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Information Technology: Analyzing Paper and Electronic Desktop Artifacts

A new organizational information/communication technology (ICT) brings changes to an individual's processes, work practices, and organizational processes. Especially challenging is the transition from a set of established and physical work processes to a set of new and cognitive work processes. These changes may create different job demands, and serious conflicts and misalignments for work practices. Such change is often unsettling and requires effort on the part of the individual to cope, interpret, adjust and resolve. This chapter analyses the role of desktop artifacts as an organizational communication medium about, and symbolic indicators of, these misalignments and adjustments. It uses examples from the case of an electronic document management system, available through desktop PCs, implemented to replace paper-based workflow and a batch-oriented mainframe system. Conceptual analyses of the misalignments and adjustments in this setting identified seven categories of desktop artifacts, and four conceptual dimensions of desktop artifacts. By understanding the forms, uses and significance of desktop artifacts -- as well as some of their disadvantages or misuses--better-designed information systems could be developed, and researchers could better understand how people adjust to changes in organizational systems by communicating with and through artifacts.

Background

Along with oral communication (such as face-to-face meetings), documents are a pervasive communication channel in organizations. Because of computing and networking technology, most documents can now either be initially created in electronic form, or converted from paper to electronic form. Electronic document management generally refers to the processing of documents as digital data files, in text or image form, or a combination of the two. If documents are initially created electronically on a computer, then that computer file can be indexed, stored, searched for, retrieved, and disseminated across organizational units and locations. They may even be used as subsequent transaction triggers, whereby some aspect of the document activates a program to perform some other task. This may occur through a workflow system, in which, when one electronic document or form is completed, the system makes that document available to the next person in the work process flow to use. Or, the document may be designed as a highly structured form in which some areas of the document represent database fields, and the data entered in that field become input to a subsequent process. For example, when one checks specific boxes on a form and faxes this completed form back to a company, the receiving system can scan it and then perform certain functions depending on which boxes are checked (e.g., sending the originator some specific materials or product). In this sense, documents can become one type of internal organizational communication-facilitation medium, as well as a component of an integrated information system process.

Similarly, if documents are initially scanned in and stored as an electronic image on a computer, the textual portions of the scanned page image can be converted to electronic text through an optical character recognition (or OCR). The text images that are processed through an OCR device are typically formatted using the code that is commonly used by a computer's default word processor (e.g., Word or Wordperfect). Hence, the OCR converted text document

is also available for additional processing as a computer file in subsequent information processing tasks.

A familiar computer-based example is a document posted on the Internet or sent as an email attachment in ".pdf" format, or "portable document format," as an image file. The user can read and print the document, but cannot usually edit it or process it; so it is a useful format for distributing final reports or copyrighted documents.

Besides improving storage, retrieval, and accuracy, shifting from paper to a computer system also presents significant benefit of reducing storage and delivery costs of documents (Sellen & Harper, 2003, p. 28). For example, almost 3% of all paper documents are misfiled, 8% are eventually lost, and one third of all forms are obsolete before they are used (pp. 28-29). Electronic document images can be tagged and processed, viewed simultaneously by multiple users across terminals and communication networks, and distributed much faster and at less cost than paper documents. See Sprague (1995) for a review of electronic document management, and Aborg and Billing (2003) for a discussion of associated physical and psychosocial disorders such as increased workload, decreased autonomy, decreased physical movement, and system use problems.

The shift from paper to paperless offices seems, then, to be an inevitable byproduct of the process of "becoming digital," a hallmark of the emerging knowledge economy (e.g., Negroponte, 1995). Teller (1998) suggests that there are, however, practical reasons for the persistence and growth of paper, including that information growth is exponential; paper – especially acid-free -- lasts longer than computer memory and media storage; paper backup is required by many laws and regulated procedures; personal files are made more possible by photocopying, compared to the prior, now obsolete, carbon-copies; and digital photocopiers now also function as primary printers.

Theoretical Explanations

Two concepts seem especially useful in understanding the user and organizational changes that may be associated with the implementation of an electronic document management system. The first is the transformation of documents from the realm of physical processing of paper to the realm of cognitive processing of symbols. The second is the role that desktop artifacts play in communicating about the progress and implications of this transformation. Brief theoretical explanations of these two concepts follow.

Transforming from the Physical to the Cognitive Realm

Kendall and Kendall (1992) define an information system as an entity composed of people, software, and hardware, which together support a broad spectrum of organizational tasks including decision-making and analysis. Early on in the diffusion of office information systems (especially desktop workstations and PCs), Weick argued that "electronic processing has made it harder, not easier, to understand events that are represented on screens" (1985, p. 51). Human understanding of events and information relies not only on an account of the information such as letters or numbers displayed on the computer screen, but on the whole event, including the extra-event information such as procedures and tangible items (Suchman, 1995).

When users must process information by different and new means or procedures (such as in digital form, represented by filenames, icons, images, folder/file directories, file types, storage and retrieval protocols, etc., through the display interface of a computer), it creates new demands and often a vague sense of unease (Weick, 1985). The information access, processing or transfer is no longer primarily physical (involving the paper) but rather is primarily cognitive. Such a change involves not only different media and formats (such as for entering data or reading

reports), but also a different set of behavioral skills. For example, the protocol, formats, and styles used in composing, processing, filing and retrieving a paper memo are different from writing, sending, reading and filing electronic mail, representing different organizational communication genres (Yates & Orlikowski, 1992).

Moreover, the shift from paper-based work flows to computer-based electronic information and processes provides opportunities to move from simply automating a job to informating it (Zuboff, 1985). Automation is the process of using technology to replace functions formerly done by humans. It does not use any processing potential to gather information about the function, the participants, or how well the work process is performed. Informating involves collecting information about the processes (meta-information) and making that available to other work processes, to the users, and to other organizational members. Informating increases the control over, and efficiency and effectiveness of, work practices, such as by providing the user with information about the job, one's performance, and the client (Davidow & Malone, 1993). Without gathering and analyzing this information, the complexities and interdependencies of a new system may make a job less comprehensible, and create conflicts between preceding and subsequent work processes.

The Desktop and its Artifacts – A Context for Understanding Information System Use

The major component of a person's work environment is the physical workspace, the area that houses a worker's furniture, supplies, equipment, decorative items, and any other items in the physical work space (Sundstrom, 1986). The ability for people to personalize the spaces they use (Sommer, 1969)--by changing and having some control over their immediate physical environments (Archea, 1977; Lucas, 1991)--is important, because the physical and social work environment affects an individual's attitudes, behavior and perceptions (Barker & Associates, 1978; Zalesny & Farace, 1987). The desktop represents an employee's personal, task and processing space (for better or worse, ranging from a dynamic and virtual organizational network, to a monitored cell-like cubicle) (Malone, 1983).

Artifacts (such as furniture, paper, office accessories, and clothes) can "communicate information about the organization and the people who work there" (Davis, 1984, p. 277). In this paper, the term "artifact" refers both to physical objects, as well as to the symbolic byproduct of other processes and phenomena (Rice, 1999). That is, artifacts are both the material medium (such as a post-it note) and the social constructions of the medium -- and it exists largely because of some other social circumstance or phenomenon (such as a post-it note representing a warning about a specific undocumented problem with an ICT). Another way to think of this is that artifacts—and media technologies generally--represent both channels for exchanging messages, and a symbolic message themselves (Rice, 1987). That is, they serve both as signal (the denotative content) and symbol (the connotative cues) (Feldman & March, 1981; Sitkin, Sutcliffe, & Barrios-Choplin, 1992).

Furthermore, artifacts are often crucial for the conduct of work--especially when tasks are interdependent (Suchman, 1995)—and are used to facilitate what Gasser (1986) calls "augmentation" or "workarounds" (e.g., phenomenon that can creatively achieve task efficiency or avoid potential pitfalls in the task processes). Indeed, some have argued that work practices should take advantage of media technologies to provide greater and more explicit support for sharing and communicating through and about visual artifacts (and for studying those processes) (Suchman & Trigg, 1991).

Gibson (1979) introduced the concept of "affordance" – a possibility for action available through characteristics and uses of objects (in particular, technologies and media). Hartson

(2003) extended the concept of "affordances" by distinguishing cognitive, physical, sensory and functional affordances. However, regardless of what types of functional technical or technological "affordances" may be available, a particular user in a given context may not perceive, use or value that affordance. Instead, a user of a new information processing system may continue to use familiar technologies to accomplish their tasks, by adjusting, bypassing, changing, or reinventing aspects of a new system that do not meet their familiar affordances, even if those familiar technologies create significant costs, errors, and interdependencies (Goodman, et al., 1990; Johnson & Rice, 1987; Majchrzak, Rice, Malhotra, King, & Ba, 2000; Rice & Gattiker, 2000).

For example, paper use persists, for rational, practical, emotional, and symbolic reasons. Paper has many different affordances, especially in combination with other technologies (such as pens or thumbtacks), supporting a wide variety of human actions (Sellen & Harper, 2003). Paper documents allow users to make notes, mark on them, and navigate or lay out the paper for different purposes flexibly, in addition to facilitating the coordination of action among organizational members, etc. Paper, in the form of binders, reports, stacks on the desktop, etc., can also serve highly important symbolic purposes (Feldman & March, 1981) to indicate, for instance, that the person sitting behind the desk is well-prepared, organized, or has access to valuable information. Conversely, the absence of paper could convey that the person is of sufficiently high status that they don't need to manage paper, or is technologically savvy because the desktop computer has replaced the paper.

So while a new technology such as electronic document-management represents possibilities for positive organizational social change, current paper-based practices represent not only costs and obstacles to such change, but also highly significant, valid and symbolic reasons for not changing. Attitudes of users toward a new information system play an important role in how well the users adjust to the system (Nelson, 1990; Rice & Aydin, 1991). These attitudes are formed by the individuals' experience with prior changes, their expectations about a new system, and their experience with the implementation process. Employees who feel that a new technology reduces their control or deskills their jobs are more resistant prior to, and less satisfied after, the introduction of new technology (Capaldo, Raffa & Zollo, 1995; Clement, Parsons, & Zelechow, 1991; Goodman, Griffith & Fenner, 1990; Kraut, Dumais & Koch, 1989; Patrickson, 1986; Pava, 1983). Thus we argue here that desktop artifacts communicate both signals and symbols about these forces for and against change, and about the transition between old and new ways of conducting organizational activities.

Empirical Findings

In order to gain a better understanding about how workers assimilate these new paperless technologies in an organization, we examined individual adjustments associated with the implementation of a document imaging service. Information gathered from a specific organizational example such as this, although not generalizable across organizations, should help develop a richer understanding of the social change implications accompanying the diffusion of ICTs into the workplace.

Methods

Participants in this study work for a large company we'll call "Syndicate" in a division we'll call "AKA," an outsourcing service which provides customer support for business users of calling cards. AKA had conducted business in the past by receiving faxes -- nearly 10,000 each week -- into a central fax room and then, once an hour, distributing via cart the faxes to the appropriate customer service representatives ("reps") by depositing them in a "hot bin" on each

representative's desk. As the reps processed these faxes, they documented their work, made a copy for the file room and placed the original work in an "out bin." The cart person would then pick up the paperwork and take it to the next person who would perform his or her service on the work, make a copy for the file room, and again place it in an "out bin." This would continue until work was completed on the original fax. The result would be copied and filed. Subsequently, there would then be multiple occasions to retrieve the files, as both specific processes and the AKA-customer relationship continued across time.

When analyzing productivity and work procedures, the company determined that it had a problem with distribution and storage of paper and tracking errors. It then decided to adopt fax/document imaging technology. Incoming faxes would be scanned directly into a digital imaging system, and images of the faxes would be electronically indexed and stamped, and made available through a network to the appropriate customer representatives or other personnel. Moreover, the company also upgraded its customer service database processing system and hardware. It replaced remote work terminals on employees' desks--connected to a mainframe computer system (i.e., a very large scale central processing system hereafter called OCS for "old customer system")--with personal computers (PCs). These were linked, in turn, to a company-wide local area network (LAN) and a client-server system (hereafter called NCS for "new customer system"). All information about each customer "account" had to be transferred or "converted" from the old system to the new one.

NCS would work differently than OCS in many ways. OCS was a text-based system that requires the user to type in specific commands at a system prompt on the terminal. All the data input from all users would be kept until the time comes to process it in a batch processing fashion during the early morning hours by the mainframe computer system. NCS provided a graphical windows interface, with icons for applications and files, and cursor-controlled dialog boxes. Hence, OCS was used to enter data, whereas NCS was designed to almost instantaneously process and update records. Under the NCS system, card holders/customers are able to get usable cards in two to 24 hours, as opposed to a couple of days under the OCS system. AKA employees would have new PC-based graphical workstations, some with the OCS interface, some with the Imaging interface, and some with both interfaces on two screens simultaneously.

The study design was based primarily on the work of Kendall and Kendall (1992), Malone (1983), and Weick (1985). Kendall and Kendall's STRuctured OBservation of the Environment (STROBE) approach provides a standard methodology and classification so that analysts may evaluate organizational elements and their influence on decision making. Deciding what desktop items to focus on was adopted from Malone's (1983) and Weick's work (1985).

The study sample was designed to represent different job functions from the five primary processes identified as areas most likely to be affected by NCS and Imaging. The participants were one volunteer from each of the five processes, with a gender ratio that was proportional to company personnel. No two participants had the same job function, as the nature of their customer service accounts differed significantly and each required separate information handling procedures.

Four field visits to the AKA company were made to develop relationships with the study participants, gain a better understanding of their organization and tasks, and assess the three phases of the system implementation (two Pre-Implementation visits, during Implementation, and Post Implementation). During each of these four visits, we interviewed the study participants for one hour and took pictures of their desktops. Participants were asked about the

significance of the placement of certain items on the desktop, the perceived importance of those items, and any problems relating to the new information system. They were encouraged to discuss issues that were of concern to them, allowing insights into issues not initially identified on the structured interview guide.

Example Implications of System Change to Desktops and Work Processes

For each implementation phase, full analyses were made to identify and describe the desktop contexts and problems noted by the participants or identified through our observations. The following provides a few illustrative examples, describing desktop artifacts, and underlying problems relating to the technical and conceptual switch from prior systems (both paper and computer) to a new (all computer) system.

Desktops. Each person's desktop included a variety of tools and artifacts such as computer, telephone, post-its, binders, files, files, forms, lists, awards, personal photographs, materials stacked on desktop and floor, etc. Figure 1 shows one person's desktop.

--- Figure 1 Goes About Here ---

One addition to the system was the peer review. AKA has employees use peer reviews to evaluate the performance of their team members and leader. The old procedure involved downloading and printing the forms, filling them out and then handing them in to the team leader. The new procedure allowed employees to fill out the forms on-line, and the team leader could later merge them for a final report (cutting and pasting were not necessary).

After several months, the implementation of imaging eliminated faxes arriving to study participants in the form of paper. One participant's old "hot bin" (which previously received new and important faxes delivered from the cart) was now used to hold that day's work to be accomplished. Her old "in bin" became storage for an important account. The other bins became holders for new and old forms. A new post-it note was on her PC as a customer-specific reminder.

Another study participant had developed and stored a pile of paper--from scrap-size to letter size with all kinds of information that she may need--slightly in front and to the right of her desktop phone. Another change was that she put a post-it note on her PC as a reminder for an experiment--which she and a client were performing to see how long the system took to respond--when information was sent by electronic feed. After the experiment was complete, it stayed on the PC, as a reminder to check the system for a different reason, but for the same client contact.

A third study participant had removed all but three of her post-it notes from the prior implementation stages. She used her "hot bin" to temporarily store completed forms -- a practice discouraged by the organization -- which she used when entering data and managing accounts to reduce the uncertainty of changing to the new system. She also kept a post-it note pad by her PC to write case numbers of faxes, whose images become obscured when the NCS window was opened simultaneously with the imaging system. That is, a flaw in system design generated the need for temporary paper artifacts.

Work processes. The organization, when it introduced the new systems, announced that it hoped to eliminate large amounts of paper as well as the errors and retrieval problems associated with it. However, all participants reported concerns that the increased amount of paper they had seemed to accumulate, with new binders and multi-page handouts of system update information. For example, some post-it-notes were one visible indication that the new imaging system in fact offered no quick or easy reminders as to how to perform certain work functions.

While the trial system was easier to view (because of its graphical interface) than OCS, it required double and triple entry of the same information (such as customer contact name),

whereas the old system automatically filled in the repeated fields. Finding filed faxes through the imaging system was difficult, even though one of the motivations for the imaging system was to overcome difficulties in finding paper faxes. This is because when the fax was scanned into the imaging system, it was electronically "stamped" with a sequential case number that was different from the confirmation numbers possessed and used by the external clients.. As both the study participants and their clients were accustomed to using the same confirmation numbers, the new system-assigned sequential case number created new retrieval problems instead of solving the old ones.

It often took longer to find information on NCS because the customer service representatives were less familiar with where the information was stored and the system prompts would not allow users to exit without completing every field on the screen. The new system's extensive reliance on a graphical user interface and the mousing function, in fact, slowed down the whole process, when compared to the quickness of executing the keystrokes for data entry used by the OCS system before the conversion.

Even though the organization expected that processing time would be reduced significantly, the time required for NCS to interface with another processing system — the one that controlled the actual ordering of new calling cards by processing these order in batch jobs each night--increased. As a result, the high-speed N**CS** actually created a bottleneck on this other processing system, which operates at a considerably slower speed. This particular system interdependency had not been thought of in advance, though it was eventually fixed.

There was also an unexpected problem under NCS, one that involved a missing feature, which was needed to segment the main file into subfiles that could be easily retrieved, processed and stored. This problem was caused by the interfacing system sending the company one large file that contained all the necessary information (such as updated information on the client companies, business calling card fees, etc.) each night. While under OCS, the system would receive the file and then break up the file into usable self-contained subfiles. Once discovered, the problem was corrected by giving NCS the capability to break down the file.

Several study participants reported that although the system seemed to run faster, it would sometimes "lock up," leaving the user unable to do anything. This was due to system problems associated with having more users on the system than it was designed to handle (which again was paradoxical given that another goal of the system was to eventually also allow all customers to access their own accounts online at any given time). The design team was trying to solve this problem.

There was yet another problem involving the system's inability to properly input or encode low-resolution or blurry information that came from the electronic feed of scanned paper images, among others. This problem created a backlog of paper for re-input and filing, resulting in the need to have the study participants (or customer service representatives) redo every transaction over the phone and on paper. Hence, the new system helped generate additional, media-based, transactions as well as media transformations that had not existed before.

One study participant also reported that not all client contact names for each account properly transferred in conversion between OCS and NCS. Consequently, if a client request was not a pre-established choice on the screen, the customer service representative would have to choose a different (incorrect) option to designate how the call came in and from whom, while adding an extra notation in the account to explain how the transaction was completed and by whom. Thus system and design flaws created certain situations that generated not only more

information and informal paper work than the traditional process, but also more opportunities for error and delay.

Conceptual Analyses

The rich over-time detail from the interviews, observations, and photographs provided the basis for two kinds of conceptual analyses, derived from the theoretical explanations described above. Those included: the transformation of paper documents from the physical to the cognitive, desktop artifacts (as signal and symbol, as medium and content), affordances, and adaptation/reinvention.

Typology of seven desktop artifacts. By inspecting the participants' comments and our photographs of their desktops, we identified seven types of desktop artifacts. (1) System and task-related information, such as procedures for processing work, was usually provided by company management to the employees in the static form of paper (with unchanging information) in binders. However, the system and task-related procedures not only changed, but one of the goals of the new system was to make changes in procedures available more quickly, eventually online. (2) Personal items ranged from the static awards and family photographs to frequently changing notes about errands and social events (including co-worker birthdays). (3) Temporary information included items generated by the management personnel (e.g., memos or one-page notices) and by the study participants (e.g., post-it notes). This type of information could be generated while someone was waiting for something to be adapted/updated, a note about a file folder that was moving between offices, or an unscheduled system problem. (4) Process-related items were usually in the form of post-it notes, generated because of a temporary change in system protocol (hence not included in the binders) or because the individual wanted a quick reference for how to execute a particular process. (5) Frequency/importance of use of a set of information was indicated in many cases by how close or far the paper information was relative to their central focus point -- the PC (similar to what Malone found in his analysis (1983) of how people organized their desktops). So the PC becomes sort of a window on information, literally and figuratively, representing not just a focal point for information access and processing, but also a symbolic landmark for indicators of the importance of other paper information. (6) Unsupported by the system describes those items (usually post-it notes) that individuals used to keep track of information which was unavailable on the system, deemed "difficult" to access (i.e., representing an error or a temporary solution), or unable to be seen or stored in the system.

The last of the seven types of desktop artifacts was (7) reminders. Reminders created by the study participants typically referenced a particular event or idea. Some information needed to be constantly available, both for immediate use as well as for potential future use. Important phone lists were created by all participants (in one case, made accessible to all employees through the LAN) and were shorter versions of the ones issued to all employees in a binder by the company. Even when information about a process or the system would come to participants on letter-sized paper, depending on the perceived importance of the information, some participants made themselves another reminder on a smaller piece of paper and posted that on their bulletin boards or elsewhere on their desktop.

When participants were asked if they used the notepad feature on their PCs--which allowed users to make notes and store them on the system--each answered that it was inconvenient to use (noting that a reminder stored within the system's notepad feature wasn't really a reminder). All, even the most technical participant, said that it was more convenient to

have a piece of paper that was visible by just turning one's head or moving one's eyes instead of opening another application on the computer.

Table One provides some examples of new desktop information artifacts that are appearing or old artifacts that are disappearing through the different implementation phases of the study period.

--- Table One Goes About Here ---

Four conceptual dimensions of desktop information artifacts. (1) Paper vs. electronic information. As discussed earlier, paper and computer files both have different "affordances," which may be more or less useful to different people and different jobs. In spite of the move to the Imaging system and the graphical customer service system, paper still exists on the desktops of the AKA information workers. This is because the complex system commands made it difficult to locate and retrieve the computer versions and users could not compare documents side-by-side on the screen. Further, in some instances, new paper records and forms were created as a by-product of the implementation, to make up for limitations of the system or to provide an interface between the old and new systems. Hence excess space (to store even worthless paper) is a cheaper resource than scarce time (to filter and evaluate and toss old paper). Groleau (1995) also found that even after computerization, office workers continued to use paper files which the new system was supposed to replace.

(2) Materiality and complexity of information. As Weick (1985) and others noted, electronic information artifacts are no less pervasive or important than paper-based artifacts, but are less visible and tangible. Both electronic and paper artifacts manifest two conceptually different aspects of information: amount/presence (materiality), and complexity/uncertainty. With respect to materiality, too great an amount of material (such as paper) or electronic information (such as individual, compressed, or concatenated files) leads to problems of storage (desktop space, file cabinets, network memory capacity, or disk storage), retrieval (finding and indexing), delay (time to find, convert to a useful format, delivery), and understanding (both cognitive and organizational overload). Note that similar problems of retrieval seem to take on different forms in paper versus electronic environments: not being able to find a paper fax corresponds, in some ways, to when the system "goes down" or "locks-up" or "response time is poor;" in neither case can the customer representative retrieve the customer's records.

The main advantage of accessing paper-based information is that the delivery system (the paper) generally needs no additional processing in order for a person to use the information on it; the obvious disadvantage here is that the information takes up physical space. That is, the artifact of its material delivery system generates problems and costs that are not inherent in the contained information (Rice, 1999). By comparison, electronic information separates the substantive information from the material artifact. A notable disadvantage here is that information requires sometimes considerable additional processing before it can be accessed, display, and interpreted

With respect to complexity (e.g., what Rogers, 2003, defines as the user's perception of difficulty, uncertainty, or learning costs of an innovation), an information artifact may represent a simplification of an inherently complex situation (such as information about a system error or an unfamiliar procedure) that may require further system encoding and decoding before its meanings could be clearly understood. This artifact may also indicate the unpredictability yet immediacy of some information (such as a reminder to call an important customer when a certain transaction occurs) that may demand an instant system response to accommodate its temporal nature. Information artifacts may also represent a temporary, necessary but costly media

transformation (such as writing down a system-generated document number from a computer database field on to a piece of paper, that will then be further communicated through, for instance, a phone call to a customer, who must then again write it on a piece of paper or type it into a computer) (Rice & Bair, 1984).

Moreover, information artifacts may even serve as an indication of poor synchronization across processes, actors or information sources that should have been coordinated or integrated in advance to ensure an unequivocal information flow. For example, even though the new system was intended to provide near-immediate updating, the upstream input system still operated on an over-night batch update process, causing delays of up to a day, prompting the reps to generate various notes and backup paper to keep track of what was supposed to be processed and when.

(3) Paper and electronic forms as communication media. Information artifacts are, in many ways, a communication medium -- between information elements, people, task processes, work units, interfaces, systems and organizations. This is especially true of forms (Sless, 1988), which are transformation and transaction interfaces between different communication systems, processes or entities. Indeed, the costs of printing forms are usually less than 5% of all costs associated with using those forms (Barnett, 1988, p 15). They can shape the nature and content of organizational information as they require, constrain, and filter inputs. They "present a picture of the organization's activities" (Barnett, 1988, p 12; see also his intriguing short history of forms, Chapter 1).

One advantage of paper forms is that they are physically decoupled from other system processes, so that incomplete paper forms can be temporarily set aside, while a user performs other tasks. Some AKA workers continued to use old paper forms during the implementation process, even when new versions were available through the system. Here, the old forms were desktop artifacts serving as symbolic interfaces for the individual between two system regimes, providing a sense of continuity and security during a time of uncertainty. From the perspective of diffusion theory, this usage of these old paper forms would be considered highly compatible with user needs and values (what Rogers, 2003, refers to as the extent to which potential adopters think an innovation fits in with prior norms, values, preferences, ways of doing things, and integration with other systems).

By comparison, on-screen forms, especially in real-time processing systems, may fail or create problems. When a system presents such forms on the entire screen within a sequential process, the system becomes unavailable for other activities (including searching for the information!) while the user is waiting for the necessary information. However, computer forms have a wide variety of benefits, including making the entered information available throughout the organization, providing on-screen error-detection and help, preventing the use of out-of-date forms, etc.

Thus both paper and online forms are part of the desktop, often serving multiple purposes, as well as providing areas of concern, limits and inflexibility for system designers, implementers, users, and customers. Indeed, informating (measures collected from an information system about a work process; Zuboff, 1985) may be used to provide users control over their processes, or to monitor, control, and routinize work (Lehr & Rice, 2005). Similar, more general points about the dual role of information technologies in both integrating as well as controlling work and information flow have been made by many others (see, for example, Clement, Parsons, & Zelechow, 1991; Orlikowski, 1991).

(4) Artifacts as meta-information. The content, or even the mere presence, of desktop artifacts may be serving as an indicator of other issues, problems or implications of system change – that is, meta-information about information (Rice, 1999)--in much less intentional or intended ways than "informating" (Zuboff, 1985). Changes in the shape, size color and location of artifacts in relation to desktop surface may be meta-information about the shifting relevance of certain kinds of --such as a post-it directly on the PC-- or they may appear or disappear as system problems arise and are resolved. Artifacts may be meta-information about "augmentation" or "work-arounds" (Gasser, 1986), reflecting how people work around inadequate computing systems by adjusting data or procedures or using backup (manual or computer) systems. An old paper form, for example, can serve as a backup system to a new on-screen electronic document that a user doesn't completely trust.

Other researchers have noted that paper artifacts (such as post-its) are frequently used to draw one's attention to a problem, explain cryptic system information, or explain otherwise tacit system knowledge (such as what an error message on a photocopier means) (Sellen & Harper, 2003, p. 140). Indeed, an internal economic analysis may well find that both desktop and electronic landscapes are strewn with negative externalities or shadow costs (costs or negative consequences that users and customers pay for but are never accounted for through traditional system costs) (Rice & Bair, 1984; Ryan & Harrison, 2000). Artifacts can be some of the indicators of shadow costs – time and money involved in a process that do not directly contribute to the value of the process, and are not included in any accounting record (Rice & Bair, 1984).

Finally, some artifacts endure because they continue to refer to some underlying common issue, account, or problem, even though the surface information is interpreted differently or has changed (Sellen & Harper, 2003, p. 63, referring to Kidd, 1994). For example, a post-it note that used to serve a reminder about an updated customer number remains because it now serves as a reminder of a different problem relating to that same contact's company. Conversely, an artifact may continue in its material form, but be used to represent or store different information, because their old uses have been transformed by a new information system.

Social Change Implications

The transformation of documents from the physical paper realm to the cognitive symbolic realm generated reasons for users to create desktop artifacts (mostly paper, but also some using the system itself) to help track no longer physically visible work practices and system misalignments. People created and used these desktop artifacts, as both signal and symbol, medium and content, to help them adapt to the new electronic document management system. The affordances of both paper and electronic documents are not mutually exclusive, and are highly contextual, regardless of the obvious benefits of a new ICT. And organizational members adapted, reinvented and personalized both pre-existing artifacts, and new ones, to communicate to themselves and with others about the new cognitive demands as well as system adjustments and misalignments. These included system and task-related information, personal items, temporary information, process-related items, frequency of use indicators, items unsupported by the system, and reminders.

Major conceptual dimensions of such artifacts that contribute to understanding changes associated with a new ICT include paper vs. electronic information, materiality and complexity of physical and electronic information, paper and electronic organizational forms (literally, the forms used within organizational settings) as communication media, and artifacts as meta-information. The items placed or posted there communicated what was not working well, what information was missing, and what processes were causing the individuals difficulty, etc.

Indeed, system implementation strategies should consider evaluating and tracking the presence of and changes in desktop artifacts, as part of initial user information needs assessment and systems analysis, as part of system evaluation and ongoing adaptation, and as evidence about possible organizational and social changes associated with new ICTs.

What are some wider potential implications of electronic document management systems and desktop artifacts? Certainly this specific ICT is not as inherently significant as the development of carbon paper, filing systems and cabinets, standardized paper form, the typewriter, electricity, the telephone, the elevator, and other innovations transformed the nature of office work in the late 1800s (Johnson & Rice, 1987); the development of scientific management and organizational communication genres such as the memo, paper and information filing systems, and mechanical adding machines (Yates, 1989, 2005); and the rise of electronic and computer media such as the radio, television, facsimile, calculators, magnetic storage typewriters, word processors, and electronic data processing transformed the nature of office work in the 1970s (see Chandler & Cortada, 2000; Johnson & Rice, 1987; Yates & van Maanen, 2001). Yet it incorporates many aspects of each of these transformational technologies, processing and facilitating both information processing and communication interaction. Thus many of the same work, organizational and social changes may be associated with the transformation of paper documents to computer icons, and the transient desktop artifacts that accompany the implementation of such systems.

Such changes may range from the very personal electronic and physical landscape of individuals' desktops, to the flow and processing requirements of communication and information within and among organizational units, to how external customers (both other organizations and individual customers) interact with and conceptualize their relationship with organizations (including government agencies, etc.). For example, the transformation to work-flow computer symbols from physical paper may increase organization-wide access to customer information and responses to customer requests, but may also make the representative-customer relationship more abstract and ephemeral. Because desktop artifacts are indicators of possibly system problems and difficulties in individual cognitive processing of ICT routines, individuals may have more difficulty transferring to new positions, and their replacements may have more difficulty figuring out how to actually accomplish the work.

The transfer of workflow and relationship indicators from physical paper to internal symbols may reduce the number of and accessibility to cues about dysfunctional system processes, making the work experience and organizational functioning more cryptic and difficult to diagnose and repair. This transformation but may also reduce many sources of error and delay associated with unnecessary media transformations, and constraints of time and space associated with physical materials. And the shift from paper to online forms may both avoid errors and confusion from using out-of-date forms, while also quickening the pace at which forms change because there is no need to reprint, and redistribute paper forms throughout an organization. These are just a few examples of the wider implications of the implementation of, and adaptation to, electronic document management systems in particular, and organizational ICTs in general.

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Table One.
Example disappearing and new desktop artifacts, by category of desktop information and implementation phase

	Implementation Phase			
Categories of desktop information	Initial	Pre-Implementation	Implementation	Post-Implementation
System (NCS/ Imaging) & M&Ps information	**Imaging binders in cabinets**		**NCS binders in cabinets**	*All old binders (by person who was leaving)* *Peer review forms replaced by an online process*
Personal	**Post-it notes**			
Temporary			**Post-it notes with passwords, backup logins, processes for NCS-transition** **Post-it note for an account which grew in importance** **A post-it note which replaced an OCS form which was about to be phased out**	**Post-it notes for fax case #s** **Post-it notes for packages sent that day or expected to be received** *Post it notes with implementation-transition information*
Process-related	**OCS process post-it note**		**Processes for NCS-transition** *OCS process post-it notes*	**Paper "to dos" and forms stored in the old "hot bin"**
Frequency of use			**Paper copy of list of necessary information (also more difficult to view in NCS compared to OCS)** **Binder of M&Ps moved closer to PC**	
Unsupported by the system – NCS or Imaging		**Post-it notes with fax #s matched to case #s**	**M&Ps not online, have to use the binder** **Paper forms required for NCS but not residing in NCS or on the LAN**	**Pieces of paper and post-it notes with information for rep who has no good way to store them**
Reminders	**Fax # on post-it notes to remind rep to check status of fax**	**New post-it notes** *Post-it note of a completed task*	**Post-it note of the path (filenames) to access LAN phone list** **Taped down post-it note**	**Post-it notes with procedures and passwords** **Post-it notes for customer-specific issues** *Wall lists of accounts with input restrictions*

Note: *italics* - disappearing items; **bold** - new items

Figure 1.

Example Desktop

Key Terms

Affordance
Automating vs informating
Desktop artifact
Document imaging
Forms as communication media
Materiality and complexity of physical and electronic media
Media transformations
Meta-information
Physicial and cognitive processing
Reinvention
Signal and symbol
System implementation