What Have we Learned from the Smart Machine?

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Abstract

Zuboff's (1988) book *In the Age of the Smart Machine: The Future of Work and Power* is one of the most celebrated texts among Information Systems researchers. Despite its significant influence, I suggest that it may have a richer story to tell than has been told to date. Motivated by this potential, my essay has two aims: to explicate the theory developed in Zuboff's text, and to determine how fully it has been used and extended by Information Systems researchers, through an analysis of papers citing her text. My findings show that the theory developed in Zuboff's text has been used in a fairly limited and piecemeal fashion. I discuss how this presents a significant opportunity for research because the theory appears to be just as relevant now as it was when the text was published.

Keywords: Zuboff, Smart Machine, citation analysis, theory, research opportunities.

1. Introduction

Because of the somewhat interpretive character of this paper, I begin with some personal context. This paper commenced in the margins of p. 70 of Zuboff's text, *In the Age of the Smart Machine: The Future of Work and Power*. At the time, I was studying the effective use of information systems in organizations, and while I had often seen citations to Zuboff's book, I had never read it. When I eventually did so, I found on p. 70 that Zuboff had already asked my research question—and went on to provide an answer—years earlier. I was dismayed that someone had already done what I hoped to do, but intrigued that the rich ideas expressed in the text did not appear to be reflected in the literature I had read. I wondered if other researchers were unaware of the ideas expressed in Zuboff's book, and if this offered opportunities for our field.

I was also intrigued by the potential that such a paper might have to reinvigorate the re-analysis of what we know: to reread and reflect rather than just propel forward to study the latest new thing. In many fields, researchers re-examine foundational texts. Economists reread Adam Smith, sociologists reread Weber, Marx, and Durkheim, psychologists reread William James, and so on. The Information Systems field is far younger, but we too have our classics. Zuboff's *Smart Machine* is definitely one of them. Willcocks (2004 p. 267) refers to it as "the most cited and celebrated in the whole of the IS field…." This essay is motivated by the view that Information Systems researchers could learn from re-reading the *Smart Machine*. In contrast to the pursuit of new theory, my aim is to see what might be gained by re-surfacing and re-examining old theory.

Because ethnographic works, such as Zuboff's, contain many detailed insights, some ideas will inevitably get overlooked on a casual reading. One might expect this risk to decline over time, as more researchers read the text, but in practice many researchers fail to read classic texts and cite them more for their symbolic value (Latour 1987). As Willcocks (2004, pp. 270-271)

demurs, “most [researchers] have probably read about, rather than read all the way through [Zuboff’s text].” One might argue that this is not a problem in a fast-moving field such as ours. Nonetheless, I suggest that the *Smart Machine* continues to have lessons for us today; indeed it may have an even stronger story to tell now than it did when first published (see also Kallinikos 2010 p. 1098). After all, Zuboff focused on fundamental characteristics of information systems, such as their representational capacities, and fundamental characteristics of organizations, such as power, that are just as relevant today as they were then. Moreover, Zuboff claimed that her insights could have quite general applicability. She wrote that she was offering a “general appraisal” (p. 71) about “general themes” (p. 424), one that was “highly representative” (p. 283) and “highly relevant” (p. 425). Finally, it would be very informative to know just how relevant her insights remain today. After all, if they are still relevant, it would serve to highlight the enduring nature of phenomena in our field. On the other hand, if they are no longer relevant, it would suggest that things must have fundamentally changed since that time. Either outcome, therefore, would be interesting.

Classic studies serve a vital role in any field. They serve as lighthouses in the sea of studies around us, helping us understand where our ideas have come from and where they are going. For instance, in the field of Sociology, Freese (1972 p. 482) wrote “If sociological knowledge were a puzzle we would have to lean pretty hard on some of the pieces to make them fit. That is why we still read Durkheim. We do not really know how the entire puzzle fits together, so at first we concentrate on the biggest pieces.” Likewise, in our own field, Scott (2000) writes that “The foundation of any attempt to discuss the distinctive nature of computer-based information systems has to be the evocation of Zuboff’s seminal (1988) work.”

I am not aware of any study that has conducted an in-depth re-analysis of the *Smart Machine*. Two studies in the Information Systems discipline have had similar goals: Barrett and

Walsham's (2004) re-analysis of Star and Ruhleder (1996), and Hansen et al.'s (2006) re-analysis of Markus (1983). Both studies report findings that resonate with mine. For instance, they find that researchers often cite classic studies in a perfunctory way, often fail to deal with the core ideas, and sometimes cite studies incorrectly. Despite these similarities, our studies emphasize different issues. Barrett and Walsham (2004) sought to identify the tactics that Star and Ruhleder used to frame their contributions, while Hansen et al. (2006) sought to discover how researchers from various fields cite a classic work differently and thereby socially construct its contribution. The purpose of my study is different. My aim is to learn what insights were conveyed in Zuboff's text and the extent to which they have been utilized.

Outside of the Information Systems discipline, Anderson's (2006) study offers a good example of the kind of analysis I will report. He examined how researchers in Management had used Weick's (1979) *The Social Psychology of Organizing*. Some of his findings are similar to mine, such as that most researchers cite the text for only a small proportion of its ideas. Our works differ primarily in that he identifies key concepts in Weick's work *ex post*, by examining the articles that cite Weick, whereas I begin by identifying key concepts and relationships in the *Smart Machine*, and then examine the extent to which researchers have used these ideas. I took this approach for two reasons. First, compared to Anderson's approach, it allows me to identify in more detail the specific aspects of the text that have not been utilized extensively in the literature. Second, while my primary aim was to learn how Zuboff's ideas had been used, a secondary aim was simply to articulate a cohesive model of the theory described in the text because this, in and of itself, could be useful for researchers (e.g., to those who might wish to use simulations or other tools to analyze Zuboff's theory in more depth) (Black et al. 2004; Boland et al. 2009; Nan 2011).

Summing up, to examine how Zuboff's insights in the *Smart Machine* have been utilized,

we must first know what those insights were. Thus, in the first two sections of this essay, I present a reading of her text. Next, I examine how the insights in her text have been used in the literature. Finally, I discuss my findings and their implications for future research.

2. Surfacing and Articulating the Theory of the Smart Machine

Most Information Systems researchers could mention some insights in the *Smart Machine*, such as the concepts of 'informating' and the 'panopticon.' However, readers of the text will know that it is difficult to articulate a detailed and cohesive account of these insights because they are spread throughout a complex text. For instance, Willcocks (2004) comments on the "twists and turns of a long, rich, and complex book" (p. 270) that is "difficult, long, and sometimes frustrating, [and] really does repay careful attention" (p. 291). Another reason why this task is hard stems from the hermeneutic principle that there is no such thing as a single "literal" reading of a text; any interpretation is constructed by a reader in a given context (Boland et al. 2010; Myers 2004). As Zuboff emphasized, "in a symbolic medium, meaning is not a given …. it must be constructed" (p. 76). Thus, it is not possible to list the insights of her work 'objectively.' Rather, I sought to explicate her insights fairly and plausibly, subject to specific constraints. As much as possible I sought, simply, to *describe* her insights. I did not seek to deconstruct the text by looking for contradictions, taken-for-granted assumptions, or power relations (Chiasson and Davidson 2012). Various approaches can be used to study text—the approach taken here is just one.

From this point on, rather than referring simply to Zuboff's "insights," I will use the word "theory." In her appendix, Zuboff explained that she had inductively built a "conceptual map" (p. 428) or "image" (p. 429) of what she had studied. I will use the word "theory" to describe such a map or image, following Weick's (1995 p. 386) inclusive use of that term. Thus, while Zuboff may not have presented her work as a theory *per se*, I argue that her work can be thought of as an

exercise in theorizing from case studies and from literature, in a similar spirit to grounded theory (Glaser and Strauss 1967). My aim was to surface and articulate the theory that she developed.

As mentioned, my representation of Zuboff's theory is subject to constraints, principally my own biases and choices. My primary *bias* is that I come to the text with an interest in testing theory. Thus, my aim is to represent her theory with enough precision that it could assist those who wish to test it. This bias stems from a belief that researchers can benefit not only by being inspired by a classic work, but also from empirically confirming, refuting, or extending it. Fred Brooks, the famous IBM engineer, made a similar point when he lamented that his propositions in his seminal *Mythical Man Month* had been well-cited but never tested (Brooks 1995 p. viii). Testing theory may seem aligned with a positivist tradition and therefore misaligned with the spirit of Zuboff's book, but such a perspective is relevant for interpretive researchers too (Lee and Hubona 2009) and Zuboff herself strove to verify her hypotheses (p. 190) and predictions (p. 273), so I believe it is a fair perspective to take. It also aligns with Lee's (1991) view that the ideas developed in interpretive research can inform and benefit both interpretive and positivist researchers.

In terms of *choices*, I had to choose a way to represent her theory. Because any theory involves concepts and relationships (Jaccard and Jacoby 2010 p. 28), it seemed fair to focus on these elements. Lee and Baskerville (2012) also took this approach in their description of the theory in Markus (1983), by listing the variables and relationships in that theory. I chose to represent the concepts and relationships in Zuboff's theory using a simplified causal-loop diagram. I did so because Zuboff often referred to circular-type effects. For instance, at one point she writes: "*managers limit their subordinates' discretion …; workers withdraw because they feel they have no discretion…and so it goes, a full-blown Laingian knot.*" While such cyclical effects can be represented using causal loop models, they cannot be represented using

linear process-based or variance-based models. Another reason for using causal loop models is that they have already been used to represent prior theories (e.g., Boland et al. 2009), including theories developed in ethnographic work (e.g., Black et al. 2004). Undoubtedly, a reader coming to the text with different biases and choices may represent Zuboff's theory differently. My claim is simply that the account I will provide is fair and plausible given these constraints.

With the above factors I mind, I began the project by seeking out methods for conducting such work. I could not find any prior papers that set out to surface and articulate the theory in a published ethnography. Several papers have revisited raw data and produced a new theoretical reading (e.g., Orlikowski 2000), but this is not quite the same aim as mine. Perhaps the closest in spirit is Lee and Baskerville's (2012) description of Markus's theory, but the case study of Markus is several hundred pages shorter than the *Smart Machine*, and Lee and Baskerville's description was also quite brief, so the task undertaken here was more complex. Without a clear exemplar, I drew upon methods that seemed to fit the task at hand. I drew mainly on methods from grounded theory and content analysis because they help researchers to develop theory iteratively from a text (whether a social text or a physical one) (Berg 2007; Charmaz 2001; Strauss and Corbin 1998).

To ensure that my account was fair and plausible, I recruited two research assistants to be the primary coders of the text and I acted as a secondary coder and moderator. To ensure they had sufficient sensitivity towards ethnographic work, they were hired from a graduate program in sociology and anthropology and were specializing in qualitative work. The coding took six months. Each coder read the book and coded it chapter-by-chapter. They worked independently but the three of us held collaborative analytic meetings every week to discuss emerging insights, resolve differences of opinion, and reach a shared understanding (Larsson 1993).

The first task was to agree upon the corpus to code. Zuboff's text iterates between prior literature, her fieldwork, and emerging insights. We focused our coding on her fieldwork and

emerging insights rather than her discussions of prior literature. For instance, in Chapter 1, we coded pp. 20-23 (which concerned the field site) and pp. 30, 41-42 and 56-57 (which concerned emerging insights). The rest of the chapter was used as background context to inform the coding, much like Zuboff described how she drew on prior literature to inform her own coding (p. 429). For instance, we did not code the material on Taylorism (pp. 42-46) because we did not wish to represent Taylor's theory, but we still read the material to ensure we understood how Zuboff's reading of Taylor influenced her own theorizing.

In the first iterations of coding, the unit of analysis was phrases and sentences in the text. The coding began inductively, with each coder assigning a code to a phrase or sentence based on his own reading of the text. Over time, the coding began to adopt inductive and deductive elements, as coders assigned new codes inductively, and deductively applied existing codes to old and new sections. We also took advantage of the structure of the text—having sections within parts within a book—to bring the unit of analysis up to the level of a section, a part, and the book, as the coding progressed. Because we could not obtain an electronic copy of the text, we manually annotated the book and each coder kept a spreadsheet with codes, categories, examples, and memos, which we shared before each weekly meeting to provide the basis for discussing codes and emerging insights.

The coding proceeded in this manner until each coder agreed with each other's codes. After that, the coders began developing causal loop diagrams to describe the emerging theory. The challenge was to determine the right level of parsimony. Some parsimony was essential or else our model would approach book length, but too much would lead to the loss of critical information. Although any guideline would be somewhat arbitrary, the coders were asked to represent the theory in a single page. When making simplifications, they were asked to simplify each part of the theory to the same degree, for consistency. An inevitable outcome of this process was that our final account of Zuboff's theory omits aspects of it. For instance, our final

model shows Zuboff's overall concept of *intellective skills* but does not show what she argues are its dimensions (*abstraction*, *explicit inference*, and *procedural reasoning*) (pp. 75, 95). This is an unfortunate but unavoidable outcome of any simplification, indeed, of any theory.

Each coder used quotations to support each concept and relationship. It was sometimes hard to find separate quotes for the concepts and the relationships (such as a quote describing the concepts followed by another quote describing their relationship). This was expected because, as she described later (Zuboff 2005), she hoped to convey the "messiness" of lived experience; she was not writing for researchers like us who wished to simplify and parse this messiness into concepts and relationships. Nevertheless, if a precise quote could not be found for a given concept or relationship, we used several quotes to triangulate on the apparent element of the model.

As before, the coders developed their models iteratively until they were agreed upon. After this, the coders and I drew upon each coder's model to construct a shared model. Despite our intentions, we were not able to represent her theory adequately in a single model and instead found that it was more effectively shown as two models at different levels of abstraction: an overall model and a detailed one. I show the overall model first purely for ease-of-reading.

We initially tried to create these two models as transformations of one another, such that every concept in the overall model was decomposed into more detail in the detailed model. However, we found that the story of the *Smart Machine* did not lend itself to such a precise decomposition. Our two models, therefore, serve as two related but nonetheless separate readings of the theory—one is simply more detailed than the other. Some concepts (such as *the introduction of IT*) appear in both models because this was a key part of the text whether one was focused on the overall story or the detailed story. On the other hand, while we covered the concept of *automation* to about the same level of depth in both models, we included much more

detail on the challenges and opportunities of *informating* and the associated *dilemmas of transformation* in the detailed model because of their centrality in Zuboff's work.

To clarify one aspect of these figures that might confuse readers at first glance, because Figures 1 and 2 reflect separate readings of her theory, their labelling schemes are independent of each other. Thus, the same label can indicate different concepts in the two figures (e.g., C8 reflects *Informating* in Figure 1 but *Intellective Mastery* in Figure 2) and the same concept can be indicated by different labels in the two figures (e.g., *Automation* is C7 in Figure 1 but C15 in Figure 2). To avoid confusion in this manuscript, I always clarify which figure I am referring to when I discuss any element, and I use the subscripts $_o$ and $_d$ for the overall model and detailed models respectively so that it is always clear which one I am referring to (e.g., $C8_o$ and $C8_d$ reflect different concepts in different models).

After creating the initial versions of the shared models, the two coders conducted two more iterations of refinement and validation until they agreed with all aspects of the models and the tables of quotes. Because the coding process took time and biases can occur during coding and group work (Kazdin 1977; Kim 2001), I then recruited a third independent coder to read Zuboff's text and audit the final models and tables of quotes. This individual agreed with all aspects of each model and table except for a few minor changes, which were re-checked and agreed to by the other two independent coders. I finally conducted one more round of checking with a fourth independent coder, but this time no changes were identified. The models and tables were then taken as final. Figures 1 and 2 present the final models; the Appendix provides tables of quotes with justification for each element in each model.

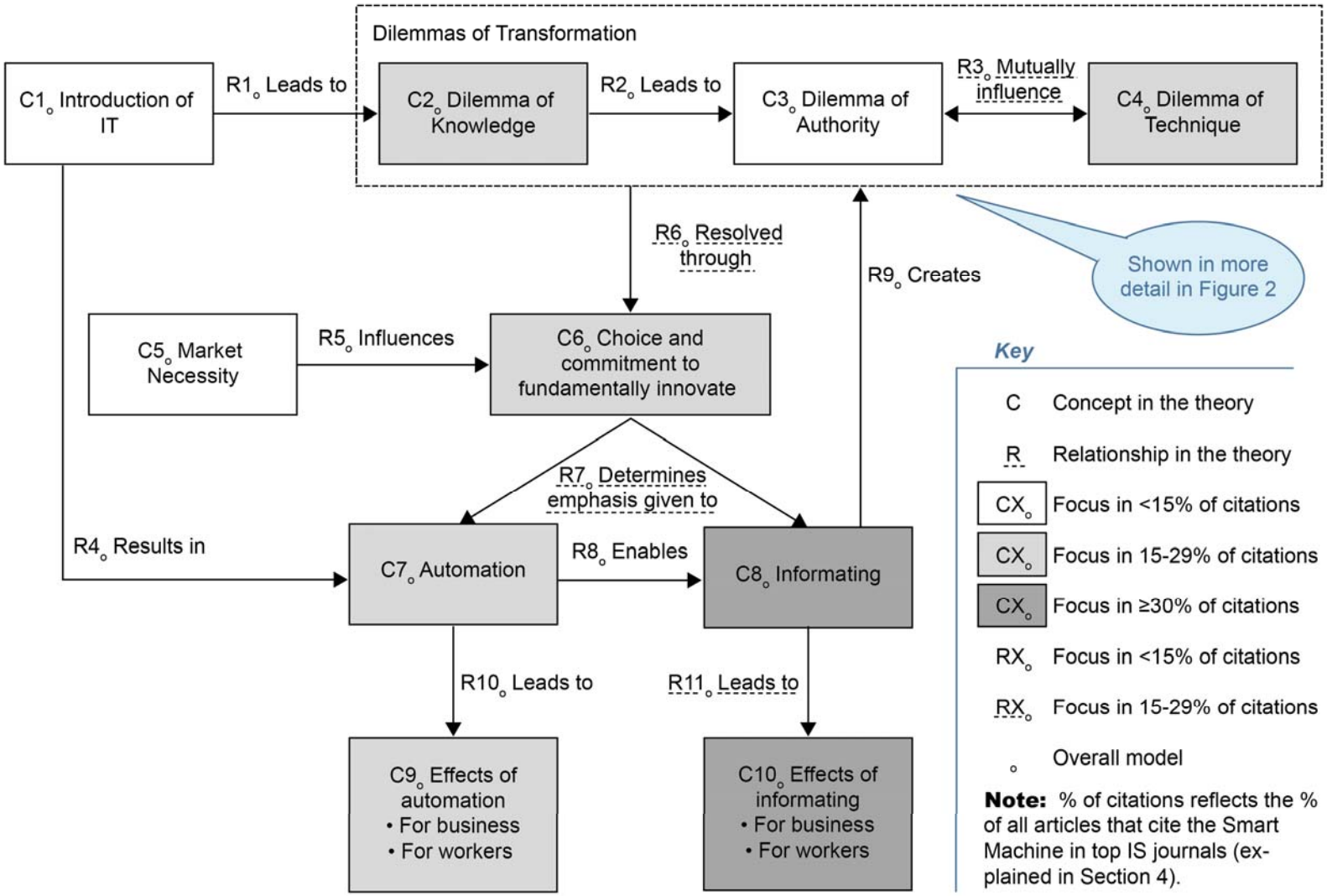

Figure 1: Overall Model

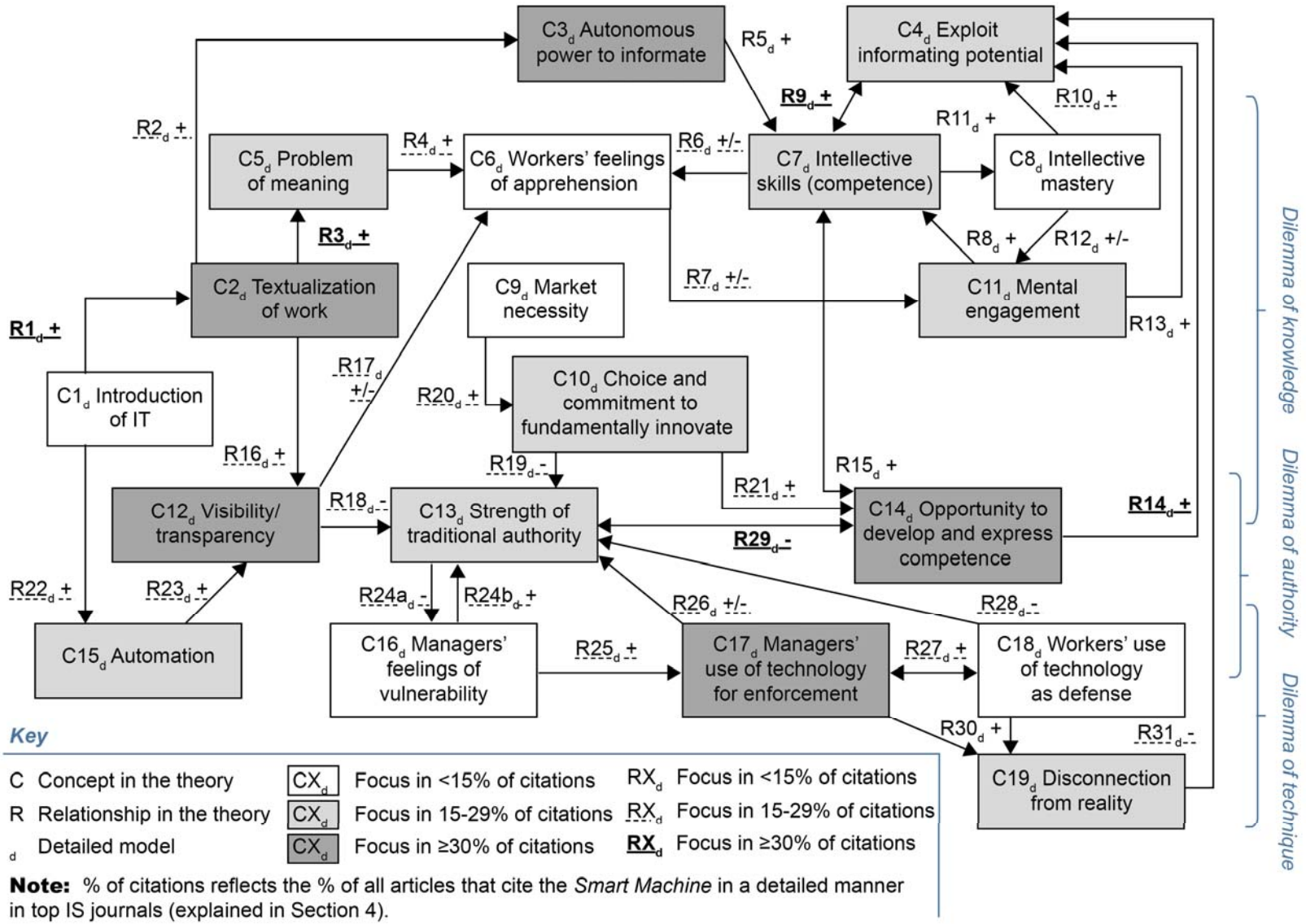

Figure 2: Detailed Model

At this point, some readers might question why I had to conduct such a detailed coding process, involving multiple coding rounds and multiple independent coders. I did so because of a specific methodological problem. I am trying to describe 'the' Theory of the Smart Machine knowing that such a goal is unachievable. No text has a single literal meaning (Fish 1978); even a text's author cannot assert its 'true' interpretation (Ricoeur 1973). There is no solution to this problem but my approach was to conduct a very detailed, intersubjective coding process with the aim of being as descriptive and faithful to the text as possible. Through such an approach, I hope to give readers confidence that Figures 1 and 2 (and the associated tables of quotes) can be taken to reflect, at least, a plausible account of the Theory of the Smart Machine. Just as qualitative field researchers often go back to their field site to share and check their interpretations with relevant members, I shared an earlier draft of this paper and the final models and tables of quotations with Professor Zuboff. Based on the ensuing dialogue, I have no reason to believe that the reading of the text presented here is problematic although this does not mean that she would have given the same reading of the text herself.

3. The Theory of the Smart Machine

In this section, I briefly summarize the theory of the *Smart Machine* and I comment on the type of explanation it offers. Overall, the theory seeks to explain the implications of information technology for organizations and workers and the choices that it necessitates. In contrast to much prior (and subsequent) work on this topic, which did not focus much on the *unique* nature of IT (Robey et al. 2013 p. 384), Zuboff argued that IT could have a transformative effect because of its unique powers to both automate and informate. The power to automate stems from the algorithms and machinery that allow IT to perform computational tasks so quickly and accurately. The power to informate stems from the ability of IT to record data about the work being performed through it,

creating a new resource that organizations can use to learn and improve. According to Zuboff, the transformative effect afforded by these two characteristics is constrained by three dilemmas.

As depicted in Figure 1, the first dilemma is the 'Dilemma of Knowledge ($C2_o$),' which stems from IT's representational character. Specifically, if a physical process is computerized, workers who previously acquired and exercised knowledge through engagement in a physical process (e.g., by feeling or smelling pulp in a paper mill) will now have to acquire and exercise knowledge in an entirely new way, through mental engagement with the textualized (represented) version of reality offered by the system, e.g., by understanding patterns of data in a paper mill's computerized process control system. As the top half of Figure 2 shows, in the movement from $C5_d$ (Problem of meaning) to $C6_d$ (Workers' feeling of apprehension) to $C11_d$ (Mental engagement) to $C7_d$ (Intellective skills), this change in the basis of knowledge can set off a string of serious consequences for an organization's workforce.

The second dilemma is the 'Dilemma of Authority ($C3_o$).' Because knowledge affords power, a change in the basis of knowledge can destabilize power structures. Specifically, if a process is computerized, IT-savvy workers can use information about that process available in the system to learn more about the process. They may even learn more than their manager. As a result, as the lower-middle portions of Figure 2 show, in the movement from $C12_d$ (Visibility/transparency) to $C13_d$ (Strength of traditional authority) to $C14_d$ (Opportunity to develop and express competence) and $C16_d$ (Managers' feelings of vulnerability), managers could feel threatened by the effect of the new system on their power and attempt to shore up their authority by relying on IT's innate potential for automating while restricting workers from leveraging its informating potential. In stressing managers' emphasis on automation, Leonardi and Barley (2010 p. 25) argue that Zuboff was "speaking to the same issues that motivated research on automation by industrial psychologists in the 1950s and 1960s."

Finally, the third dilemma is the 'Dilemma of Technique ($C4_o$).' This dilemma arises because IT has what Zuboff called an *autonomous* power to informate. That is, it makes available new information and provides new opportunities for learning that cannot be closed off completely. As a result, managers' response to the 'Dilemma of Authority' – relying on IT's innate automating potential and suppressing informating – is unlikely to work completely and they are likely to turn to another tactic – leveraging the informating potential of an IT not for learning and improvement but for control and enforcement. As the bottom of Figure 2 shows, in the links from $C16_d$ (Managers' feeling of vulnerability) to $C17_d$ (Managers' use of technology for enforcement) to $C18_d$ (Workers' use of technology as defense) and back to $C13_d$ (Strength of traditional authority), this strategy is unlikely to work as successfully as managers expect. And as the link to $C19_d$ (Disconnection from reality) shows, managers' reliance on the system for power is likely to erode its real usefulness.

Zuboff's theory is both idealistic and critical. It is idealistic in that it highlights IT's potential and how that potential can be realized. It is critical in that it stresses the tendency of those in power to place their power above the realization of idealistic goals. Recognizing both aspects, Zuboff stressed two points. First, she argued that managers must ultimately choose to take a more idealistic path and she wrote her book as a "call for action" (p. 7). Referring to this aspect of Zuboff's theory, Orlikowski (1992 p. 401) referred to it as a 'Strategic Choice' model. Second, Zuboff argued that irrespective of managers' desires, their hand may be forced by market necessity. Specifically, market competition may simply force managers to leverage the informating potential of IT if their companies are to survive.

Zuboff's theory also has both deterministic and emergent elements. It is deterministic in that it argues that IT does offer the potential to automate and informate ($R4_o$, $R8_o$), which does create dilemmas ($R9_o$), which do require managerial choice to resolve ($R6_o$). However, it is emergent in that specific outcomes can be unpredictable. For instance, notice that, in Figure 2,

Zuboff described both positive and negative relationships for $R6_d$ and $R7_d$. Thus, depending on how the effects play out in any given case, an increase in workers' feeling of apprehension could result, over time, in even more apprehension, less apprehension, or no change at all – the theory does not allow us to determine which outcome will occur. The constructs and relationships in Figures 1 and 2 provide a roadmap of what we should look out for when tracing the effects of an IT implementation, but they do not suggest that actual outcomes will be the same in every case.

4. How Have Information Systems Researchers Used the Theory of the Smart Machine?

This section explains how researchers have used Zuboff's theory. Figures 1-2 provide a prelude of these results because the shading shows how often each concept and relationship has been examined in the Information Systems literature. I discuss these and other aspects of the literature below.

4.1 Coding Process

The study commenced with locating and coding all articles that cited Zuboff's text in the following journals from the book's publication date (1988) through 2011:

- *European Journal of Information Systems (EJIS)*
- *Information and Organization (I&O)*, formerly *Accounting, Management, and Information Technology (AMIT)*
- *Information Systems Journal (ISJ)*, formerly *Journal of Information Systems (JIS)*
- *Information Systems Research (ISR)*
- *Journal of the Association for Information Systems (JAIS)*
- *Journal of Information Technology (JIT)*
- *Journal of Management Information Systems (JMIS)*
- *Journal of Strategic Information Systems (JSIS)*
- *MIS Quarterly (MISQ)*

These nine journals were selected because our aim was to see how Zuboff's theory had

been used in the Information Systems literature, and these are thought to be the best journals in the discipline. I should stress that this has a major effect on the nature of my review. Specifically, at the time of my review, Google Scholar™ listed 5530 citations to the *Smart Machine*, spread across many fields (Psychology, Cultural Studies, Organization Science, etc.). My review solely focused on citations in Information Systems. Even within this field, it has been cited in a range of books, conference papers, and journal articles. My review focuses solely on citations in our best journals. This is not for any intrinsic preference but rather because of the influence of journals in our discipline's discourse (Grudin 2005; Introna and Whittaker 2004). Not all of these journals existed when the *Smart Machine* was published (in 1988). Moreover, because of the intensive nature of the work, I only examined the years for which papers in these journals could be obtained electronically. Thus, my review was focused on the following years:

- *EJIS:* 1999-2011
- *I&O (AMIT):* 1991-2011
- *ISJ:* 1991-2011
- *ISR:* 1990-2011
- *JAIS:* 2003-2011
- *JIT:* 1988-2011
- *JMIS:* 1988-2011
- *JSIS:* 1991-2011
- *MISQ:* 1988-2011

The end result is that I examined 186 studies that cite the *Smart Machine* (described below) rather than 5530. While just a small subset, it is the appropriate subset for the purpose of this study. By way of comparison, it is a smaller number of articles than Hansen et al. (2006) examined (307) but a larger number than Barrett and Walsham (2004) examined (35).

The two coders were MBA students taking courses in IT management. I used coders with different backgrounds for this portion of the coding because I felt that an understanding of

IT in business was more critical at this stage than an understanding of ethnography, given that the coders in this step were coding Information Systems articles whereas in the prior step they were coding Zuboff's text. Even so, we followed the same process as in the prior phase of coding, with the two coders reading Zuboff's book in depth before undertaking the work, and having regular meetings with me to understand the models produced in the prior step, reconcile differences of opinion during the coding, and reach a shared understanding (Larsson 1993).

The coders began by searching the journals for any article that cited the *Smart Machine* using keyword searches in online library databases and GoogleScholar™. For each article found, coders were asked to map each statement citing Zuboff to the concepts and relationships in Figures 1 and 2. This would show the extent to which Information Systems researchers have utilized the theory. To facilitate this, the coders were asked to split the articles citing Zuboff into two categories: (1) *Cursory citing articles*: those that referred to a very general idea and/or very few ideas in Zuboff's text; and (2) *Detailed citing articles*: those that referred to more specific ideas and/or more ideas in the text.

An example of a cursory citing article was the article by Ward and Elvin (1999), which cited Zuboff just once, for a very general idea, and cited three other papers alongside it, as follows: "*That IT has a key role in enabling business change is well established (see, for example, Zuboff, 1988; Davenport & Short, 1990; Venkatraman, 1991; Teng et al., 1994).*" An example of a detailed citing article was Brown et al. (2002), which cited Zuboff for four different arguments, one being: *As Zuboff (1988) demonstrated, while employees may use the technology, their job satisfaction, feelings toward their supervisors, and loyalty toward the organization can be severely and negatively affected*. While the distinction between cursory citing articles and detailed citing articles is somewhat subjective, the two coders worked until they reached 100% agreement in their classification of each article. Similar distinctions between cursory and detailed citation

patterns have also been made in prior work (Barrett and Walsham 2004; Hansen et al. 2006).

Of the 186 articles citing Zuboff, the coders classified 33 as detailed citing articles and 153 as cursory citing articles. Our coding of the detailed category was inclusive in that an article was coded as detailed if it included statements referencing Zuboff that were detailed in nature even if the article also included other statements that were more cursory, but our coding of the cursory category was exclusive in that articles were coded as cursory only if all statements referencing Zuboff in that article were cursory in nature. Overall, the proportion of cursory-to-detailed citing articles is similar to that found in past research. For example, Hansen et al. (2006 p. 413) found that: "More than three quarters (78.8%) of the articles cited "Power, Politics" in a perfunctory way." On average, the articles we classified as cursory cited Zuboff 1.4 times per article and referred to 2.2 concepts in the overall model (Figure 1), while the articles we classified as detailed cited Zuboff 3.6 times per article and referred to 6.2 concepts in the overall model.

Because our distinction between cursory and detailed citing articles differed on similar dimensions (namely, specificity and detail) to our distinction between the overview and detailed models (Figures 1 and 2), we performed two rounds of mappings. First, the coders mapped each statement citing Zuboff in all 186 articles against the concepts and relationships in the overview model. The coders then mapped each statement citing Zuboff in the 33 detailed citing articles against the concepts and relationships in the detailed model. It did not make sense to map the statements in the cursory citing articles to the detailed model, because the cursory citing articles were typically referencing Zuboff for ideas that were at a higher level of abstraction.

The process we used to map citations is called 'citation context' analysis (Anderson 2006; Small 1982) and involves reading the passage in which a citation occurs and coding the statements it contains (see Table 1 for examples). Of the full list of 186 citing articles, 15 of the cursory citing articles could not be coded to any element in our models. Most of these cited the

Smart Machine to justify a general perspective, such as the use of Foucault (Mosse and Whitley 2009), the use of phenomenology (Introna and Ilharco 2004), or a specific methodological choice, such as a style of interviewing (Sarker and Sarker 2009). Others merely cited it along with other papers for a very general idea, such as the importance of organizational context (e.g., Goodman and Darr 1998). Despite not being able to map these 15 citing articles to elements of our models, we were able to map the other 171 citing articles to one or more elements of them.

The coders initially performed their coding independently with regular group meetings with me to discuss the codes and any issues arising in the work. After completing a significant portion of the work, I compared their codes and found them to be highly comparable (on average the codes were the same in 80% of cases). The coders and I then worked to reconcile differences and reach a shared understanding. They modified their codes accordingly until they reached 100% agreement. As with the production of the causal models, I then hired another independent research assistant to audit 30% of the articles to check the accuracy of the coding. This coder identified several potential discrepancies which were discussed and reconciled among the coders and I until we reached full agreement. As before, the coding process was designed to achieve an intersubjectively-agreeable account. That is, while other coders might have coded some citations differently, our coding was as fair and plausible as possible. Table 1 provides examples of the codes assigned to three articles with explanations provided by the coders.

Table 1: Examples of Mapping Articles against Concepts in the Detailed Model

Article	Citation	Analytical summary	Elements Coded	Explanation of coding
(Karuppan and Karuppan 2008)	Learning styles affect the use of an information system …and its understanding (e.g., Frese et al., 1988; Zuboff, 1988; Sein & Bostrom, 1989) through the development of mental models …. In her study of factory workers, Zuboff (1988) found that operators who	Intellective skill development leads to better understanding of processes through sharpening of abstract thinking skills.	$C7_d$ $C8_d$ $C11_d$ $R4_d$ $R8_d$ $R9_d$ $R13_d$ $R14_d$	All concepts and relationships describing intellective skills have been coded. Citation 1 is quite abstract but relates most closely with $R9_d$, i.e. the development of mental models and individual capability to

Article	Citation	Analytical summary	Elements Coded	Explanation of coding
	possessed intellective skills developed a better understanding of the computerised control system than did other operators. She identified abstract thinking as one of the central elements of those skills.			enhance use of the information system.
(Gallivan and Depledge 2003)	IT is clearly a 'machine' that may be substituted for human agency and judgement. Firms use IT to control employees, in … manufacturing environments (Zuboff, 1988)…. Zuboff (1988), who extended philosopher Jeremy Bentham's notion of the panopticon to show that it is not the innate capabilities of a technology that serve to enslave or liberate employees, but rather managers' intentions for deploying a given technology – whether to empower employees (by informating their jobs) or to subjugate them (by automating their jobs).	IT can use machines to replace humans. Managers can use IT to control employees as well as to empower them; the concept of the panopticon.	$C10_d$ $C14_d$ $C15_d$ $C17_d$ $R14_d$ $R22_d$ $R25_d$	$C14_d$ and $C10_d$ are coded because they talk about the dichotomy of informating vs. automating and managers' intentions/ choices. Also coded are the C's and R's that introduce or describe the ideas of automation and informating and directly discuss the idea of managerial control (e.g. $R25^d$) or emancipation of workers.
(Barrett and Walsham 1999)	Advocates of technological utopianism suggest an era that fosters the development of a "postindustrial Nirvana of knowledge" (Clement and Myles 1994) constituted by elite knowledge workers (Drucker 1993) who are able to enjoy a higher level of skill development with the potential for improved job satisfaction (Piore and Sabel 1984; Zuboff 1988). In addition to these contradictory outcomes of transformations associated with the introduction of new IT, other work (e.g., Zuboff 1988; Dunlop and Kling 1991) has highlighted the importance of examining how new information technologies are implicated in profound changes in the nature of organizational work. An interpretive case study approach (Zuboff 1988; Orlikowski and Baroudi 1991; Walsham 1995) was adopted which examined the actions and perceptions of the human stakeholders concerned with the development and use of the electronic placing support system (EPS), and the changing contexts within which the attempted	Intellective skill development increases job satisfaction. IT leads to profound changes in the nature of work. The "informated" organization is a more transparent and visible organization.	$C2_d$ $C3_d$ $C7_d$ $C9_d$ $C12_d$ $C14_d$ $R1_d$ $R9_d$ $R13_d$ $R20_d$	Although $C8_d$ talks about intellective skill development, the essence of it is the difference between intellective skills and intellective mastery and how the former progresses to the latter. This is not discussed in the citations and therefore has not been coded. Although $C14_d$ is not directly relevant it has been coded because it is a comprehensive construct, and indirectly addresses the relevancy of intellective skill development of workers and how this could lead to job satisfaction. $C10_d$ is not coded because it fundamentally talks about managerial choice, which is not discussed in the citations. Although $R6_d$ talks about job

Article	Citation	Analytical summary	Elements Coded	Explanation of coding
	introduction of electronic trading was taking place. An important facilitator of potential interorganizational transformations is the introduction of new information and communication technologies that allow for the development of informated organizations (Zuboff 1988) across the market. IT has the ability to translate and make visible what resides within the minds of individual underwriters.			satisfaction, it mentions its cause as being workers feeling more competent and in control, which these citations do not mention.

4.2 Findings

I conducted the analysis in four phases. First, I aimed to get a broad sense for how people have cited the *Smart Machine* by examining citing articles by year and by journal, along with co-citations. I then conducted the primary analysis: examining the pattern of citations against the overview model and detailed model, the results of which are partly shown already by the shading in Figures 1-2, as I explain further below. Third, I investigated whether the patterns varied significantly by year or by journal to see if different parts of Zuboff's theory were being utilized or emphasized in different time periods or in different scholarly outlets. Finally, I examined if researchers were testing or extending ideas from the *Smart Machine*, or just taking them as given.

4.2.1 Results by Journal, Year, and Co-citation

Figures 3 and 4 show how Zuboff's work has been cited by journal and by year. In Figure 3, the low numbers for *JAIS* and *EJIS* should be interpreted in light of the shorter periods of time they have existed or were electronically searchable, but the other journals have existed and were searchable for all, or nearly all, the years since the *Smart Machine* was published (as noted earlier). Overall, the data show that her work has been cited in each journal, but much less in *ISR* and much more in *MISQ* and *Information and Organization*. The lower citations in *ISR* may

relate to the greater proportion of technical and analytical papers in that journal. The higher numbers in *MISQ* and *I&O* makes sense because they are well-known outlets for research on the organizational implications of IT.

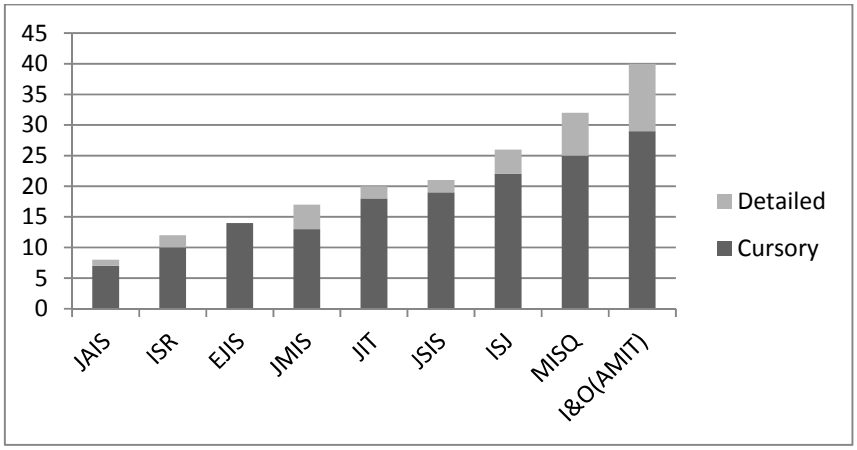

Figure 3: The Sample of 186 Citing Articles (153 Cursory and 33 Detailed) by *Journal*

The results by year (Figure 4) show that Zuboff's work has ebbed and flowed in influence. Hansen et al. (2006) found a similar pattern in their study of citations to Markus (1983). Like them, I will not speculate too much about changes across such short periods. The clearer message in Figure 4 is that the work has maintained influence over time. When I correlated the number of citing articles against time, I found that the number of citing articles has increased slightly over time ($r = 0.24$) due to an increase in the number of cursory citing articles ($r = 0.34$) and a slight decrease in the number of detailed citing articles ($r = -0.06$), the latter being quite evident in Figure 4 in the last few years. This is reminiscent of the point in Hansen et al. (2006) that classic papers tend to become cited symbolically over time rather than for the ideas they contain. Yet, even this finding should not be overgeneralized because the pattern in Figure 4 is non-linear and some researchers clearly have engaged with Zuboff's ideas in a detailed fashion in recent years (e.g., in 2005, 2007, and 2008, per Figure 4).

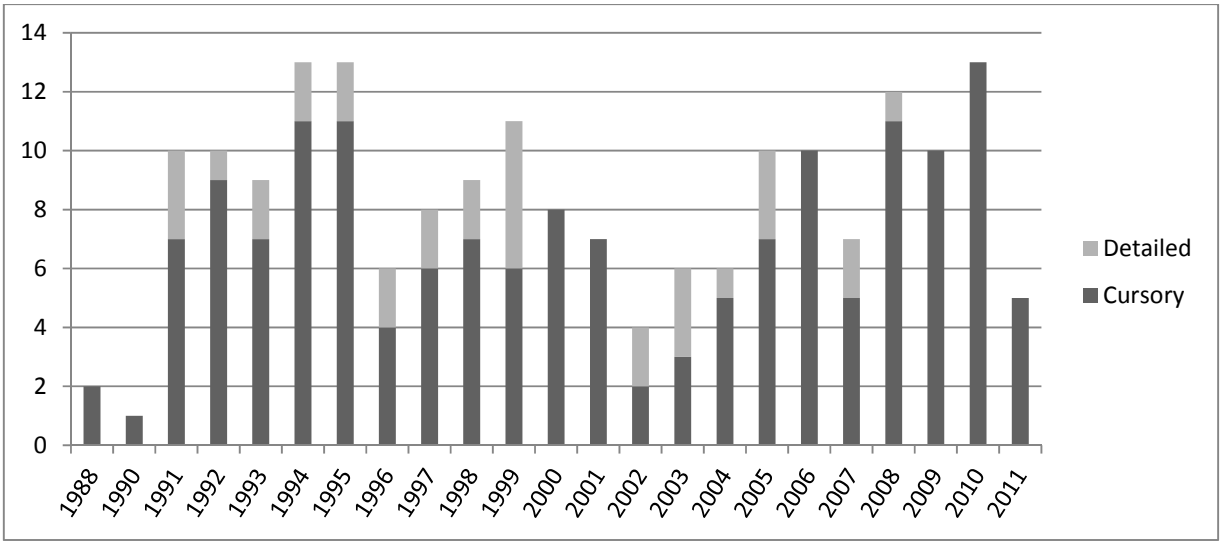

Figure 4: The Sample of 186 Citing Articles (153 Cursory and 33 Detailed) by *Year*

Table 2 lists the articles most frequently co-cited along with Zuboff's *Smart Machine*. To calculate co-citations, I examined each unique article co-cited along with Zuboff in any given article. I found 235 unique co-citations. This indicates that authors have enrolled the *Smart Machine* along with many other authors' works for the points they wish to make in their articles. The small values for "number of unique co-citations" in Table 2 complement this finding because they suggest that the *Smart Machine* has its own unique identity because it is not routinely co-cited with any other article. At the extreme, if another article had been co-cited along with the *Smart Machine* in all 186 articles in our sample, it would be difficult to distinguish the intellectual ownership of the idea being cited. Therefore, the fact that the *Smart Machine* is broadly used and yet has a unique identity is further evidence of its classic status.

Table 2: Five Articles Most Frequently Co-Cited with the Smart Machine

Article	Number of unique co-citations
(Markus 1983)	10
(Schein 1992)	6
(Orlikowski 1992)	6
(Orlikowski 1991)	4
(Orlikowski 1993)	4

4.2.2 Results of Mapping the Citing Articles against the Models

Tables 3 and 4 record the degree to which the articles that cite Zuboff refer to the elements of her theory. Table 3 maps all the citing articles (both cursory and detailed) to the elements in the overview model (Figure 1) while Table 4 maps the detailed citing articles to the elements in the detailed model (Figure 2). For ease of reference, recall that I use the subscripts $_o$ or $_d$ on each model element to indicate whether it is from the overview model or detailed model respectively.

In Table 3, the first two columns of values reveal how authors refer to Zuboff's theory, depending on whether they are citing it in a cursory or a detailed fashion. Notice that most of the cells in these columns (14 of 21) are shaded. The shading reflects cases in which Zuboff has been used quite differently across the two levels of engagement (cursory and detailed). The difference is judged on a percentage basis where the denominator is the number of articles of each type. For instance, the values for $C8_o$ indicate that 41% of the cursory citing articles covered $C8_o$, 76% of the detailed citing articles covered $C8_o$, and 47% of all the citing articles (cursory plus detailed) covered $C8_o$. Overall, the results in these first two columns of values make sense because they show that although the concept of 'informating' is the most commonly noted idea in both sets of articles (cursory and detailed), none of Zuboff's ideas are used much by papers that cite her work cursorily (the percentages in the first column of values are mostly low), whereas her ideas are used much more broadly in studies that cite her work in a detailed fashion.

My main interest in Table 3 is the final column, which shows the extent to which the 186 articles engaged with each element of the overview model (Figure 1). It shows that Zuboff's ideas are used to widely different degrees, e.g., only 2% of articles referred to $R8_o$ (the relationship between automation and informating) while 47% of articles referred to $C8_o$ (informating). The shading in Figure 1 shows these differences in broad strokes. The darker cells in Figure 1 show concepts referred to in 30% or more of the articles, grey cells show concepts used in 15-29% of

the articles, and white cells show concepts referred to in less than 15% of the articles. Overall, two findings are apparent in the final column of Table 3:

- *Relative depth versus breadth*: All elements of Zuboff's theory have been engaged with by at least some researchers. However, there is a clear point of focus, as half of all papers that cite the *Smart Machine* do so for the concept of *informating* and around a quarter cite it for concepts and relationships closely related to it (such as the need to innovate, the concept of automation, and the effects of informating). The rest of Zuboff's ideas have not been used much (referred to in less than 20% of the citing articles).
- *Relative focus on concepts over relationships:* Researchers refer much more to concepts in Zuboff's theory than relationships she posed among them. For instance, 23% of articles referred to $C7_o$ (automation), 47% referred to $C8_o$ (informating), but only 2% referred to $R8_o$ (the relationship that Zuboff posed between them). Averaging the values in the third column of Table 3, constructs were cited twice as often as relationships (20% to 10%).

Whereas Table 3 includes the results for all 186 articles (cursory and detailed), Table 4 reports the results for the 33 detailed citing articles only. It shows the extent to which the citations to Zuboff in those 33 articles referred to elements in the detailed model (Figure 2). Just as with Table 3, the values in Table 4 show that Zuboff's ideas have been examined to widely different degrees, from only 3% of articles referring to $C1_d$ (the introduction of IT) to 58% of articles referring to $C14_d$ (the opportunity to develop and express competence). The shading in Figure 2 shows these differences in broad strokes. Overall, the findings are much the same as with the overall model: all the elements of the detailed model have been referred to by at least some researchers, but only a few of them have been examined in depth. Moreover, in terms of focus, there seems to be two general pockets of interest: one pocket of interest in informating and its generation or realization (e.g., concerning $C3_d$, $C7_d$, $C14_d$, $R9_d$, and $R14_d$) and another regarding

the implications of IT for managers (e.g., concerning $C12_d$, $C15_d$, $C17_d$, and $R29_d$).

Table 3: Mapping all Citing Articles to the Overview Model (186 articles)*

Element of model	Number (%) of cursory articles	Number (%) of detailed articles	Number (%) of all articles
$C1_o$ Introduction of IT	7 (5%)	2 (6%)	9 (5%)
$C2_o$ Dilemma of knowledge	16 (10%)	14 (42%)	30 (16%)
$C3_o$ Dilemma of authority	15 (10%)	7 (21%)	22 (12%)
$C4_o$ Dilemma of technique	9 (8%)	17 (52%)	35 (19%)
$C5_o$ Market necessity	15 (10%)	2 (6%)	17 (9%)
$C6_o$ Choice and commitment to fundamentally innovate	25 (16%)	16 (48%)	41 (22%)
$C7_o$ Automation	34 (22%)	9 (27%)	43 (23%)
$C8_o$ Informating	63 (41%)	25 (76%)	88 (47%)
$C9_o$ Effects of automation	25 (16%)	14 (42%)	39 (21%)
$C10_o$ Effects of informating	41 (27%)	16 (48%)	57 (31%)
$R1_o$ Introduction of IT leads to dilemma of knowledge	4 (3%)	9 (27%)	13 (7%)
$R2_o$ Dilemma of knowledge leads to dilemma of authority	13 (8%)	10 (30%)	23 (12%)
$R3_o$ Dilemma of authority and dilemma of technique mutually influence each other	17 (11%)	14 (42%)	31 (17%)
$R4_o$ Introduction of IT results in automation	4 (3%)	2 (6%)	6 (3%)
$R5_o$ Market necessity influences choice and commitment to fundamentally innovate	6 (4%)	2 (6%)	8 (4%)
$R6_o$ Dilemmas of transformation are resolved through choice and commitment to fundamentally innovate	14 (9%)	11 (33%)	25 (13%)
$R7_o$ Choice and commitment to fundamentally innovate determines emphasis given to automation and informating	10 (7%)	17 (52%)	27 (15%)
$R8_o$ Automation enables informating	2 (1%)	2 (6%)	4 (2%)
$R9_o$ Informating creates dilemmas of transformation	11 (7%)	13 (39%)	24 (13%)
$R10_o$ Automation leads to effects of automation	8 (5%)	4 (12%)	12 (6%)
$R11_o$ Informating leads to effects of informating	29 (19%)	13 (39%)	42 (23%)

* Shading indicates a difference of >10% between type of citation (cursory and detailed).

Table 4: Mapping Detailed Citing Articles to the Detailed Model (36 articles)

Element of model	Number (%) of all articles
$C1_d$ Introduction of IT	1 (3%)
$C2_d$ Textualization of work	10 (31%)
$C3_d$ Autonomous power to informate	12 (38%)
$C4_d$ Exploit informating potential	6 (19%)
$C5_d$ Problem of meaning	9 (28%)
$C6_d$ Workers' feelings of apprehension	4 (13%)
$C7_d$ Intellective skills (competence)	8 (25%)
$C8_d$ Intellective mastery	3 (9%)
$C9_d$ Market necessity	3 (9%)
$C10_d$ Choice and commitment to fundamentally innovate	8 (25%)
$C11_d$ Mental engagement	5 (16%)
$C12_d$ Visibility/transparency	11 (34%)
$C13_d$ Strength of traditional authority	6 (19%)
$C14_d$ Opportunity to develop and express competence	21 (58%)
$C15_d$ Automation	6 (19%)
$C16_d$ Managers' feeling of vulnerability	3 (9%)
$C17_d$ Managers' use of technology for enforcement	13 (41%)
$C18_d$ Workers' use of technology as defense	4 (13%)
$C19_d$ Disconnection from reality	8 (25%)
$R1_d$ Introduction of IT leads to textualization of work	11 (34%)
$R2_d$ Textualization results in autonomous power to informate	65 (16%)
$R3_d$ Textualization results in a problem of meaning	10 (31%)
$R4_d$ Problem of meaning leads to workers' feelings of apprehension	9 (28%)
$R5_d$ The autonomous power to informate affects intellective skills	4 (13%)
$R6_d$ Intellective skills influence workers' feelings of apprehension	7

	(22%)
$R7_d$ Workers' feelings of apprehension affects mental engagement	9 (28%)
$R8_d$ Need mental engagement for intellective skills	3 (8%)
$R9_d$ Intellective skills and the exploitation of informating potential are mutually reinforcing	15 (47%)
$R10_d$ Intellective mastery enables the exploitation of informating potential	5 (16%)
$R11_d$ Need intellective skills for intellective mastery	4 (11%)
$R12_d$ Intellective mastery affects mental engagement	1 (3%)
$R13_d$ Mental engagement enables exploitation of informating potential	3 (9%)
$R14_d$ Having the opportunity to develop and express competence is essential for exploiting the informating potential of IT	18 (56%)
$R15_d$ Having intellective skills (competence) and having the opportunity to develop and express them are mutually reinforcing	2 (6%)
$R16_d$ Textualization results in visibility/transparency	7 (22%)
$R17_d$ Visibility/transparency affects workers' feelings of apprehension	6 (19%)
$R18_d$ Visibility/transparency undermines the strength of traditional authority	9 (28%)
$R19_d$ Fundamental innovation is required to reduce the strength of traditional authority	7 (22%)
$R20_d$ Market necessity influences choice and commitment to fundamentally innovate	6 (19%)
$R21_d$ Fundamental innovation is required to create the opportunity to develop and express competence	6 (19%)
$R22_d$ Introduction of IT results in automation	6 (19%)
$R23_d$ Automation reinforces the strength of traditional authority	7 (22%)
$R24_d$ The strength of traditional authority affects managers' feelings of vulnerability and vice versa	6 (19%)
$R25_d$ Managers' feeling of vulnerability leads them to use technology for enforcement	6 (17%)
$R26_d$ Managers' use of technology for enforcement influences the strength of traditional authority	9 (28%)
$R27_d$ Managers' use of technology for enforcement affects workers' use of technology as defense and vice versa	6 (19%)
$R28_d$ Workers' use of technology as defense reduces the strength of traditional authority	6 (19%)
$R29_d$ The strength of traditional authority and the opportunity to develop and express competence undermine each other	10 (31%)
$R30_d$ Managers' use of technology for enforcement leads to a disconnection from reality	3 (9%)
$R31_d$ Having a disconnection from reality impedes the ability to exploit the informating potential of IT	8 (25%)

When examining the shading in Figures 1 and 2, some findings may seem odd at first glance. For instance, in both figures, the Introduction of IT ($C1_o$ and $C1_d$) is white, indicating that it is referred to in less than 15% of citing articles. Although this might initially seem strange, it makes sense because it simply means that the passages in which authors cite Zuboff rarely contain detailed discussions of the introduction of IT. Instead, the introduction of IT is typically a background condition in such passages and authors cite the *Smart Machine* for a more specific issue associated with its introduction. Having said this, it is surprising that some of the more specific concepts in Figure 1 (such as $C3_o$, Dilemma of Authority) and Figure 2 (such as $C6_d$, Workers' Feelings of Apprehension, $C16_d$, Manager's Feeling of Vulnerability, and $C18_d$, Workers' Use of Technology as Defense) are cited so sparingly. It suggests that these elements of the *Smart Machine* are rarely used by other researchers whereas other elements are much more frequently used. I return to this issue in the Discussion.

4.2.3 Comparing Mappings across Time and Journal

Table 5 shows how the results differ across time periods and across journals. For these analyses, I focused on the full sample of 186 citing articles and the overview model. I also examined the results for the 33 detailed citing articles and the detailed model but did not include them in this paper for reasons of space and because the results for the overview model convey essentially the same message but are simpler to both report and interpret.

For analysis across time, I split the citing articles into two time periods (1988-1999 and 2000-2011) that were equal in length and that were long enough not to be affected too much by the ebb and flow in citation patterns revealed earlier (in Figure 4). For analysis across journals, I compared the citations in *I&O (AMIT)* and *MISQ*. I focus on these two because as Figure 3 showed earlier, Zuboff's book is cited most frequently in these journals and they had a similar

number of citing articles. Thus, if the results differed across these journals, the differences would likely be substantive rather than an artifact of comparing unequally-sized samples.

Although Table 5 contains many numbers, the patterns are actually very similar, shown by the very little shading in the table. The shading reflects cases in which there is a substantial difference in the citation patterns across years or across journals. Depending on how one makes a comparison (raw articles or percentages), the size of the difference can vary. To control for these differences, the shading reflects cases in which there is a substantial difference on both measures (raw articles and percentage). I interpret a 'substantial' difference to be a case where there were five (or over) more articles in one period or journal than the other time period or journal and where this difference was greater than 10% in the relevant citations for that period or journal. For instance, in Table 5A, $R6_o$ was examined in 8 more articles in 1988-1999 than in 2000-2011, which reflected a change of 10% in the proportion of articles. It seems fair to say that this is a substantial difference.

The results are quite clear: Zuboff's story has been cited in a very similar manner across time (Table 5A) and across journals (Table 5B). Across time, the only major difference has been a gradual reduction in citations associated with R6 (how the dilemmas of transformation are resolved) and to a lesser extent R9 (how the process of informating creates dilemmas of transformation), perhaps reflecting a simplification of Zuboff's story over time. Across journals, the only differences were that articles in *Information and Organization* tend to refer to $C3_o$ (the dilemma of authority), $C4_o$ (the dilemma of technique), and $R3_o$ (the relationship between these two dilemmas) more than articles in *MIS Quarterly*. This probably stems from the fact that research taking an interpretive and/or a critical lens (especially on topics such as power) appear more often in *Information and Organization* than in *MIS Quarterly*. Despite these differences, the overall message in these tables is one of similarity. In other words, although many ideas in

the *Smart Machine* have been overlooked or hardly used, those that have been used have had broad and enduring influence.

Table 5: Mapping all Citing Articles to the Overview Model across Time and across Journal (186 articles)*

	5A. Across time		5B. Across journal	
Element of model	**Number (%) of all articles, *88-99***	**Number (%) of all articles, *00-11***	**Number (%) of all articles, *I&O***	**Number (%) of all articles, *MISQ***
$C1_o$ Introduction of IT	5 (6%)	4 (4%)	0 (0%)	4 (13%)
$C2_o$ Dilemma of knowledge	16 (18%)	14 (14%)	10 (25%)	7 (22%)
$C3_o$ Dilemma of authority	11 (12%)	11 (11%)	7 (18%)	2 (6%)
$C4_o$ Dilemma of technique	19 (21%)	14 (14%)	12 (30%)	1 (3%)
$C5_o$ Market necessity	9 (10%)	8 (8%)	3 (8%)	4 (13%)
$C6_o$ Choice and commitment to fundamentally innovate	19 (21%)	20 (21%)	7 (18%)	7 (22%)
$C7_o$ Automation	18 (20%)	23 (24%)	8 (20%)	10 (31%)
$C8_o$ Informating	42 (47%)	44 (45%)	18 (45%)	20 (63%)
$C9_o$ Effects of automation	18 (20%)	20 (21%)	10 (25%)	10 (31%)
$C10_o$ Effects of informating	24 (27%)	32 (33%)	10 (25%)	13 (41%)
$R1_o$ Introduction of IT leads to dilemma of knowledge	7 (8%)	6 (6%)	4 (10%)	2 (6%)
$R2_o$ Dilemma of knowledge leads to dilemma of authority	11 (12%)	11 (11%)	6 (15%)	5 (16%)
$R3_o$ Dilemma of authority and dilemma of technique mutually influence each other	16 (18%)	14 (14%)	8 (20%)	3 (9%)
$R4_o$ Introduction of IT results in automation	3 (3%)	3 (3%)	1 (3%)	1 (3%)
$R5_o$ Market necessity influences choice and commitment to fundamentally innovate	6 (7%)	2 (2%)	1 (3%)	3 (9%)
$R6_o$ Dilemmas of transformation resolved through choice and commitment to fundamentally innovate	16 (18%)	8 (8%)	5 (13%)	2 (6%)
$R7_o$ Choice and commitment to fundamentally innovate determines emphasis automation versus informating	15 (17%)	10 (10%)	8 (20%)	4 (13%)
$R8_o$ Automation enables informating	1 (1%)	3 (3%)	0 (0%)	2 (16%)
$R9_o$ Informating creates dilemmas of transformation	15	8	6	8

	(17%)	(8%)	(15%)	(25%)
$R10_o$ Automation leads to effects of automation	6 (7%)	6 (6%)	4 (10%)	0 (0%)
$R11_o$ Informating leads to effects of informating	23 (26%)	19 (20%)	8 (20%)	8 (25%)

* Shading indicates a difference of ≥5 articles and ≥10% across *periods* (in Table 5A) and *journals* (in Table 5B). The denominator for the % reflects the total number of articles in each period or journal; hence it differs in each column.

4.2.4 Examining Tests or Extensions

In the final phase of the analysis, I examined whether authors used the *Smart Machine* 'as is' or if they challenged or extended it, e.g., by testing its ideas or by extending the ideas to new situations. Obviously, to test, challenge, or extend ideas, one must engage deeply with them, so I only focused on the 33 detailed citing articles for this analysis, not the cursory citing articles. To perform the analysis, I followed Anderson (2006) in looking for both conceptual critiques and empirical tests. Interestingly, the two coders and I found only one conceptual critique and no empirical tests. The lone conceptual critique was the following from Orlikowski (1991 p. 34):

> *The information environment, while it may facilitate integrated and flexible operations, may also enable a disciplinary matrix of knowledge and power. The former resembles the "informate" concept, coined by Zuboff (1989, p. 9) to express the ability of information technology to generate "information about the underlying productive and administrative processes through which an organization accomplishes its work." Zuboff suggests that this "informating" ability of information technology allows managers to transform organizations into "learning institutions," noting (1988, p. 311) "An emphasis on the informating capacity of intelligent technology can provide a point of origin for new conceptions of work and power." Zuboff, however, does not acknowledge that technology's "informating" capacity can just as easily be used to increase systemic forms of control in organizations [footnote 7].*

This critique was fairly mild because Orlikowski (1991) immediately acknowledged in her footnote 7 that Zuboff did in fact illustrate in many of her case studies how a technology's informating capacity can be used to increase control. Thus, it seems that Orlikowski was critiquing the degree of emphasis that Zuboff gave to the issue rather than critiquing her lack of awareness of it. Robey and Boudreau (1999 p. 174) made a similar point, but they instead

critiqued those who cite the *Smart Machine*, arguing that many people who cite the book focused on the positive aspects of informating alone, seemingly unaware of its political aspects:

> *Zuboff's (1988) text is widely cited as empirical support for the concept of informating, in which advanced information technologies are used to expand the scope of work and draw out the intellective capacities of workers. However, Zuboff's empirical results more readily support political arguments in which the promise of informating is frustrated by managers and others acting in self-interests.*

The fact that Zuboff's work was never seriously critiqued or tested in the 186 citing articles parallels Anderson's (2006) findings in his study of Weick (1979). He found that (2006 pp. 1686-1687): "… *only a small percentage of citations refuted arguments …, and even these refutations were fairly minimal… Overall, authors thus appear to be remarkably willing to accept [Weick's] concepts* …." My findings are the same: researchers generally treat the *Smart Machine* as accepted truth.

Even if the *Smart Machine* is taken as accepted truth, it is still possible for researchers to extend the ideas rather than treating them 'as is.' Although I did not find many examples of such work, I did find a few. Elmes et al. (2005), for instance, cited the *Smart Machine* to discuss how IT textualizes work and thereby requires workers to invest a new level of intellectual effort to deal with the abstract electronic text. They then noted (2005, pp. 18-19) that although "*abstraction can be challenging at any time …in an [enterprise system] the difficulty is compounded by the demands of integration*." By linking Zuboff's concepts with the concept of integration, they were then able to extend Zuboff's ideas from the kinds of systems that she studied to modern integrated enterprise systems. Whereas Elmes et al. (2005) extended Zuboff's ideas to a different type of information system, Kohli and Kettinger (2004) extended her ideas to a different type of worker. They wrote that one of their aims was (p. 364): "focused on extending the informating concept to better fit the context of a clan of physicians." To do so,

Kohli and Kettinger (2004) then tried to link Zuboff's ideas with those of agency theory from economics to come up with a new idea of 'informating the clan.' They wrote:

> *Expanding upon Zuboff's (1988) definition, we define informating the clan as a managerial intervention whereby the principal, lacking legitimacy, indirectly introduces behavioral performance information … through legitimized messengers as catalysts to stimulate the process of concertive control toward changes in the clan's normative patterns of behavior in greater congruence with those of the principal*.

Based on this new idea, Kohli and Kettinger (2004) then described the dynamics that ensued after the implementation of a new information system to informate a clan in a hospital setting.

Summarizing all the evidence presented to date, it seems that some insights in the *Smart Machine* have had an enduring influence on researchers in the Information Systems field, particularly the idea of informating, but many other insights have been forgotten or overlooked. The influential ideas have largely been treated as accepted truth rather than being critiqued or tested, but a few researchers have been willing to extend them to new situations (e.g., to new types of IT or different groups of workers), thereby extending the influence of the text.

5. Discussion and Conclusion

As I noted earlier, several papers have examined classic studies and found results that mirror some of mine (Anderson 2006; Barrett and Walsham 2004; Hansen et al. 2006), e.g., finding that classic studies are cited for only a small portion of their ideas. As Hansen et al. (2006) note, this is likely due to the social process by which texts become highly-cited. For instance, researchers will naturally cite ideas that help them develop their own arguments (Latour 1987) and it is unlikely that all of the ideas in any given work (such as the *Smart Machine*) would suit that purpose at any given time. Instead, just a few ideas are used, and through a process of cumulative advantage, these ideas become widely diffused, while others languish (Merton 1988). Although this is interesting from a sociology of science perspective, my focus, instead, has been to

learn which parts of the text have been used (or not) and the opportunities this offers for research. In particular, my analysis highlights three broad themes that could motivate further work.

First, consider the collection of white and light-grey boxes in the upper-right of Figure 2 ($C4_d$, Exploit informating potential, $C6_d$, Workers' feeling of apprehension, $C7_d$, Intellective skills, $C8_d$, Intellective mastery, and $C11_d$, Mental engagement), and their associated relationships. These concepts and relationships occupied a large part of Part 1 of the *Smart Machine*, and yet they have been largely ignored in the literature. It seems that researchers have been quick to cite the *Smart Machine* for the general concept of informating (shown, for example, in the dark shading in $C8_o$, Figure 1), but they seem to have largely overlooked the emotional and mental demands on workers in an informated environment that Zuboff discussed in her text. Examining such topics would seem to be a very good opportunity for future research.

Second, see the white and light-grey boxes in the lower-middle and lower-right of Figure 2 (such as $C13_d$, Strength of traditional authority, $C16_d$, Managers' feeling of vulnerability, and $C18_d$, Workers' use of technology as defense). Information Systems researchers have largely overlooked these even though other concepts and relationships in their vicinity have been examined. For instance, 41% of the detailed citations referred to $C17_d$ (Manager's use of technology for enforcement) but only 9% referred to $C16_d$ (Managers' feeling of vulnerability). When I examined the citations that referred to $C17_d$, many of them referred to Zuboff's discussion of the 'panopticon.' Much like the concept of informating, the panopticon is a memorable part of Zuboff's book. Researchers clearly enjoy citing this idea but they appear to largely overlook the processes that motivate its use and its effects on workers and managers. Even so, these were then and still remain fundamental issues associated with IT management (see Vieira da Cunha 2006 for an unpublished but very detailed examination of some of these issues).

Third, recall my finding that researchers have cited Zuboff's theory primarily for its

concepts, not the *relationships* among them. It is the relationships among concepts, however, that make a theory a theory (Jaccard and Jacoby 2010 p. 28; Sutton and Staw 1995 p. 378). It is also through understanding how these relationships work that the story of the *Smart Machine* comes alive, allowing researchers to understand the process of change rather than just its static elements. By focusing primarily on the concepts in the theory rather than the relationships, Information Systems researchers seem to have focused on enrolling Zuboff's ideas into their *own* theories rather than taking advantage of Zuboff's theorizing. Future research may well benefit from leveraging Zuboff's insights on these relationships and testing and extending them further.

I should stress that I identified these opportunities purely from my analysis of the *Smart Machine* and the studies that cite it in the Information Systems field. A lack of studies that cite the *Smart Machine* for a given idea does not necessarily mean that the idea has not been studied elsewhere. After all, perhaps other researchers have done so quite independently and had no need to cite Zuboff. As a result, some of the opportunities I noted could prove to be more apparent than real. The only way to know for sure would be to conduct a thorough review of the literature for every single element in Figures 1 and 2, a major undertaking outside the scope of this essay. Nonetheless, given the relative youth of our discipline, I would suggest that many ideas that have been overlooked in researchers' use of the *Smart Machine* are relatively overlooked in general.

For instance, many of the concepts understudied in the top right of Figure 2 relate to the requirements for and expression of intellective skills (competence). There are very few dedicated studies of competence in Information Systems research. The only major program of research on user competence that I am aware of is that of Marcolin and colleagues (e.g., Gravill et al. 2006; Marcolin et al. 2000; Munro et al. 1997) and they have called for more research on the topic and seem to have been unaware of Zuboff's work. In addition to Marcolin's programmatic work, other authors occasionally examine what it takes to use IT in a successful or competent fashion

(the paper by Stein et al. 2013 is a recent example) but such papers rarely cite Zuboff. Studies on the effective and competent use of information systems could be informed greatly by drawing on her ideas. The *Smart Machine* offers a wealth of detail on user competence, such as the network of concepts shown around competence in Figure 2 (opportunities, apprehension, mental engagement, and mastery) in addition to concepts that are at an even lower-level of detail than those shown in Figure 2, such as the three dimensions of competence, *abstraction*, *explicit inference*, and *procedural reasoning* (Zuboff 1988, pp. 75, 95). Rather than starting from scratch, future authors could take Zuboff's ideas as starting points and extend her work further.

As reviewers of this manuscript reminded me, an unused or little-used theory does not equate to an underutilized theory. In this light, the citation numbers I have reported simply show the low utilization of Zuboff's theory, not its underutilization. I suggested earlier, however, that if theory of the *Smart Machine* had not been utilized extensively, then it *should* be utilized more. I believe that such a claim for underutilization is fair when the numbers I have reported are interpreted in the context of how research evolves. After all, research communities do not develop in a purely rational, open, and linear fashion. They are heavily influenced by personal, social, and market dynamics (Kuhn 1996; Ramiller et al. 2008). In particular, I argue that four factors in combination have led both to the *low* utilization and *underutilization* of Zuboff's work.

I first discuss three reasons for the *low* utilization in the Information Systems field. The first likely reason relates to the author herself. That is, a major reason why Zuboff's work has not been taken further is that Zuboff did not take it much further herself. As Chatman and Flynn (2005) observe, it is often incumbent on individual authors to drive their programs of research. Others may use pieces of the work, but they will inevitably use those pieces that relate to their own work and when different people use different pieces, the work is ultimately used in a patchwork manner, just as we have seen here. This contrasts, for example, with the programmatic

work undertaken by researchers using structuration theory around the same time (Barley 1986; Barley and Tolbert 1997; DeSanctis and Poole 1994; Orlikowski 1992; Orlikowski 2000; Poole and DeSanctis 2009). By continuing that work over many years, such researchers gradually enrolled others into that line of work, leading structuration theory to become widely adopted and influential (Jones and Karsten 2008).

Another likely reason for the low utilization is the gap that exists between different research paradigms. According to Lee (1991), a theory developed inductively (such as the theory of the *Smart Machine*) can subsequently be tested deductively by researchers with a more positivist or quantitative inclination. To date, however, positivist researchers have not directly tested Zuboff's work, either in whole or in part. This is unsurprising because the theory has never been represented in the form of a model that researchers of this tradition would recognize—a problem that I hope my work helps to overcomes. Thus, while a deductive approach could have supported the programmatic development of Zuboff's work in principle, it has not to date.

Third, the sheer scale and detail of the *Smart Machine* may have made it hard for Zuboff and others to use and extend her work. As Alvesson and Sandberg (2011) note, it is now rare to publish book-length ethnographic work in professional schools, especially in the North American system (for an exception, see Leonardi 2012), and while it is possible for researchers of a positivist and quantitative bent to test the theory, the statistical tools that such researchers typically use are not designed for testing the complex, reciprocal relationships that Zuboff proposed.

The three reasons I have raised so far are similar in that they do not relate to the specific ideas in Zuboff's work. It is when we consider the ideas in her work that I think we find a basis for underutilization. On this point, I believe that the main reason for underutilization is that Zuboff developed her ideas quite *holistically*, including a broad range of "historical, psychological, and organizational forces" (p. 7). This led her to address both sides of issues that

have traditionally been examined in a fairly one-sided manner. Consider three examples.

First, consider emotions and cognitions. Zuboff's theory included both elements. Specifically, she argued that informating can empower the cognitions of individuals and organizations, ultimately creating a 'learning organization,' and yet this also has profound implications for workers' and managers' emotions (per $C6_d$ and $C16_d$ in Figure 2). In contrast to this dual focus on cognition and emotion, much Information Systems research during the 1990s and early 2000s, especially in the quantitative literature (Venkatesh et al. 2003), took a cognitive perspective alone. Although exceptions can be found that examine both aspects (Te'eni 2001), several studies have stressed that Information Systems researchers have long given short shrift to emotions and have called for a more balanced treatment (Beaudry and Pinsonneault 2010; Ortiz de Guinea and Markus 2009).

Second, consider representations and practices. Both played a key role in Zuboff's theory. The notion that computer systems provide representations in place of a direct connection with reality was a major theme in Part 1 of the *Smart Machine* (see $C2_o$ in Figure 1, and $C2_d$, $C5_d$, and $C19_d$ in Figure 2), and the importance of practices pervaded Zuboff's detailed descriptions of the work at each case site. In contrast to this dual focus, most research in Information Systems has emphasized the study of practices without much attention to representation (see Kallinikos 1999 for an exception). Some have even cautioned against representational thinking (Boland and O'Leary 1991 p. 2; Scott and Orlikowski 2013 p. 78). The practice turn, for instance, "shifts the focus from questions of correspondence between descriptions and reality … to matters of practices/doings/actions" (Barad 2003 p. 802). Only recently have studies begun to consider both the representational aspects of IT and their use in practice (Bailey et al. 2012; Burton-Jones and Grange 2013; Stein et al. 2013).

Third, consider organizational change and effectiveness. Zuboff's text combined an

interest in both elements (see $C6_o$ and $C10_o$ in Figure 1, and $C4_d$ and $C10_d$ in Figure 2). As others have noted (Leonardi and Barley 2010 p. 25; Orlikowski 1992 p. 401), Zuboff's assessment of outcomes was socio-technical in nature in that she examined implications both for workers, such as job-enrichment (p. 159), and the organization as a whole, such as competiveness (p. 288), innovation (p. 289), and performance (p. 324). Few studies in the Information Systems literature provide such an integrated picture of change and effectiveness at multiple levels of analysis. In the quantitative literature, researchers have often studied change (such as changes in IT use) (Venkatesh et al. 2003) but only recently have they focused on whether such changes lead to effective or ineffective outcomes (Burton-Jones and Straub 2006). Likewise, in the qualitative literature, many researchers have focused on organizational change alone rather than also the effectiveness or ineffectiveness of that change. For instance, although Dewett and Jones (2001 p. 338) refer to the "structure-technology-performance" relationship of early contingency studies, many studies both at that time, and since then, have examined the relationship between technology and organizing (or technology and structure) without also looking at the performance element. Consider, for instance, the following quote in which Robey and Azevedo (1994 p. 24) acknowledge the role of effectiveness but then focus on the link between IT and organizational change alone:

> *These and other revisions in organizational design, as enabled by information technology, hold promise for the more effective functioning of … organizations. Unfortunately, excitement over the prospect of organizational transformation is not matched by a set of consistent empirical findings. In empirical work, information technology is sometimes associated with organizational change, but often it is not.*

My point is not that it is *better* to focus on both change and effectiveness rather than just one of them. My point is that it is *interesting* that Zuboff managed to combine a focus on both elements. Several studies both before and after Zuboff's work have argued that studying performance can be quite problematic (Hirsch and Levin 1999; March and Sutton 1997; Mohr 1982). Even so, many

if not most firms are interested in how to change to be more effective. Some Information Systems researchers have begun to develop theories that combine an interest in change and effectiveness (Bala and Venkatesh 2014; Beaudry and Pinsonneault 2005; Burton-Jones and Grange 2013). Such researchers may find that they can learn from the theory and methods in Zuboff's work.

In addition to Zuboff managing to overcome dichotomies and trends that subsequently came to shape extant research, the elements that were studied less in subsequent work are now viewed as very important, evident in the renewed interest in emotions and cognitions (Ortiz de Guinea and Markus 2009), representations and practices (Bailey et al. 2012), and effectiveness and change (Burton-Jones and Grange 2013). Thus, the fact that the theory of the *Smart Machine* manages to weave these different ideas together makes it an interesting and relevant theory to study. In fact, with recent studies urging researchers to account for the unique nature of IT (Robey et al. 2013 p. 384), to adopt socio-technical thinking (Sarker et al. 2013), to study power (Leonardi and Barley 2010), and to develop holistic accounts (Mitchell 2009), Zuboff's work stands out as a particularly relevant work for today's researchers. For all of these reasons, I think there are good reasons to believe that Zuboff's work has been underutilized and that there would be great value in utilizing it more. Although our discipline often propels itself forward by engaging with new phenomena and new ideas, it can also propel itself forward by re-examining what we have uncovered in the past, rethinking its implications, and leveraging it anew.

In claiming that Zuboff's work is underutilized, I do not mean that we should take it at face value. On the contrary, I mean that it deserves in-depth study and evaluation. For example, it would be valuable to engage in much more critical readings of the text than I have engaged in here (Chiasson and Davidson 2012). Other readings of the theory could also be offered and research could advance through examining alternative interpretations (Langley and Abdallah 2011). As noted earlier, because the *Smart Machine* focused on fundamental characteristics of IT (such as its

representational capacity) and fundamental characteristics of organizations (such as power), the results of testing her ideas would also be revealing. If the results upheld her ideas, it would underscore the enduring nature of these characteristics. If the results refuted her ideas, it would suggest that these characteristics might have fundamentally changed since that time. Either result would be valuable. In fact, it is remarkable that such a highly cited theory has *not* been tested to date. Although this implication for theory-testing might seem more relevant for positivistically-inclined researchers, I do not wish to stress the opportunities for this tradition over any others. On the contrary, I would stress the value of more in-depth and critical examinations of Zuboff's theory regardless of one's ontological or epistemological persuasion.

Researchers could also extend Zuboff's ideas much more than they have to date. The examples provided earlier show one way to do this; examining how her ideas would apply in different contexts. Another way to extend these ideas, however, would be to draw on the concepts and relationships in her theory to make new predictions. For instance, rather than simply use the detailed story presented in Figure 2 (and in the associated tables in the Appendix) to understand Zuboff's ideas, as I have done, one could use them to design a simulation to learn how such an interlinked set of actions, behaviors, and outcomes may evolve over time (Boland et al. 2009). The simulations studies of Black et al. (2004) (using systems dynamics) and Nan (2011) (using agent-based modelling) show how researchers can draw on such evidence to obtain new insights. The details offered in this paper, therefore, could be used as an input to such research.

In conclusion, the aim of this study has been to examine our field's collective use of a classic text. To some extent it is ironic that a book that described the underutilization of electronic texts has itself been underutilized. Nonetheless, this offers a great opportunity for future work. Therefore, it would seem that a fitting conclusion would be to restate and emphasize Willcock's (2004, p. 291) view that "Zuboff's text really does repay careful attention."

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APPENDIX

This appendix provides justification, in the forms of quotes from the *Smart Machine*, for the concepts and relationships shown in Figures 1 and 2.

Table A1: Explanations and Quotes for Concepts in the Overall Model

#	Concept	Explanation and evidence
$C1_o$	Introduction of IT	***IT is a unique technical product that engenders change when introduced in organizations*** p. 7: "Computer-based technologies … embody essential characteristics that are bound to alter the nature of work …." p. 415: "Information technology is a label that reflects the convergence of several streams of technical developments, including microelectronics, computer science, telecommunications, software engineering, and systems analysis."
$C2_o$	Dilemma of knowledge	***The computer mediation of work disrupts the previously physical basis for knowledge and necessitates a search for a new basis for knowledge*** p. 16: "Part 1 is directed toward the dilemmas associated with the changing grounds of knowledge as a result of the computer mediation of work." p. 71: "A fundamental quality of this transformation…, involves a reorientation of the means by which one can have a palpable effect upon the world. Immediate physical responses must be replaced by an abstract thought process …."
$C3_o$	Dilemma of authority	***A change in the basis for knowledge disrupts power structures. Those in authority will tend to try and shore up the power structure but role relations are unlikely to persist unchanged*** p. 16: "Part 2 focuses upon the dilemmas of authority that develop as the new demands for intellective skills blur traditional distinctions between operational and managerial roles…. The [cases] also illustrate how, despite these attempts to resist change, new roles and relations of authority begin to take shape." p. 348: "The role requirements associated with managerial authority have demanded that managers have the answers and be in control. …Like the operators they are supposed to direct, many of these managers felt robbed of the familiar ways in which they have experienced mastery, with little to embrace as a substitute."
$C4_o$	Dilemma of technique	***To maintain power, those in authority will use IT as a means to monitor and discipline staff but this response is likely to weaken rather than strengthen their power*** p. 16: "Part 3 concerns the attempts to shore up these threatened authority relations with new techniques of control that draw upon the technology's tendency to heighten the visibility of organizational processes…. Their efforts … ironically, weaken managerial authority even more profoundly."
$C5_o$	Market necessity	***Fundamental innovation may be driven by the requirement to be competitive*** p. 305: "…necessity that may derive from market conditions, the nature of the production process, or other conditions. For example, rapidly changing market conditions that put a premium on flexibility and responsiveness, competitive conditions that offer opportunities for value-added products or services, … the persistence of "unknowns" in the core production process, [and] opportunities for increased quality or decreased costs …."
$C6_o$	Choice and commitment to fundamentally innovate	***Fundamental innovation requires managers to truly choose and commit to engage in it*** p. 11: Managers can choose to exploit the emergent informating capacity and explore the organizational innovations required to sustain and develop it. Alternatively, they can choose to ignore or suppress the informating process." pp. 413-414: "… organizational innovations [in the past were insufficient]…. In contrast, an informating strategy suggests the need for a more wholistic reconceptualization of the … organization. Partial change efforts…are unlikely to result in the kind of learning

#	Concept	Explanation and evidence
		environment necessary …. An informating strategy requires a comprehensive vision based upon an understanding of the unique capacities of intelligent technology and the opportunity to use the organization to liberate those capacities."
$C7_o$	Automation	***The execution of a set of decomposed and rationalized activities by means of technology*** p. 9: "[Devices] automate by translating information into action…. [Technology] can be applied to automating operations according to a logic that hardly differs from that of the nineteenth-century machine system—replace the human body with a technology that enables the same processes to be performed with more certainty and control."
$C8_o$	Informating	***The recording of information about work done through information technology*** p. 10: "…technology simultaneously generates information about the …processes through which an organization accomplishes its work. It provides a deeper level of transparency to activities that had been either partially or completely opaque. …The word that I … coined to describe this unique capacity is *informate*. Activities, events, and objects are translated into and made visible by information when a technology *informates* as well as *automates*. p. 181: "At the same time, activities are made transparent. They are exposed in detail as they are textualized in the conversion to explicit information—that is informating.
$C9_o$	Effects of automation	***For business*:** p. 134: "…productivity had increased by 105 percent…" p. 138: "…many transfer assistants saw that there was little possibility of mistakes." p. 172: "…fewer people needed to accomplish routine [work]" p. 172: "…decreasing their dependence on human talent." p.305: "… reproduces the status quo and consolidates the managerial hierarchy..." p. 391: "…likely to find themselves crippled by antagonism from the work force and the depletion of knowledge that would be needed in value-adding activities." ***For workers*:** p. 129: "…further distanced … from involvement in the managerial process." p. 137: "…withering effect on the sociality of the office environment." p. 138: "…[reduced] need for task-related knowledge and judgment…. pp. 141-156: Numerous descriptions of "physical suffering" and "social exile."
$C10_o$	Effects of informating	***For business*:** p. 6: "…jobs [are imbued] with more comprehensive meaning…." p. 288: Comments regarding competitiveness, e.g., "…comparative advantage…"and "…competitive edge…." p. 289: "…higher levels of innovation." p. 324: "…accelerate learning and improve performance." p. 395: "[becomes] a learning institution…." p. 398: "[increased] pace of change." ***For workers*:** p. 6: "…unprecedented opportunities for a wide range of employees to add value to products and services." p. 260: "[development of] a new, more universal language that took them to the heart of the managerial arena." p. 361: "… mutual participation in and responsibility for operational and behavioral events., … joint learning…., understand[ing] the business more broadly."

Table A2: Quotes for Relationships in the Overall Model

#	Relationship	Explanation and evidence
$R1_o$	Leads to	***Introduction of IT leads to dilemma of knowledge*** pp. 61-62: "Computerization brings about an essential change in the way the worker can know the world, and with it, a crisis of confidence in the possibility of certain knowledge…. In

#	Relationship	Explanation and evidence
		the precomputerized environment, belief was a seamless extension of their sensory experience. As the medium of knowing was transformed by computerization, the placid unity of experience and knowledge was disturbed. ”
$R2_o$	Leads to	***Dilemma of knowledge leads to dilemma of authority*** p. 243: “[An informating approach uses IT] to increase the intellectual content of work at virtually every organizational level…. [This] intensifies the knowledge-management demands …throughout the organization. When this occurs, the experiential divergence that has defined the boundaries between the managers and the managed is diminished.” p. 391: “The shifting grounds of knowledge invite managers to recognize the emergent demands for intellective skills and develop a learning environment in which such skills can develop. That very recognition contains a threat to managerial authority, which depends in part upon control over the organization’s knowledge base.”
$R3_o$	Mutually influence	***From the dilemma of authority to the dilemma of technique:*** p. 313: “When authority fails, or appears fragile, managers frequently look toward a second dimension of power: its material aspect, which I shall refer to [as] “technique.” Techniques…protect authority by diminishing the likelihood of disobedience….” p. 344: “This example illustrates how a lack of confidence in the shared values of the authority relationship can lead to a new reliance on technical means of promoting group interests.” ***From the dilemma of technique to the dilemma of authority:*** p. 326: “Some managers…[used technique] to distance themselves from the kind of qualitative knowledge about one’s subordinates that was so vital in maintaining good reciprocal relations.” p. 334: “Despite [the potential for technique to improve authority relations], most agreed that there was a distinctive shift toward less interaction, less engagement, and more impersonally administered relationships.” p. 392: “Techniques … meant to safeguard authority create suspicion and animosity…..”
$R4_o$	Results in	***Introduction of IT results in automation. It is a taken-for-granted logic for implementing IT.*** p. 11: “It is quite possible to proceed with automation without reference to how it will contribute to the technology’s informating potential.” p. 390: “The organizations described in this book have illustrated …a conventional emphasis on automation. … the promise of automation seemed to exert a magnetic force….”
$R5_o$	Influences	***Market necessity influences managers’ choice and commitment to fundamentally innovate*** p. 305: “The value of an informating strategy varies in relation to the degree of necessity associated with learning and innovation…. [When this necessity is] *not* present …an automating strategy [rather than an informating one] is likely to be most feasible.”
$R6_o$	Resolved through	***Dilemmas of transformation are resolved through managers’ choice and commitment to fundamentally innovate*** pp. 5-7: “…new technology, such as … the computer…eliminates former alternatives. It creates new possibilities. It necessitates fresh choices." p. 5: “The choices that we face concern the conception and distribution of knowledge ….” p. 6: “The choices that we make will shape relations of authority ….” pp. 6-7: “The choices that we make will determine the techniques of administration that color the psychological ambience and shape communicative behavior ….”
$R7_o$	Determines emphasis given to	***Managers’ choice and commitment to fundamentally innovate determines emphasis given to automation vis-à-vis informating.*** p. 156: “While the informating power of the technology resulted in a more comprehensive textualization of office work, it did not lead to an increase in the intellectual content of clerical tasks…. This is because …managers and designers chose to emphasize the automating rather than the informating capacity of the new technology.” p. 390: “The relative emphasis that organizations give to these capacities [to automate or to informate] will become the foundation for a strategic conception of technological

#	Relationship	Explanation and evidence
		deployment and so will shape the way the dilemmas are confronted and resolved." p. 392: "Managers must have … a commitment to fundamental change in the landscape of authority if a comprehensive informating strategy is to succeed. Without this … commitment, the hierarchy will use technology to reproduce itself."
$R8_o$	Enables	***Automation enables informating*** p. 11: "These dual capacities of information technology are not opposites; they are hierarchically integrated. Informating derives from and builds upon automation. Automation is a necessary but not sufficient condition for informating."
$R9_o$	Creates	***Informating creates dilemmas of transformation*** p. 11: "... The informating capacity of the … technologies brings about radical change as it alters the intrinsic character of work…. It also poses fundamentally new choices...." pp. 389-390: "The dilemmas of transformation that have been described are embedded in the living detail of … the workplace as it undergoes computerization. … Information technology essentially alters the contours of reality—work becomes more abstract, …organizational memory and visibility are increased by an order of magnitude….Individuals caught up in this [new] reality face questions that did not need to be asked before."
$R10_o$	Leads to	***Automation leads to effects for business and for workers*** p. 10: "In its capacity as an automating technology, information technology has a vast potential to displace the human presence..... As long as the technology is treated narrowly in the automating function, it perpetuates the logic of the industrial machine ….."
$R11_o$	Leads to	***Informating leads to effects for business and for workers*** pp. 10-11: "…when the technology also informates the processes to which it is applied, it … sets into motion a series of dynamics that will ultimately reconfigure the nature of work and the social relationships that organize productive activity."

Table A3: Quotes for Concepts in the Detailed Model

#	Concept	Explanation and evidence
$C1_d$	Introduction of IT	***Same as in the overall model (see quotes in Table A1, $C1_o$).***
$C2_d$	Textualization of work	***By providing a representation of the work and activities performed in an organization, the IT system becomes much like a text that can be read.*** p.126: "in many cases, organizational functions, events, and processes have been so extensively informated—converted into and displayed as information—that the technology can be said to have "textualized" the organizational environment. In this context, the electronic text becomes the new medium in which events are both observed and acted." p. 393: "The electronic text becomes a vast symbolic surrogate for the vital detail of an organization's daily life."
$C3_d$	Autonomous power to informate	***The potential to informate is an inherent characteristic of IT, and so informating can occur automatically, at least to some extent, without being planned or intended.*** p. 11: "…the consequences of the technology's informating capacity are often … unintended. … and the potential that it lays open remains relatively unexploited…. It is quite possible to proceed with automation without reference to … informating potential. When this occurs, informating is experienced as an unintended consequence of automation." p. 308: "If the technology cannot shoulder the entire burden of strategic change, it nevertheless can set into motion a series of dynamics that present an importance challenge to imperative control and the industrial division of labor."
$C4_d$	Exploit informating potential	***The act of taking advantage of the new information about the work offered by the IT*** p. 70 and p. 392: "... exploit the informating capacity of the [new] technology..." p. 413: "…the disappointing performance could be attributed, not to what operators *were*

#	Concept	Explanation and evidence
		doing, but to what they *were not* doing. The operators' errors were sins of omission—an underutilization of the data interface resulting from their refusal to notice, to think, to explore, to experiment, or to improve."
$C5_d$	Problem of meaning	***IT replaces one's physical connection with reality with a representation of it. Users can experience difficulties because they no longer interact with the real world referent.*** p. 62: "[In the computerized environment,] accomplishing work depended upon the ability to manipulate symbolic, electronically presented data…. The workers in this transition were at first overwhelmed with the feeling that they could no longer see or touch their work, as if it has been made both invisible and intangible by computer mediation." p. 63: "[Workers felt] robbed of one's senses and plunged into darkness." p. 76: "In a symbolic medium, meaning is not a given value; rather, it must be constructed."
$C6_d$	Workers' feelings of apprehension	***Workers' apprehension due to problem of meaning****:* p. 63: "Workers reiterated a spontaneous emotional response countless times—defined by feelings of loss of control, of vulnerability, and of frustration." p. 79: "…operators experienced a blunt mistrust of the electronic data." ***Workers' apprehension due to feeling of visibility****:* p. 343: "We don't want them to second-guess our minute-to-minute decisions. …[Our] concern is that they will be on our backs and we will all end up with ulcers." p. 344: "To be visible in this way evokes a sense of vulnerability and powerlessness. The person … begins to wonder, "Am I exposed in some way that I would not choose to be?""
$C7_d$	Intellective skills (competence)	***A bundle of cognitive processes necessary for interacting competently with an IT system*** pp. 75-76: "The thinking that this operator refers to is of a different quality from the thinking that attended the display of action-centered skills. It combined abstraction, explicit inference, and procedural reasoning. Taken together, these elements make possible a new set of competencies that I call *intellective skills*." p. 95: "Accomplishing work came to depend more upon thinking about and responding to an electronically presented symbolic medium than upon acting out know-how derived from sentient experience. The bundle of cognitive processes associated with these new activities—"thinking about," "responding to"—I have labeled *intellective skill*."
$C8_d$	Intellective mastery	***Intellective skills in tacit form.*** p. 192: "Over the long-term, intellective mastery will depend upon being able to develop a tacit knowledge that facilitates the recognition of decision alternatives and frees the mind for the kind of insight that could result in innovation and improvement." pp. 192-193: "Intellective skill is necessary for the creation of meaning, and real mastery begins to emerge when such meanings are consolidated in tacit knowledge."
$C9_d$	Market necessity	***Same as in the overall model (see quotes in Table A1, $C5_o$).***
$C10_d$	Choice and commitment to fundamentally innovate	***Same as in the overall model (see quotes in Table A1, $C6_o$).***
$C11_d$	Mental engagement	***The extent to which one is focused or immersed in one's use of the IT*** p. 156: "The inherent abstractness of this text … placed unique mental demands upon the clerks … vigilance and sustained concentration." p. 188: "...the computerized environment [demanded] a new kind of deliberate cognitive commitment to their work."
$C12_d$	Visibility/ transparency	***By textualizing the work environment, the IT system allows people to see and understand parts of the work environment that might have previously been opaque or unknown*** p. 9: "Information technology … provides a deeper level of transparency to activities that

#	Concept	Explanation and evidence
		had been either partially or completely opaque. ” p. 181: “The computerization of... processes in an organization [results in activities being] made transparent. They are exposed in detail ….
$C13_d$	Strength of traditional authority	***The extent to which managerial authority is accepted without question*** p. 221: “In organizational life, power is widely expressed through a framework of what Max Weber called "imperative control," in which commands yield a high probability of obedience. … obedience to authority is achieved through a belief in a hierarchical order….” p. 222: “Chapter 6 traces the belief systems that have legitimated managerial authority in order to understand how the manager’s role came to be identified with the guardianship of the organizations explicit knowledge base. It is this identification of management with "scientific" understanding that [underpins its traditional strength] …..”
$C14_d$	Opportunity to develop and express competence	***A function of several factors****:* <u>*Economic pressures*</u> p. 248: “Perhaps the most compelling reality that drives managers to a narrowly conceived emphasis on automation [ignoring the development of workers’ intellective skills] is the web of economic logic in which they must operate. Frequently, new expenditures for technology can be justified only as a capital substitution for labor." <u>*Education*</u> p. 195: “The skills necessary for competent operation in an informated environment appear to be related to the kind of explicit, inferential, scientific reasoning traditionally associated with formal education." <u>*Ability to engage in collaboration and communication*</u> p. 197: “The frequent necessity of pooling intellective insight in order to achieve the best possible interpretation of the text, and the requirements of explicit communication to match the explicit thought, were each in evidence in the [case studies].” pp. 200-201: “[To] competently engage with the data interface..., they needed the communicative skills related to joint data-based problem solving. … Thus, a more automated future would seem to increase the importance of this kind of collaboration ….” <u>*Role definitions*</u> p. 208: “Individual potential is a necessary … condition for intellective skill development. However, the way in which roles are conceived, and [their] rigidity or permeability are likely to be more definite indicators of [the] commitment to intellective skill development....” <u>*Sufficient motivation/incentives*</u> p. 291: “When tasks require intellective effort… the need for positive motivation and internal commitment becomes all the more crucial.” p. 295: “… more managers were beginning to discuss the … psychological relationship between the worker and the data interface. They had [concluded] that…only the strength of an operator's commitment and motivation would insure high-quality performance.” <u>*Access to data*</u> p. 356: “The informating process has not only provided workers with the language to confront their managers but also equalized their respective realities, since the objective record stands as final arbiter of what has happened. For the textualization of organizational processes…to have this effect, [requires] egalitarian access to the … electronic text....”
$C15_d$	Automation	***Same as in the overall story (see quotes in Table A1, $C7_o$).***
$C16_d$	Managers’ feeling of vulnerability	***Emotional concerns triggered by the new environment*** p. 251: “We are afraid that if we quit controlling things, the organization will fall apart." p. 251: “… management is afraid to let us learn too much about how this system operates.” p. 264: “The managers have a bigger job security problem …. We have a union; they don't.”

#	Concept	Explanation and evidence
$C17_d$	Managers' use of technology for enforcement	***The way in which managers use IT to control workers and shore up managerial authority.*** p. 267: "[Managers'] enthusiasm for …[a system with automated controls] can also serve as a summary of a hundred daily frustrations in which managers feel thwarted in their attempts to direct and control subordinates." p. 314: "Managers, too, have used a wide variety of techniques to safeguard their authority and increase the certainty of their control. Part 3 explores how information technology makes itself available as such a means."
$C18_d$	Workers' use of technology as defense	***Actions workers take using the IT system to protect their own interests (possibly at managers' expense).*** pp. 344-345: "[One response is for workers] to circumvent the observer, to thwart the power of the panopticon. ... One [worker] looked around and… announced, "Look, if it gets to the point that they really want access, we'll just make sure it doesn't work. Right, fellas?"'" p. 353: Because they did not trust their managers to interpret the data correctly, and because they did not trust their own ability to explain the data adequately, foremen preferred to manipulate the data...."
$C19_d$	Disconnection from reality	***The extent to which the IT system no longer provides its users with an adequate understanding of the phenomenon it is supposed to represent*** p. 326: "The system can't give you the heartbeat of the plant; it puts you out of touch." p. 332: "There seemed to be something compelling about the "black-and-white" information from the system. [As a result]…foremen were less motivated to …verify or understand the causes of the workers' behavior." p. 361: "The electronic text can so insulate managers from the … realities of their workplaces that they will no longer have available the means with which to rekindle [action-centered skills] if they should want to. Paradoxically, that very insularity increases the vulnerability of the text to contamination while it simultaneously heightens the requirements for valid objective data. Thus insulated, managers often collude in ignoring the ever more slender relationship between their data and the organizational realities that they are meant to reflect.

Table A4: Quotes for Relationships in the Detailed Story

#	Effect	Explanation and evidence
$R1_d$	+	***Introduction of IT leads to textualization of work:*** p. 9: "Information technology not only produces action but also produces a voice that symbolically renders events, objects, and processes so that they become visible, noble, and shareable in a new way…."
$R2_d$	+	***Textualization results in autonomous power to informate*** p. 10: "…when the technology also informates the processes to which it is applied, it increases the explicit information content of tasks and sets into motion a series of dynamics that will ultimately reconfigure the nature of work and the social relationships that organize productive activity." p. 306: "The evidence indicates that informating typically unfolds as an objective, unplanned, autonomous process." p. 307: "... the autonomous dynamics set into motion by a technology that informates ..."
$R3_d$	+	***Textualization results in a problem of meaning*** p. 180: "The textualization of work-related processes can destroy the sense of meaning inherent in action-centered skills and the oral culture in which they are embedded…. Textualization can also be the occasion for the construction of new meaning." pp. 203-204: "…textualization entails the need to construct meaning... "
$R4_d$	+	**Problem of meaning leads to workers' feelings of apprehension** p. 81: "The computer makes the job easier... but it also makes things more complicated. You have to know how to read it and what it means. That is the biggest problem. What does that number

#	Effect	Explanation and evidence
		actually mean? You have to know this if you want to really learn how to trust the technology." p. 165: "The concerns about loss of contact with the actual dynamics of the business due to this impersonal quality of the new data environment was also voiced by professionals: "The old banker is a bloodhound—he sniffs out deviations... With the manual systems, we had a smell for errors.... Now the bloodhound are disappearing. You can't sniff the new technology."""
$R5_d$	+	***The autonomous power to informate has a positive but halting effect on intellective skills*** p. 306: "… informating typically unfolds as an … autonomous process. Though a technology that informates invites learning, organizational members can find themselves confronting a system of imperative control that is inimical to learning. Under these conditions, intellective skill development occurs only haltingly…." pp. 308-309: "If learning is a pivotal experience in the effort to utilize the value of new information, then the autonomous dynamics set into motion by a technology that informates will not be sufficient to achieve its full realization."
$R6_d$	+/-	***Positive (increased skills, more apprehension)*** pp. 299-300: "Workers across the plant were disgruntled. … they argued that their wages should be increase in proportion to the increase in responsibility. The unifying them in their comments was one of a contract violated…. [evoking] feelings of incompetence and victimization." p. 411: "In any organization, there will be some individuals who reject the demands of intellective work ….Some will be repelled by the mental stress of such work and find it too perplexing or anxiety-inducing." ***Negative (increased skills, less apprehension)*** p. 81: "… need for competent interpretation as a prerequisite for trust…" p. 89: "This means that a return to feelings of certainty, competence, and control will depend more and more upon the quality of intellective skill [of the user]."
$R7_d$	+/-	***Positive effects (more apprehension, more mental engagement)*** p. 63: "Workers [experienced a] loss of control, … vulnerability, and … frustration. It was sharpened with a sense of crisis and a need for steeling oneself with courage and not a little adrenaline in order to meet the challenge." p. 132: "The immediacy and significance of the ENTER key often engendered anxiety.... At the same time, the knowledge that one was actually accomplishing the transaction—not just completing paperwork—entailed a sense of control, responsibility, and seriousness." ***Negative effects (more apprehension, less mental engagement)*** p. 300: "[Workers adapted in several ways ….. One solution was to stop] "performing some of the tasks for which they had formal responsibility…. Another [approach] was to challenge the notion that exposure to data demands responsiveness. …Why resort to the machine-breaking tactics of an earlier century when it was so much more elegant to simply ignore data?"
$R8_d$	+	**Need mental engagement for intellective skills** pp. 191-192: "the construction of meaning from the electronic text... is likely to require more deliberate, controlled, aware, cognitive effort than the earlier action-centered, context-dependent routines.... intellective skill development [requires] heightened mental effort."
$R9_d$	+	***Intellective skills enable the exploitation of informating potential*** p. 70: "[intellective skills are]… those that are able to exploit the informating capacity of the technology..." pp. 181-182: "Whether or not [the benefits of informating are] achieved depends upon …the presence of individual competence …." ***The exploitation of informating potential enables intellective skill development*** p. 395: "The informated organization is a learning institution, and one of its principal purposes is the expansion of knowledge… knowledge that comes to reside at the core of what it means to be productive. Learning is no longer a separate activity... the behaviors that define learning and the behaviors that define being productive are one and the same."

#	Effect	Explanation and evidence
$R10_d$	+	***Intellective mastery enables the exploitation of informating potential*** p. 202: "One manager described the data base as the new "vault" that contained the bank's real assets. Intellective mastery and teamwork could provide the keys to the vault." p. 390: "Intellective mastery will allow them to become interpreters of the text and so to add value to its contents."
$R11_d$	+	***Need intellective skills for intellective mastery*** p. 73: "… the abstract cues available through the data interface do require explicit [intellective skills], particularly in the early phases of the learning process." p. 192: …intellective mastery…cannot be achieved without a level of intellective skill development….Meaning must be constructed explicitly in order to become implicit later."
$R12_d$	+/-	***Individuals can reduce engagement in lower-level tasks and engage more in higher-level tasks*** p. 192: "…attention is freed …. Intellective mastery …frees the mind for the kind of insight that could result in innovation and improvement." p. 193: "While the development of mastery... does not solve the problem of attentional commitment, it does imply that attention can be freed for increasingly comprehensive tasks, invention, and experimentation...."
$R13_d$	+	***Mental engagement enables exploitation of informating potential*** p. 75: "You get it done through your thinking." p. 296: "Much of what now constitutes "work" involves the mindfulness and intellective effort necessary for continual responsiveness at the interface."
$R14_d$	+	***Having the opportunity to develop and express competence is essential for exploiting the informating potential of IT*** pp. 181-182: "Whether or not [the benefits of informating are] achieved depends upon two crucial conditions: the presence of individual competence and the opportunity to express that conference…. A second condition for fulfilling the knowledge-generating potential of an informating technology involves performance (the opportunity to express competence), which is determined in part by the manner in which the technology is both designed and deployed." p. 309: "…successful utilization of intelligent systems requires maximizing the cognitive capacity and learning ability of the work force."
$R15_d$	+	***Intellective skills (i.e., competence) provides opportunity to increase skills even more*** p. 92: "Once operators had established the referential function of the data, many moved to a higher level of complexity in dealing with system.... Instead of the problem of correspondence, the data now presented an opportunity for insight into functional relationships, states, conditions, trends, … and underlying causes, none of which can be reduced to a concrete external referent." ***Opportunity enables intellective skill development*** p. 200: "…the informated control rooms required people who could competently engage with the data interface. To do this, they needed the communicative skills related to joint data-based problem solving [and so they needed the opportunity to develop that first]." ***Interdependent nature of relationship*** p. 207: "Competence and performance [i.e., the expression of competence] are …dynamically related.... Performance not only displays competence but also contributes to [its] development…." p. 216: "The interdependence of [competence and performance] cannot be overemphasized. Opportunities for performance are themselves developmental, and they increase the probability of the kind of learning that is necessary for developing intellective competence."
$R16_d$	+	***Textualization results in visibility/transparency*** p. 319: "… information technology had textualized... the task-related behaviors of the men and women....This parallel text presented managers with a new set of divergent choices... [including how to deal with the] increased visibility of behavior...." pp. 362-363: "Their computer-mediated exchanges had created a new electronic text that …provided DrugCorp's managers with a new window onto the organization."

#	Effect	Explanation and evidence
$R17_d$	+/-	***Uncertainty regarding the effects of visibility on apprehension (felt by many)*** p. 342: "…operators wondered how far managers would go in their reliance upon the Overview System … Would this lead to an unbearable work environment or a more just organization?" ***Positive effect of visibility on apprehension (felt by a few)*** p. 351: "I like the invisible presence of the foreman. I know he's there, but I don't have to deal with him unless I need him. At least there is some imagined independence involved." ***Negative effect of visibility on apprehension (felt by many)*** p. 352: "I hated it. Management could monitor me by the hour, and that was kind of scary."
$R18_d$	-	***Visibility/transparency undermines strength of traditional authority:*** p. 285: "A technology that informates can have a corrosive effect on … hierarchical organization …." p. 304: "as the informating process textualized their work and task execution came increasingly dependent upon witnessing and responded to data, the boundaries that once defined the domain of managerial knowledge began to blur." p. 309: "the informating process may not be sufficient to transform authority, but it does appear to erode the pragmatic claims that have lent force and credibility to the traditional managerial role."
$R19_d$	-	***Without organizational innovation, a traditional hierarchical approach to authority will remain*** p. 392: "Managers must have an awareness of the choices they face, a desire to exploit the informating capacity of the new technology, and a commitment to fundamental change in the landscape of authority if a comprehensive informating strategy is to succeed. Without this strategic commitment, the hierarchy will use technology to reproduce itself. Technological developments, in the absence of organizational innovation, will be assimilated into the status quo."
$R20_d$	+	***Same as in the overall story (see quotes in Table A2, $R5_o$).***
$R21_d$	+	***Fundamental innovation required to create opportunity to develop and express competence*** pp. 216-218: "Organizations must provide performance opportunities; that is, conditions must exist that require, invite, and nurture [intellective] skills. …If the informating process is to be exploited for its competitive opportunities, then widely distributed mastery over the new intellective grounds of knowledge becomes an acute demand. For this to occur, organizational innovation is required."
$R22_d$	+	***Same as in the overall model (see quotes in Table A2, $R4_o$)***
$R23_d$	+	***Automation reinforces the strength of traditional authority*** p. 245: "Building the smart machine preserves the boundaries between those who command and those who obey." p. 305: "Automation reproduces the status quo and consolidates the managerial hierarchy's monopoly over knowledge."
$R24_d$	+/-	***Cyclical relationship: Reduced strength increases feelings of vulnerability ($24a_d$); managers react by trying to reinstate authority ($24b_d$)*** p. 264: "The managers have a bigger job security problem than the operators....And they have to be able to show something, so they take over what we [operators] do on the ETS." p. 265: [It was no surprise that] managers… resisted operator responsibility for the ETS…. In order to sustain faith in the logic of the hierarchy and the appropriateness of their authority, it would be necessary to continually reaffirm the difference between subordinate and superior."
$R25_d$	+	***Managers' feeling of vulnerability leads them to use technology for enforcement*** p. 313: "Managers are often unnerved by the chronic uncertainties associated with …dependence …upon the subordinate. When authority fails, or appears fragile, managers frequently look toward a second dimension of power: its material aspect, which I shall refer to [as] "technique." The techniques … concern the concrete practices that can shape and control behavior….
$R26_d$	+/-	***Positive: Use of technique for enforcement shores up authority*** p. 313: Techniques of control, are used for monitoring, surveillance, detection, or record keeping. They can be a source of comfort and relief to those in a position of authority because they offer ways to shore up … the imperfections of imperative control."

#	Effect	Explanation and evidence
		p. 345: "The … expectations of the observer [manager] can be so keenly anticipated by the observed [workers] that the foreknowledge of [their] visibility [through the system] is enough to induce conformity to those [managers'] standards." ***Negative*: *Use of technique for enforcement increases resistance to authority*** pp. 344-345: "The … vocabulary of "us" and "them" invaded the language of operators towards their managers…. This mistrust was…rooted in …the feelings evoked in the silent dance of the observer and the observed. To be visible in this way evokes a sense of vulnerability and powerlessness. …[Workers'] resistance to such exposure reflects …an effort to … avoid feelings of shame…. Too much shaming [results] in a secret determination to try to get away with things when unseen."
$R27_d$	+	***Cyclical relationship: Managers and workers engage in back-and-forth efforts to retain a sense of self-control*** p. 344: "Once superiors reveal their lack of trust in the power of legitimate authority to guide behavior, then subordinates are alerted to the danger of a broken covenant. When superiors betray a tenuous faith in the hierarchy, then subordinates will develop means of self-protection. When superiors doubt their own legitimacy and so turn to technique as a means of enforcement, subordinates, too, cast about for "extralegitimate" techniques of defense."
$R28_d$	-	***Workers' use of technology as a defense reduces the strength of traditional authority*** p. 352: "The culture of adversarialism and the emphasis on the [system] as a means of unilateral control also stimulated barely latent antagonisms and evoked … sly, subversive, and frequently imaginative adaptations. For many, surveillance represented an exciting challenge: "Go ahead, try and catch me." The goal was to thwart management's efforts at omniscience."
$R29_d$	-	***Traditional authority impedes skill development*** p. 279: "Operators sensed that the ultimate barriers to their skill development involved their managers' need to revive an already tenuous sense of authority by affirming the inherent difference between manager and subordinate." ***Lower skills increase need for authority:*** p. 284: "the less attention is paid to enabling workers to make a contribution at the data interface, the less they will be capable of contributing, and the more … control necessary." ***Higher skills implies less basis for managerial authority:*** p. 250: "Teaching and learning lead to insights, doubts, and questions. There are likely to be questions that managers cannot answer. If that is the case, what gives them the right to manage?" ***Cyclical nature of relationship (authority impedes skill development; skill development undermines authority):*** p. 284: "… managers limit their subordinates' discretion because they don't trust them to be smart enough; workers withdraw because they feel they have no discretion…and so it goes, a full-blown Laingian knot." p. 309: "A redistribution of authority is both the basis upon which intellective skill development can proceed and the necessary implication of its success."
$R30_d$	+	***An information system can fail to reflect reality faithfully as a result of managers' use of it to control and subordinates' use of it to defend*** p. 354: "The WFSS had been designed as a technical means by which to control workers' behavior and increase managers' certainty …. It was … a vehicle for transmitting and legitimating "facts" to levels of the organization that no longer have contact with the concrete realities this abstracted information is meant to represent. What is even more striking is that the WFSS was able to fulfill [this] role … even when many individuals had cause to either reject or suspect the validity of these "facts." These managers colluded in treating the … text as a legitimate reflection of the workplace, because it could continue to fulfil their emotional and pragmatic requirements for certainty." p. 361: "Unilateral techniques of control tend to evoke techniques of defense from subordinates … [that can] contaminate the validity of the data."

#	Effect	Explanation and evidence
$R31_d$	-	***The ability to exploit the informating potential of IT depends on having a connection with reality*** pp. 83-85: "The crucial thing is that the symbols must derive from reliable data. That is key." … "…You have to know what is happening when something is wrong…." p. 88: "The ability to supply a referential world for the electronic data is a first and necessary step toward being able to invest the data with conceptual meaning." p. 349: "This perception of the truth value conveyed in the information system brings organization members together as brethrens in the data….[As a result] human energy can be turned toward the implementation of solutions whose appropriateness is amply demonstrated by the "facts.”"

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