevance and may not even be considered at the time of a decision (Feldman et al. 1981).

Information is needed for decision making but information itself is an outcome of several decisions. Several such decisions are taken for data to be fed into the database system. These decisions could be guided by multiple interests that shape the quality of information that resides in the database system. However, usability of information could also be explained by the fields and functionality of the database system *as designed* since these constrain and enable the data that could be eventually fed in. In order to fully understand how information can contribute to poor decisions, one therefore, needs to go back in time and examine this other prior set of decisions that shape the produced database system.

I examine the *production* of a *database system* as a site for the material production of data. Once the database system is created, it provides a scaffolding to hold the data that individuals enter into it. This scaffolding, once erected, shapes both the volume and the type of information that can be collected, retained or used, which then shapes the kind of decisions that organizations make.

Production of database systems is a laborious exercise. Drawing from my ethnographic study of database creation at Welldon, a large university, I find that construction of database systems is guided not by actual usage of data but by imagined usage of data reflecting different purposes. Database creation is a dynamic process involving several actor groups, each group focused on one or more of these imagined purposes of data. These imagined purposes guide the database creators as they add bits and pieces to the emerging scaffolding.

The two most common purposes for data invoked in the database design discussions are efficiency and accountability. Data, especially formal records, are used by organizations for collective memory to maintain decisions and rules over time and across people. Data here are used as documentary traces representing and reinforcing the requirements of rational and efficient decision-making. Data are also used to support organizational control efforts (Rule et al. 1992; Zuboff 1988), typically involving the recording and tracking of material resources or the monitoring of organizational members.

The third purpose commonly referred to in the database design process is that of comparability, the capacity to assess status, variance, and change across entities and time. Comparability is made especially possible by modern standardized and integrated computerized database systems. The database that I study is part of an organization-wide Enterprise System (ES) that provides the ability to capture information about business processes in an integrated manner across functional and departmental boundaries, enabling (at least according to its proponents) faster, more efficient and more integrated decision making.

These three invoked purposes (efficiency, accountability, and comparability) serve as my exploratory lenses of rationality, control, and standardization to examine different design arguments proposed by participants in the database production process. I find that these imagined purposes do not work in isolation. Each of these imagined purposes interacts with and feeds on the other. It becomes important therefore to consider these lenses (and the purposes they reflect) together in examining the database creation process. By juxtaposing these lenses in this paper, I propose an integrated model of database creation. I show how imagined purposes of data reinforce each other to create both a fear against and desire for data. As more data purposes are imagined and capacity created in the scaffold, fears of misuse escalate and desires for unambiguous data increase resulting in a feedback loop exploding the capacity of the database and reducing the number of details captured. Eventually, the resulting huge but overly simplified database may have little relevance for the originally stated objective, and be less than useful for its intended users.

In the sections that follow, I first describe the database system planned at Welldon, the actor groups that were involved in the database design process and my own methods of observation and analysis. Next I analyze the database creation process from three different lenses to interrogate three different purposes for using data – efficiency, accountability, and comparability. I then synthesize the insights from these three descriptions to highlight the complexity and dynamics of database creation. I show how in practice, the expression of these purposes interact with each other to produce an overly standardized, abstracted, simplified, and potentially voluminous amount of data. I conclude with implications for research and for the database design process.

EHS Database and Welldon

My analysis and findings are based on ethnographic research done at Welldon, a large American research university that accommodates over 10,000 students and a similar number of employees – mainly faculty members, research and administrative staff. Welldon is known for its cutting edge research and houses some 25 departments and over 500 research labs engaged in a range of established and emerging scientific disciplines.

Universities are professional bureaucracies (Mintzberg 1979) composed of an operating core of faculty and researchers and a bureaucratically organized administrative staff. In this sense, universities do not follow a strict hierarchical structure, at least on the faculty side. The structure at universities is much more loosely coupled (Weick 1976) than at other hierarchical organizations and the departments are relatively autonomous and independent of one another.

Despite the relative autonomy and independence of departments, universities, also share similarities with other typical, for-profit organizations. Like their for-profit counterparts, they also require coordination and control to ensure budgetary, strategic and regulatory compliance. This is especially true in modern research universities that are instrumental in advancing scientific knowledge but that also suffuse the environment with untold risks and hazards.

In 1998, the Environment Protection Agency (EPA), in an inspection at Welldon, found many minor infractions in its research labs. While the violations themselves did not pose any major imminent threat, what concerned EPA was the lack of a self-sustaining system that would provide the checks and balances to control the potentially devastating hazards[1] commonly found in Welldon research labs. In response to these findings, Welldon signed a consent decree with EPA and agreed to create a self-sustaining Environment Health and Safety (EHS) Management System over a period of five years. This management system would create a web of roles, responsibilities and processes that would guide not only Welldon researchers in hazard management, but would be a role model for similar research organizations nation-wide. The system design process started in 2001 and over the last five years, the Welldon community has mapped out several components to create environmentally sustainable research practices. At the heart of this management system is a database system that captures information on location of hazards, regulatory and systemic violations, accidents and research training. This database is being designed to capture the myriad rules – both regulatory and self-created – governing the EHS practices in the scientific labs and to serve as a tool to monitor regulatory and environmental compliance through reports and trend analysis. The database itself is part of the larger Enterprise system (ES) that is in use for other university operations such as financial accounts and human resources.

Since the early 1990s, ES packages have become the norm in large organizations. They provide symbolic legitimacy to organizations that want to highlight their nimbleness. ES is supposed to enable greater integration that leads to faster business cycles and more efficient decision-making as data now subscribe to a standard format. Economically, greater integration would mean lower data maintenance costs. Greater integration would also lead to increased collaboration between departments and more streamlined operations (Davenport 1998).

For Welldon, use of ES is an attempt to harness the benefits of ES systems while minimizing the risks of implementation. Welldon, though not a typical global manufacturing organization, has operations and research scattered not only spatially, but more important, culturally. Each department has its own set of equipment, and epistemic cultures (Knorr-Cetina 1999). The diverse equipment and procedures in departments come with equally diverse hazards. A physics lab's hazards from using laser machines are different from the radiation threats from a nuclear lab that again are different from the threats of contamination posed by mice in the biology lab. The research at Welldon, therefore, comes with myriad hazards that go hand-in-hand with the benefits of knowledge advancement that it brings. The ES is envisaged as a tool for centrally managing these risks of modernity and modern research. This means having the same form and fields to capture data at highly diverse departments.

The EHS database system

The EHS database system consists of several inter-connected components (as shown below):

[1] The EHS related hazards form both the input of research activity as well as its by-product. Chemicals, laser, biological or even nuclear components are used as key components in research. As by-products of research, hazards can take the form of chemical or waste, or even radiation. These hazards could pose immediate and long term threats to researchers, community members and environment – both locally and regionally.

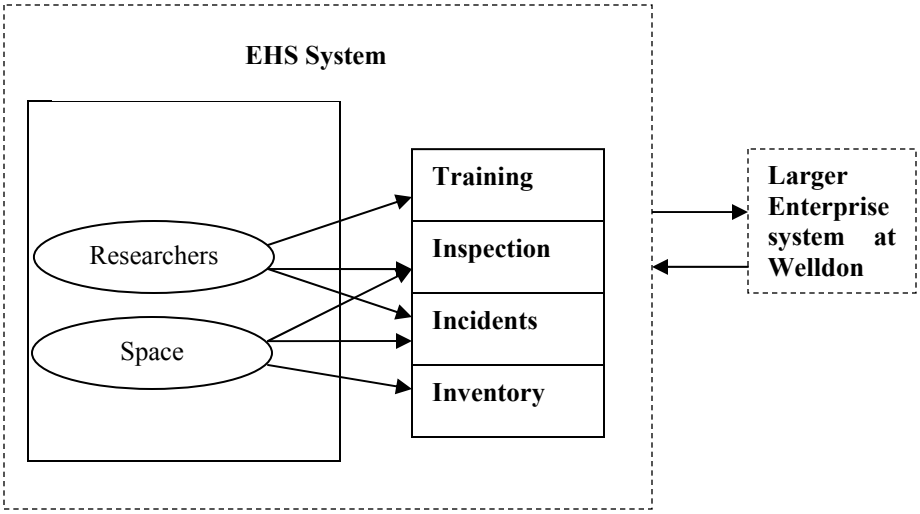

Figure 1: The Integrated EHS database system at Welldon

Within the EHS system, sub-systems are being created to capture inventory, regulatory training for researchers, record of the bi-annual lab inspections, and information on accidents and incidents such as fires and spills – both in terms of researcher information and the physical space at which such inspections and accidents occur.

Each component interacts with the others within the EHS system and also with the rest of the enterprise system at Welldon. For instance, the inspection system feeds off of the training system to determine that the training requirements are being met; accident investigations rely on inspection and training records in order to assess the past compliance within the accident area. The EHS system also needs to be integrated with the larger ES at Welldon. The data for researchers is extracted from the human resources database and the facilities system needs to be integrated to ensure, for instance, that a broken safety shower found during an inspection of a lab is fixed.

IT systems can, at best, map out the espoused processes in an organization. The map may bear some resemblance to the actual terrain but it would only still be a representation (Berg 1998). The systems design process becomes contentious because systems, even when they are very rough representations of reality, have the potential to shape actions. The participatory design process is known to generate direct contact of people, evoking emotions of jealousy and competition, especially as different sides want to exert influence (Barki et al. 1994; Robey et al. 1982). Systems may be consciously or unintentionally designed in ways that can shift the prevailing political balance and can make some processes, or some actors, more visible than others (Berg et al. 1997; Bowker et al. 1999). Thus, the design process excites general interest and may sometimes lead to strong resistance among some potential users (Bloomfield 1991; Markus 1983; Markus et al. 1987; Myers et al. 1997). Moreover, when the formal systems are experienced as constraints, they result in workarounds (Gasser 1986; Pollock 2005) and creative interpretations (Berg 1997). These adaptive practices restructure the processes supposedly programmed into the system. The process of systems design, therefore, is a political process when there is an established precedent for doing things.

At a place like Welldon, systems design became significantly more dynamic and political because there was almost no EHS process prior to the EPA consent decree. Every department followed its own protocols for hazard management and in most these were quite limited. The IT system design became a channel for articulating both the terrain and its representation. There were innumerable debates about what the process should be as well as how it would be captured in the database system. The database design discussions provided a sounding board for different community members to argue not only for their own preferred way of representing the EHS system but for enacting their roles. Several people seemed to recognize implicitly the potential importance of this database system for shaping what would become EHS practice and participated extensively in its design. There were others who were explicit and more articulate about how they perceived this potential system. One of the users in a candid moment told me: "I go to the design meetings because they will help me shape my job in the future."

I spent approximately 20 hours per week between December 2004 and November 2005 observing the design of the inspection component of the database system. This particular component was a source of active conflict because it

sought to make visible the errant actions in the labs. I had a workstation at the IT office and followed the IT designers as they went about interacting among themselves and with user communities across campus to consolidate the database design. What started as my observations of design of the inspection system exposed me to other aspects of the entire IT infrastructure for the management system. The purpose of the inspection system was to have an electronic form that would record both the fact of the inspection and its results, including violations of Welldon's adaptation of state and regulatory regulations. But as the design process continued, several debates broke out about what datafields should exist on the form, what information should be captured, who should be capturing it, and who was to have access to any piece of information. I attended more than 100 committee meetings where I observed and recorded notes about negotiations on design considerations. I also had one-on-one conversations with more than 30 stakeholders as I tried to understand their interpretations and mental constructions as they put forth their arguments in these meetings. In this sense, I was able to substantiate my understanding of reactions that were sometimes non-verbal. Every group of stakeholders had its own perspectives and each of these communities contributed to the creation of the database system. My data collection methodology helped me examine the multiple perspectives that are inevitably present in any design process. It also helped me understand the importance of ostensibly trivial arguments that stemmed from these perspectives. Eventually, an interaction of these multiple arguments – big and small – contributed to the shape of the database system-as-designed.

My analytical approach is interpretive and iterative, primarily employing the techniques of grounded theory (Glaser et al. 1967). I coded my notes from meetings and interviews to discover themes. My initial coding was open-ended (Strauss et al. 1998) and helped me generate several memos. An examination of these memos led to the identification of recurrent themes and helped me re-code my data for specific sub-codes associated with these themes.

Stakeholders

The EHS database system could potentially touch work lives in terms of how employees would be evaluated and how existing routines would be disrupted by data collection and database maintenance. There were several such stakeholders who participated in shaping the ultimate design of the database system[2]. For the purpose of this paper, I primarily focus on two of them.

EHS office. The staff at the EHS office considers itself responsible for the success of this system. They are responsible for training, inspecting and providing guidance to the research community at Welldon on the handling, storage, and disposal of hazardous materials including chemicals, radioactive matter and biological matter. The EHS office also provides emergency response interventions for accidents, spills, fires, explosions etc. Finally, the EHS staff are partners in laboratory inspections of the research facilities. EHS office has spearheaded the creation of this management system. The staff is actively engaged in the committee discussions, and some of them have become leading voices shaping this new system.

Departmental coordinators. When the design of the management system started in 2001, one of the first decisions was to create a new position: Departmental EHS coordinators. Departmental coordinators act as an interface between the EHS office and the academic researchers, in essence, delivering the management system within the academic departments, helping to ensure compliance. Since the position is a recent creation, the boundaries of the role are still ambiguous. The various systems[3] being created (i.e., training, and inspection) will shape the development of the coordinator role, specifically how much of their time will be spent feeding and maintaining data and how much of the coordinators' time will be spent ensuring that others in their domain are fulfilling their database obligations. The coordinators have thus contributed a particularly strong voice in the design process.

In addition to these two groups of actors, there were others involved. These included the IT design team, that wanted to deliver a "good" product within the budgetary and time constraints; the faculty members who wanted to maintain

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[2] There was of course individual variance in perspectives within each of these groups but at a less granular level, the individuals in each group had similar aspirations and concerns about the database system.

[3] It is hard to disentangle the management system on paper and the database system that is a representation of the management system. As the database system comes into greater use, it may diverge from the practiced processes although the two would potentially continue to interact with and shape each other. In the period of my study, the two systems were much more conjoined because of their largely fresh and theoretical existence.

their autonomous existence and not be regimented by strict rules while still regulating their hazards; and finally the senior administrative staff who wanted to create an effective system without noticeably disrupting the valued autonomy of the scientists.

Representatives of these groups spent the year arguing about small and big details in the database system – from what would be the labels for the data fields to who is authorized to access what portions of the database. There was a strong desire for some pieces of information and an equally strong fear of some of the potential data[4]. Several fears and desires were evoked because of political aspirations or fears of reduced control. However, the micro-negotiations also highlighted the fears and desires that were not always prompted by direct considerations of power, control and resistance, but stemmed from other imagined purposes that different actors expected the database, when complete, to satisfy.

Moreover, the desires and fears were not shared by all the stakeholder groups. A piece of information desired by one group could be very much feared by another group. The desires had to be negotiated, as did the fears. As these debates continued, they started to shape the database system that was being created – both in terms of the amount of data that was going to be potentially stored and the kind of information that was going to be captured. Both the fears and desires resulted in several changes to the data fields and functionality. I was able to observe these changes as decisions were made in meetings. These decisions would be made after long arguments across multiple forums, and once a decision was made, I was able to trace its antecedents in notes from the meetings. In addition, I have been able to observe how the desires and fears shaped the system by comparing the technical documents as they were prepared for each meeting.

Fear and Desire for Data

Wheeler (1969) identifies four attributes of databases and written communication:

(1) Permanence. Unlike verbal communication, written communication, especially that which is meant to be stored and recorded, has permanence. The words once inscribed, can be easily invoked and memories refreshed at another time.
(2) Transferability. The cost of transferring information, at least in its physical format, is minimal. This means that records can be consumed not only at another time but also at another place.
(3) Records are faceless. The person who authors a record is usually far removed from the consumer of that record. In fact, once the record is created, it takes on a life of its own and there is little control on how it will be interpreted.
(4) Records can be combined in multiple ways – combined with each other or with other pieces of information - that give them whole new meanings.

These attributes can incite both a desire for and a fear against records. At an organizational as well as an individual level, the permanence of records helps as a memory aid. For example, in clinical practices, recorded information is essential to communicating the history of the patient and provide a basis for decisions on current patient care (Garfinkel 1967).The transferability and combinatorial attributes enable the use of records as a justification of organizational existence. For profit making organizations, records such as balance sheets reflect their health to the investors. For a university like Welldon, EHS records signal to the rest of the community, and to government agencies, the seriousness of environment safety efforts at the university. They indicate to the parents of students that their children are in a safe environment. Finally, good records signal the smooth operation of the EHS system which makes Welldon's processes something to be imitated by other universities, further establishing Welldon's repute and leadership among American universities.

The same attributes that make records desirable also make them feared. Records have the ability to "abstract events" and allow them to exist in a "formal, timeless, [and] institutional context" (Ewick et al. 1998, P.101). There is usually a murky process that exists behind the clean numbers that are in a database. Information is coded according to the standards of the day and aspects are left out or included for a variety of reasons. The actual phenomenon may just be too complex to fit into a database. Or it may require too much effort to include in a database. Or it may be purposefully hidden to create a rhetorical image of a particular event (Van Maanen et al. 1994). Databases could be

[4] The words "fear" and "desire" are coded categories that I created to describe emotions that actors either explicitly alluded to (through descriptions like "I fear...", "I worry…", "I want...", etc.) or that I could gauge from non-verbal reactions to certain database features.

deceptive because they typically present aggregates of elements that are different from each other. At Welldon, for instance, the proposed database may present the cumulative results and violations of a laboratory inspection without mentioning the nature of those violations. Even if a diligent person feeds in several details about each inspection violation and an astute reader pays attention to those details, the data field would not capture the actual event in all its physical and social dimensions. This is because the power of the database to capture the "metadata" – the details on the data-production process - is limited and paradoxical (Desrosieres 2001). Users must be given enough details to make sense of the data but they also do not want to be bothered by these data production processes.

Arguably these fears and desires are most salient at the time of database creation. Once people start using a database and start feeding data into it, they are more familiar with how it is being used and devise ways to show only favorable representations (Ball et al. 2000). But this benefit of hindsight is missing during the period of database creation when the uncertainty about the possible uses of data incites active imaginings among the database creators. As they envision ways in which the data could be ultimately used, they argue for inclusions and exclusions based on their fears and desires. This is what makes database creation exercises laborious in even highly localized and customized settings.[5] I examine the desires and fears expressed in the design of the EHS database through three lenses that reflect different purposes people imagine for the database: efficiency (rational lens), accountability (control lens), and comparability (standardization lens) (Table 1). The lenses emerged through an iterative process of data examination and theoretical exploration. Purposes such as efficiency and accountability were described abundantly in the consent decree. In fact the consent decree explicitly mentioned the need for greater 'accountability", "automation", and "centralization" at Welldon. These purposes are also described in literature on records and therefore provided me with appropriate exploratory lenses. For instance, Garfinkel (1967), Porter (1992), and Yates (1989) provide research on the use of records for rationality, coordination, and efficient decision making. Similarly, McKemmish et al. (1993), Van Maanen & Pentland (1994), Wilmott (1996), and Yakel (2001) explore the use of records for establishing control and accountability. Comparability was the third imagined purpose at Welldon and wasn't explicitly referred to in the consent decree but I found several references to it in the design discussions as I spent time in the field. Within the literature, the discourse on standardization provided me with a lens to examine this particular imagined purpose. Fear and desire constitute different sides of these lenses with which to sort and analyze the database design process.

	Efficiency (Rational Lens)	**Accountability (Control Lens)**	**Comparability (Standardization Lens)**
Desire for Data	For trends and metrics	About others Portraying self-image	Consistency across constituent units
Fear of Data	Substituting numbers for details	About self Creating new lines of responsibility	Losing the local

Table 1. Three Purposes in Database Creation

Rational Lens: Efficiency

The most commonly cited rationale for databases is that of efficiency. Information provides basis for decisions and actions. Besides serving the purpose of control and coordination, records allow managers to "think about what is being done" (Yates 1989, p.10).

The EHS database system provides information on whether conditions are improving, what changes need to be made and whose practices need correcting. The espoused goal of the management system, besides meeting the consent decree is to create a safer, healthier and cleaner work environment. An often mentioned term in the discussions on database design is "trend". Much data collection effort is for the purpose of highlighting trends – for example trends in inspection results, trends in accidents and trends in missed trainings. Trends allow Welldon to identify both

[5] There are instances, in some organizations, where databases are created in a purely top-down manner with little involvement from the community at large. Such databases may be created more swiftly but are not the focus of my study. My study involves more participative database creation exercises.

improvements and problem areas that ultimately serve as guidelines for focused action. An increase in missing fire extinguishers is a cause for concern, a cause to take corrective action in the lab and possibly against an individual. A reduction in the number of missing fire extinguishers is a cause for celebration. It is but one "data point" to show that Welldon is improving in its EHS processes.

Trends fuel the desire for data. Without data, one would only get a vague sense of what is happening. As departmental staff started recording the hazardous chemicals in the database system, it was found that the Welldon campus had much higher quantities of hazardous materials than previously thought. This was a testament to the electronic database's systematic ability to capture more exhaustive and integrated information than was possible through the past paper based system. Jim, an IT designer pats himself on the back about the huge return that the electronic database system is already giving over the old paper-based system: "[It is] easy to throw paper. We gave them an easy thing to do. A good app.[6]" The database provided more "accurate" measures.

Even if there was no foreseeable requirement for this information, it could be immensely valuable for some big decision in the future. Missing information, therefore, created a palpable anxiety among users. One of the meetings starts with several people questioning what they think is a relentless pursuit of data. Cathy, an EHS staff member asks in a quiet voice:

> We have to figure out what we're looking for. Data is just an entity. We have to decide what it helps us understand. Data has no value. It's the interpretations.

But very soon, the mood of the meeting has changed. Cathy, who had been largely reflective at the start of the meeting, becomes increasingly anxious:

> All need to be connected. What if someone asks us who are the new reps - we *cannot* [she bangs the desk] say. Jack said I can run a quick dirty report but this is not trendable by us. We can see in the report who has generated [a record], but do we know when? Are we capturing how many PIs have gone in the system? To follow up? To look at corrective actions? The system knows it, right? Why don't we have that?

Such discussions often led to renewed efforts to search for more data so that every possible trend could be captured.

The information collection efforts, especially those for the purpose of establishing metrics and trends, were highly energetic but also triggered anxieties about the excessive quantification of data. Quantification of information allows the translation of messy details into metrics (Miller 1992; Yates 1989). The most common metrics are those used by accountants such as metrics for costs, revenues and profits. But modern organizing practices have expanded the scope of these metrics beyond that achieved by regular financial metrics. Various metrics have been proposed that seek to measure the overall health of the organization. These metrics commensurate varied qualities into an overall score. Commensuration defined as "the transformation of different qualities into a common metric" – is a way to resolve this problem (Espeland et al. 1998). One such metric (or more accurately a set of metrics) is incorporated in the "Balanced score card." The balanced score card combines metrics on often counteracting goals to create a composite organizational metric, enabling decisions based on an organization's overall progress (Lipe et al. 2002). The administrators of the EHS system at Welldon wanted quantified information in order to evaluate themselves on a balanced score card. And the way to achieve such quantification was through the use of "drop-down" options instead of text-based descriptive fields in the database system. For instance, a question about lab personnel using appropriate personal protective equipment (PPE) had the following options: a) Appropriate eye/face protection not worn; b) Appropriate gloves not worn; c) Appropriate foot protection not worn; d) Appropriate body protection not worn; e) Other.[7] Drop-down fields enabled the evaluation of Welldon along such constructed measures of efficiency as created by the dimensions of the balanced score card. With the drop-down options, EHS staff could have not only an exact number for PPE related violations in a lab but also a number for violations related to appropriate gloves not being worn. These "scores" could then be incorporated into a score for an overall safety improvement metric, which would eventually find its way into the Balanced Score card.

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[6] Technical jargon for "application"

[7] While there was an option called "other" where text details could be provided, the staff members completing the inspection form were encouraged to use the drop-down options.

The need for such constructed metrics of efficiency guided the use of drop-downs. But efficiency pushed the use of drop-down fields in another way. While text boxes require time to complete, drop-downs are time-saving. With a simple check, the record creator could generate some information. Such economic efficiency is one of the 'normal' incentives that produce "bad" records (Garfinkel 1967). Drop-down options became a solution for the departmental coordinators' complaints concerning the time that data completion would take.

Several departmental coordinators voiced their fears about the missing details that could potentially result from this over-reliance on "drop-downs." There was a discussion about what the inspection report should show – should it just show that one violation was found in a lab space about researchers not wearing safety glasses or should it also say something about the nature of that observation and the details about the inspection. When it is proposed that the faculty researchers would not receive the details of an inspection but would instead get a summarized inspection report, Stan, a departmental administrator, raises his concern:

> Stan: what gets rolled up into this report? What's dropped in the executive summary?
> Systems analyst: well, there are 45 questions and 40 have no [observations]. So you submit no details on 40. You send the 5 [observations] and details.
> Stan: I still need to understand how that 45 gets boiled down to the details. That's where I have concern. The nuances to the [faculty researcher], the culture of the lab, etc will be lost by the formula.

In the battle between efficiency and details, details are often sacrificed. But the instance above highlights the discomfort that such arguments invoke.

Control Lens: Accountability

Technological artifacts can be used to enhance both direct and indirect control (Orlikowski 1991). Direct control is made possible by the technology's ability to provide a one-way gaze to the supervisors (Zuboff 1988). The indirect control is made possible by new non-hierarchical forms of organizing such as self-managed teams and quality circles (Barker 1993; Sewell et al. 1992; Tannenbaum 1968; Wilkinson 1998). In self-managed teams, for instance, team members check each others' actions to maintain the overall team performance (Sewell 1998).

Since technology provides an opportunity to inscribe socio-technical control, its design is usually a ground for lengthy debates. At Welldon, the inspection database system can provide similar socio-technical control. But this control is not restricted to any single layer at Welldon. Different stakeholder groups desire different kinds of control.

The EHS office wants the ability to control the dangers in research labs and the ability to cumulate information about inspection results, especially violations, deviant actions such as missing training or errant individuals. EHS staff feel that such information would allow them to take responsive actions to prevent accidents and bring deviant actors into line. The departmental coordinators want "local control" over their departmental information, rather than centralized control, because it provides resources they can deploy in relations with faculty and researchers, who otherwise are not accountable to them. One of the departmental coordinators, in a meeting, demanded to have more data about a faculty member in his department who he believed was not meeting the requirements for certain chemicals in his space:

> I have a professor now who has been in a lab for 3 years and he says the chemicals in the room don't belong to him. I have nothing to back me up on this. I want the documents as a backup.

The lawyers and the central administrators too want the information that would allow them to have a "central oversight" over the entire system, ensuring the health of the system and preventing regulatory penalties.

While possibility of more control has created this immense desire for data, it has also created an acute fear among the same group of people. This can lead to dialectic of control where the controlled group, through its own influence on controller, is no longer the object of total control (Giddens 1984). While this dialectic of control is present at any stage in the use of a technological artifact, it is perhaps most prevalent during the time of its production. It is during the production phase when the artifact is most fluid, its routine uses and adaptations undeveloped, where both desire for control and resistance to the possible control by others have a large part to play in beating it into shape. At Welldon, coordinators who want information on their own departments for better control within their own sphere of responsibility have also been resisting the visibility of that information by others or the central EHS office. Researchers who are extremely guarded about protecting their autonomy have been resisting the bureaucratic control

that they may be subject to if information were to be collected about them. And the central administrators have their own fears about data being used by regulatory agencies to investigate and sanction the university.

A highly contentious issue that highlights both this desire for managerial responsibility and fear of data for surveillance concerns what the EHS staff refers to as "consequences." Consequences are penalties issued to individuals for non-compliance with environmental, health and safety rules and guidelines. For example, all chemical waste must be stored in designated containers with clearly marked labels within the lab for no longer than three days, after a container is full. At that point, the waste container must be moved from its home "in situ," or what is called a satellite accumulation area, to another locale in which it may stay for no more than 90 days when it must be shipped off campus. Should a chemical waste container in a laboratory be lacking appropriate labeling, this constitutes a serious infraction of EPA regulations and local EHS instructions and process. An inspection of the lab would identify this as a violation of the rules. When the violation is noted in the database, a consequence may also be noted. If a problem is fixed on the spot, no consequences may be recorded.

Information about consequences is highly desired by the EHS office; the staff wants to create histories of actions taken against individuals who flouted rules. According to the EHS staff, sanctions are necessary for the sustainability of the EHS management system, which is now their principal responsibility. However, the departmental staff and researchers have been apprehensive about storing information on local sanctions in a central database. For about two months, this issue generated volatile discussions. In one meeting, departmental coordinators met among themselves to discuss their anxieties about consequences. They felt that consequences were an EHS device to limit their own local control that they were working so painstakingly to create in their own departmental domains:

> Coordinator 1: I am fearful of EHS going into labs telling people "oh you can do this"…We worked hard to get them to understand the regulations.
> Coordinator 2: I think EHS should be brought in to be more responsible.
> Departmental administrator: they are controlling from afar.

After a few such discussions among the coordinators, they sent a representative who, in a joint meeting with other stakeholder groups, communicated the departmental concerns about consequences:

> We, the coordinators met to discuss this. There were multiple coordinators involved and there is general consensus and strong opinion that we do not want to document consequences electronically. Is it a [regulatory] requirement? If so what is the minimum we can do? Because the less entered into the system the better off in the end. Generally the thoughts are 5-fold: 1) This is too bureaucratic, and 2) too time consuming. Will we have to document more consequences now for [something that is] out of compliance when lots of times we just fix it? 3) Concern that the EHS office will feel compelled to use this data for other purposes. 4) There is no clear [guideline on] consequences [when to issue them]. The auditors may feel there is no cohesion in the system. 5) We don't want drop down menus for selective consequences, if we record them. We want free-form text.

This, and several similar, rather heated outbursts of protest, led to 'consequences' being struck from the electronic database.

The awareness of control also creates the need for accountability. Sinclair (1995) defines accountability as:

> something a person is or feels (a personal attribute to affect), something a person has been granted (an obligation bestowed or part of a job's contract), something a person exchanges for authority (a property of a relationship), a more abstract and impersonal property of an authority structure, or an artifact of scrutiny.

Although accountability is an aspect of social control, it invites attention to the transactional nature of control. That is, accountability systems, by shaping routine actions and beliefs, formally and informally, by making us answerable for our actions, require performance by the subject of control. Records and databases participate in systems of accountability in two ways: (1) they allow lines of responsibility to be verified; (2) they create new or reinforce existing lines of responsibility. In the first situation, the database is used by the subject of control to provide accounts of her actions in an existing relationship of control. In the second situation, possibilities of accounts in the database create new relationships of control, or reinforce existing ones.

By their visibility and often accessibility, database records invite both authorities and the subjects of control to produce records that portray their performance in advantageous ways. Thus, once something is part of a record, it

can potentially establish a norm and create a new benchmark for normalcy (Garfinkel 1967; Wilmott 1996). The increased visibility of lines of responsibility leads to potential control by others since a person authorized to view the record can access an individual's accounts of his/her actions. But the increased visibility also allows individuals to provide accounts of their own lines of responsibility thereby manifesting self (Roberts 1991). This leads to further desire for data.

In the discussions about database design, this desire was expressed on several occasions when individuals asked the IT designers to create fields that allowed them to provide accounts of actions that they had already taken before the design of the system, or to revise records after data was initially entered.

> [Systems analyst]: so, if you want to come back, and iterate through the [responses to violations and find that it] didn't get done, or it didn't work, does the [faculty member] get notified again? Or is that good enough? Realistically how does it happen today?
> [Departmental coordinator]: realistically the [faculty member] won't be involved but it would be nice to keep a record that the [faculty member] was notified again.

In this conversation, the EHS department coordinator admitted that sending reminders to a faculty member would not serve the purpose of getting a required action done. It was necessary, nevertheless, because sending a reminder created a written account that the required task was not the coordinator's responsibility, that an inspection had been completed, and now the onus was on the faculty member to take the necessary steps to correct the observed violations. By providing an account of actions taken, the coordinator transferred the obligation to provide an account [of the violation and responsive action] to the faculty member. Several such opportunities for information were placed in the database with the sole purpose of creating work boundaries and lines of accountability.

Accounts in a database can verify lines of responsibility but can also create entirely new ones. This is especially true for roles that are not quite established and remain ambiguously defined. In the database system being proposed, there were several such roles. One of them was the role of "reconciler" – someone who would be able to verify the names of researchers engaged in any physical space. This was necessary to ensure that these people were trained to work with the hazardous materials used in that research space. However, creating such a role in the database and assigning a specific person to that role was something that people were worried about. When it was proposed in a committee meeting that departmental administrative assistants do this reconciliation, one of the departmental coordinators, Mike put his foot down:

> Mike: you're asking administrative assistants to take personnel tasks.
> [Systems analyst]: how do you clean up data today, Mike?
> Mike: I request from [administrative assistant] an updated personnel list twice a year. But it's a request. Not a fun job.
> [Systems analyst]: but you're doing it. What if you do this same fun job via a computer or phone now
> Mike (very loudly and vehemently): but it's a request - not a job!
> [Departmental coordinator2 joins in]: lets not put a mandatory stamp on it!

Mike acknowledged that it had always been the administrative assistant in his department who had done the reconciliation for him. But having a role inscribed in the database translated a collegial, perhaps reciprocal, informal and entirely voluntary exchange into something that was officially mandated, something for which the assistant would now become accountable. Data's ability to create such new lines of responsibility made it a source of much anxiety.

Standardization Lens: Comparability

An important factor that contributes to the lengthy database creation process at Welldon is the existing enterprise system (ES). Through standardized and integrated data, the ES promises a seamless organizational operation at Welldon.

Standardized, consistent databases have several espoused advantages for the organization as a whole but for individual stakeholder groups, the standardized nature of the data fuels both the desire and fear of data. Each individual stakeholder group desires the inclusion of information that they already collect or use within their local context. While some local needs are sacrificed for the sake of consistency, often integration results in a superset of

local informational practices to accommodate the lowest common denominator. For instance, Meela, a departmental coordinator wanted to keep personal text notes for every inspection in her department. This had not been a part of the original database design and most other departmental coordinators did not really care for a "notes" field. However, it was not possible to provide a "notes" field only to Meela and not to the others. The format had to be consistent across departments. At Meela's insistence, the field became part of the standard inspection form. Arguably, this additional but optional field may not result in additional data since departmental coordinators can choose to ignore it. However, during usability testing,[8] I noticed some of the coordinators who had earlier indicated that they would not be maintaining notes, actually type in some details in the notes field. The new field had become an accepted and used part of the scaffolding.

The key characteristic of ES that simultaneously fueled both the desire and the fear of data from different stakeholders' perspective was the increased visibility of information. Enterprise systems enhance the visibility of data but not everything becomes equally visible. Based on what gets chosen to be included in the database, some things become visible at the cost of those that are left out of the database and these visible aspects have the potential for making some work processes more important than the others down the road.

As the inspection form got underway, some of the departmental staff realized that the data captured was only about violations and not about things "done right." There was asymmetric importance being given to the negative at the cost of positive. Some coordinators feared that this would lead to an over-emphasis on attempts to reduce the violations and a neglect of attempts that may result in across-the-board improvements. This led to Colin, a departmental coordinator, demanding the inclusion of "positive findings" in the database. In a committee meeting, Colin stood up and noted:

> My feeling is that people should be able to [mention positive things]. There should be reinforcement top-down that this isn't just punitive. [The current form] lends itself to negative. An opportunity to record positive should be there.

In this case, there was a decision to look into ways to capture positive findings in addition to the negative violations. But asymmetry did not always lead to an addition of information. Sometimes balancing the asymmetry meant that things that were going to be included could no longer be because they would disrupt the delicate consistency of the database. Some departmental coordinators wished to have a field in the database that allowed them to track when a violation had been resolved and a suitable action had been taken. Not everyone, however, was comfortable about having such a field because tracking corrective actions meant extra work. Eventually it was decided that this additional field would only be included if every department agreed to have it. If everyone was not on board then such inconsistencies could not be tolerated.

The above discussions highlight the fear caused by asymmetric visibility of information. Figure 2 summarizes the outcome of this fear caused by asymmetric visibility. Asymmetric information can make some aspects or some entities appear more important than others. Having only negative violations could place undue importance to correction rather than prevention. This is because once things are inscribed in a database, they gradually start mattering more than those that are not in the database. This was also noted by Bowker & Star (1999) in their study of the nursing classification scheme. The tasks that found their way in the classification scheme became more important while those not included found themselves eroded out of the nurses' professional jurisdiction. Enterprise systems exacerbate the perceived asymmetry because they make whatever they record overly visible so that the residual aspects look starkly unimportant in contrast. Colin recognized and feared the potential problems of asymmetric information and communicated his desire for more data that would balance the inspection database between negative and positive. The fear of incomplete data, therefore, resulted in a desire for more information that would restore the symmetry. However, the asymmetry is also corrected by a reduction in information. In the case of tracking findings, it was recognized that not having some departments track their violations would make them look bad in comparison with others who were tracking it.

[8] Usability testing is a stage before the system launch when prospective users are asked to use the system to perform some hypothetical tasks. The purpose is to catch design-related problems and to correct them before the system goes live.

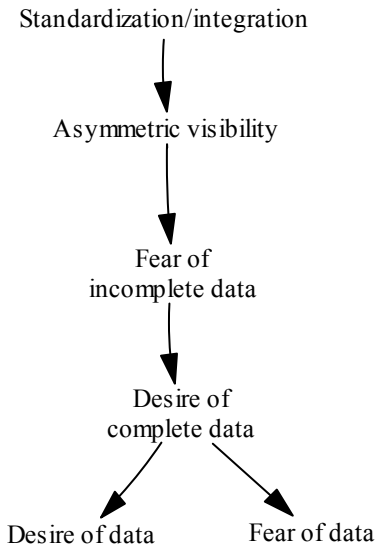

Figure 2. Standardization and Data

Reinforcing Purposes

While I have discussed the three lenses above separately, the purposes they express are highly intertwined in practice. Each purpose reinforces the others creating a dynamic loop of both fear and desire. A debate from the perspective of one lens easily spills over and overlaps with that from another lens. The data desired to serve one set of purposes may be feared when understood from the perspective of another lens and set of purposes.

The desire for efficiency produces a fear of quantification which clashes with the desire for standardized data. The possibility of integrated data creates an ability to share information, and to compare and coordinate (Galbraith 1969). It enables aggregation of information that enables a certain kind of decision making. Information about accidents can now be easily combined and assessment of common safety violations in labs can be made. But as things get integrated, details are no longer always possible. Quantification resolves the inconsistency between the details, but at the cost of local interpretive differences. While previously each department could store detailed information about any actions taken against individuals locally, such details are no longer possible when this information needs to be integrated. Instead of recording separate details about each "consequence," the EHS database simply asks for the number of consequences. Such commensuration allow the creation of trends and metrics but also creates fear. In the discussion on consequences, an EHS staff member asks how one can be sure what is behind that number representing consequences in a lab:

> If caps [on chemical bottles] are off and the inspector warns to put the caps on, is that a consequence? Are we planning to capture information like verbal warning? Is that a consequence?

Despite such fears, it was decided to only record the *number* of consequences.

The above argument highlights how the fear of unstandardized data creates the need for commensuration through metrics and numbers. Quantification of consequences allows a comparison of actions that were heretofore incomparable. What is often forgotten is that too much quantification may make some comparisons meaningless.

The desire for quantified and standardized data also fuels the fear of too much control. Consider the question that Ken, a departmental coordinator, asks when discussing the corrections required for certain kinds of SAA[9] violations:

> I go to one lab with 40 people that has 4 SAA problems and another lab with 5 people that also has 4 SAA problems. Are they the same? Should the actions required be the same?

[9] Satellite Accumulation Areas are regulated areas in labs earmarked for waste storage.

The need for metrics and trends guides the use of drop-downs to report observations on SAA type of findings. Chances are high that the optional text-boxes that could be used to provide additional details would not be used – they take more time to complete than drop-down boxes. So there is a desire for simple, straightforward information on violations related to SAAs. The standardized nature of the inspection form requires that a SAA problem reported in a lab with 5 people is recorded in the same manner as the SAA problem recorded in a lab with 40 people. Moreover, even labs that do not have SAA areas have a question about SAA in their inspection forms. Finally, the desire for metrics and the need for consistency trigger a fear of misguided control as information, not only is more visible, but is also likely to be misinterpreted – a SAA violation in a lab with 40 people may be treated the same way as the SAA violation in the smaller lab even though the severity of the latter would be much higher. The fear of misinterpretation may in fact exist even when the details about the size of the lab, or the nature of the hazards could be ascertained. Use of standardized metrics creates the fear of increased visibility, enhanced control and a dilution of what was once thought to be local departmental discretion.

The reinforcing purposes are depicted in Figure 3. The need for integrated data creates a need for commensuration that results in a reliance on numbers and metrics. This triggers a fear of missed particulars that creates a desire for details. But details create asymmetry and this again reinforces the need for standardized indicators. The resulting database ends up with few details and a high number of quantifiable drop-down menus, allowing a comparable format across the departments. Numbers, metrics and trends create high visibility, which fuels a fear of control among the departments. For instance, employees no longer know how their reported number of consequences will be interpreted and fear that these interpretations may lead to misguided control. This again leads to a quest for greater contextual specificity which is once again abandoned because of a need for commensuration.

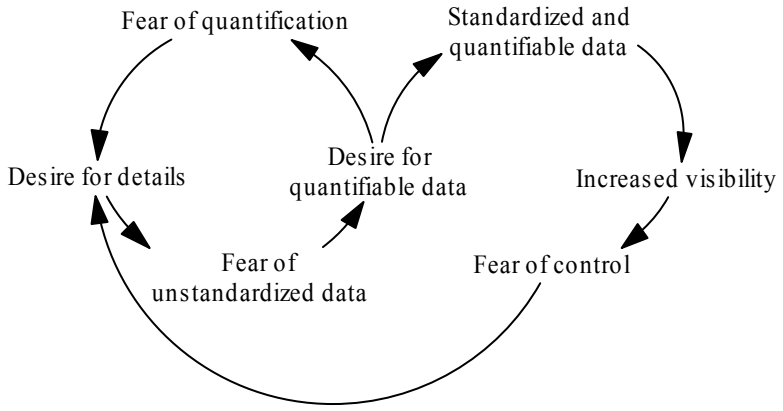

Figure 3. The Reinforcing Lenses

The fear of control also reinforces the desire for rationality. As the possibility of control increases, the desire to highlight a rational, efficient process increases. This is especially so at an organizational level when there is a possibility of legal control through data, although it also applies at an individual level. There is an assumption at Welldon that EPA, the legal agency for environmental regulation enforcement, wants Welldon to not only establish a comprehensive EHS system but to also establish a trend of fewer violations. Such interpretations of the regulatory requirements create a strong desire for establishing metrics and benchmarks that can then be used to highlight improvement. For individuals, the fear of control increases their desire to provide accounts when they've met the requirements. But it also creates a desire to hide data when there is ambiguity and a risk of misinterpretation. While I do not have much data on the actual use of the database system, a recent inspection used the new electronic database system, and there was not one consequence reported in the electronic database system.

Implications

The complexity involved in the design of databases can increase exponentially when people seek to meet multiple purposes through them. This is because every piece of data considered during the design process reflects multiple purposes and can trigger multiple debates. Data can serve one purpose but fail to meet another one. For instance, the

resulting database may provide consistency but by stripping away the details to achieve standardization it may impede decision making. The reinforcing cycle of consistency and rationality may result in overly quantified, simplified, and standardized data. Moreover, consistency may be provided by selectively including one group's protocols while hiding those of another group.

The research at Welldon indicates that the database creation process – and more generally, the technology design process - is a dynamic exercise with unpredictable outcomes even when efforts are made to elicit multiple views, requirements, and purposes. Conventional wisdom about technology developmental methodologies suggests that a participative design allows multiple perspectives to be expressed, which creates more appropriate technological tools that are likely to find greater support and use (Darke et al. 1997; Fitzgerald 1997; Kirsch et al. 2002). My research at Welldon, however, suggests that even the most participative design process is highly political, organic and conflictual despite attempts to manage it strategically. However, the process is so not only because of imagined power shifts but an interaction of these imagined purposes with other interests such as those of efficiency in this case. In that sense, the process of systems design is political but in the broader sense of the word as is defined by Knights & Murray (1994, xiv):

> By politics we mean the very stuff, the marrow of organizational process; by politics we mean managerial and staff concerns to secure careers, to avoid blame, to create successes and to establish stable identities within competitive labor markets and organizational hierarchies where the resources that donate relative success are necessarily limited.

The design efforts involve a negotiated compromise between diverse and contradictory perspectives. Eventually the data resulting from the design process may not be able to entirely satisfy anyone. It may result in a volume of data that few can assimilate, and include content that few have much use for. This may explain puzzles that Feldman and March (1981) pose about poor decision-making in organizations despite their seemingly abundant information.

The research at Welldon further emphasizes the importance of studying the process of technology production. There is always a potential for technological artifacts to be used in unintended ways. However, procedures inscribed at the time of an artifact's production can have important implications for the interpretive flexibility it offers (Pinch et al. 1987). Ultimately the artifact can play an important role in "configuring the users" themselves especially if it gains stability and becomes black-boxed (Grint et al. 1997; Latour 1987). The database system at Welldon is unlikely to be black-boxed just yet and may go through several iterations before becoming stable; nonetheless it already shapes the actions of EHS staff and departmental coordinators. This is especially so because the artifact in use is part of an enterprise system and thus acts as an infrastructural system. Enterprise systems, once created, can get deeply embedded in organizational processes thus shaping conventions of practice (Star et al. 1996). They can shift these conventions by making some processes more visible than others, enhancing comparability between aspects and enabling great control (Bowker et al. 1999). Thus, the transformative potential of infrastructural systems is best understood during production when things are not (yet) taken for granted. Record production, in fact, "is one of the principal means of accommodating the variable and sometimes competing goals and purposes of people in organizations" (Cochran et al. 1980).

Technological artifacts constrain and enable the actions of actors around them. But artifacts themselves are a result of actors' fears and desires (Akrich 1992; Orlikowski 1992). Empirically, however, there aren't enough studies that study the "formative potential of surveillance in action, and of the varying nature of participation within the surveillance complex by different types of actors" (Ball 2003, p.133). The imagined uses of an artifact, and the interests these reflect, play an important role in shaping organizational technologies.

I do not make claims of generalizability because I examined the database design process in just one setting. However, my findings echo those of several other researchers who have studied the use of record systems by a diverse range of actors, including cops (Van Maanen et al. 1994), auditors (ibid), clinical staff (Garfinkel 1967), and radiologists (Yakel 2001). Record systems are used by cops and auditors to generate rhetorical accounts of their efforts (Van Maanen et al. 1994). The fear of litigation among cops and auditors leads to the use of record systems as a means of portraying legitimacy and rationality. In Yakel's account of radiologists' record-keeping practices, records are used to construct notions of accountability. All of these studies highlight the *use* of record systems. The production perspective of my study not only reinforces the findings of these researchers but also explains how the production of a database system encompasses imaginations and purposes that go beyond the actual uses to which database systems are put. The study at Welldon indicates that the designers of a system are guided not by actual uses but by desires and fears of imagined uses that make the resulting system a culmination of several forces interacting with each other.

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