Desktop Artifacts: A Site for Individual Adjustment to New Information Systems[1]

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This study analyzes a specific manifestation of individual adjustments associated with the implementation of a document imaging and a customer service database system: how the physical landscapes of users' desktops change. While the participants had different job functions and different levels of comfort with technology, all had on their desktops paper artifacts related to system changes. Many of these items were placed on or around their computer monitors, and were used as reminders, process summaries, indicators of system failures of poor interface design, or temporary, transitional information. Individuals were often reluctant to dispose of paper related to the old system even though they no longer used that system to process information. More generally, conceptual analyses identified several underlying dimensions of paper desktop artifacts: paper/electronic, materiality/complexity, forms as organizational media, and artifact as meta-information. Physical desktop artifacts play a useful role in individuals' adjustment to a new system, can provide valuable information for systems analysis and evaluation, and should be included in research on both traditional and new communication and information systems.

Key words: system implementation, document imaging, desktop artifacts

An information system consists of people, software, and hardware, which together support a broad spectrum of organizational tasks including decision making and analysis (Kendall & Kendall, 1992). Computer-based information and communications systems have become integral aspects of organizations since the rise of "data processing" and "office automation" in the 1970s and 80s, so are pervasive aspects of individuals' organizational environments. But they are not necessarily easy to use, understandable, or successful.

Early on in the diffusion of office workstations, Weick argued that "electronic processing has made it harder, not easier, to understand events that

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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. When users, who are accustomed to accomplishing their work in a particular manner, must process information by different means or procedures (such as in digital form, through a computer), it causes them unease (Weick, 1985). The information is no longer physical (the piece of paper) but rather is conceptual (represented through and in screens, filenames and databases). Such a change involves not only different forms (such as for entering data or reading reports), but also different behaviors. For example, the protocol, formats, and styles used in composing, processing, filing and retrieving a memo are different from writing electronic mail, representing different organizational communication genres (Yates & Orlikowski, 1992). Technology typically requires users to adjust, but individuals may also influence, adapt, or reinvent technology (Capaldo, Raffa & Zollo, 1995; Goodman, et al., 1990; Johnson & Rice, 1987; Nelson, 1990; Patrickson, 1986; Rice & Gattiker, 2000). Thus a new organizational information system brings changes to individuals' processes, work practices, and organizational environments. Change is often unsettling and problematic, requiring effort on the part of the individual to understand, cope and adjust; simultaneously the system may have to be adjusted to accommodate users' practices and insights, and overcome design flaws, errors, and missing resources.

Desktops and Paper Artifacts

The major component of the work environment is the workspace, the area for work assigned to a specific individual including furniture, supplies, equipment, decorative items, and any other items in the physical space (Sundstrom, 1986). The ability for people to personalize the spaces they use (Sommer, 1969), and change and have some control over their immediate physical environments (Lucas, 1991) is important because the work environment affects individuals' attitudes, behavior and perceptions (Barker & Associates, 1978; Zalesny & Farace, 1987). The desktop represents an employee's personal, task and process space (for better or worse, ranging from a dynamic and virtual organizational network, to a monitored cell-like cubicle) (Malone, 1983). The desktop contains the tools which the employee uses everyday, sources of information, and work in various stages of completion. It also provides a space and context for artifacts.

Artifacts (such as furniture, paper, office accessories, clothes, and desktops) "communicate information about the organization and the people who work there" (Davis, 1984, p. 277). Here, the term "artifact" refers both to physical objects as well as to the symbolic byproduct of other processes and phenomena (Rice, 1999). That is, informational artifacts are both the material medium (such

as a post-it note) and the social constructions of the medium as it becomes familiar and taken-for-granted even though it is "caused" or "created" or "appears" largely because of some other phenomenon (such as a post-it note representing a warning about specific undocumented problem with a new information system).

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). Artifacts can be 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). Indeed, an internal economic analysis may well find that both desktop (paper and electronic) landscapes are strewn with externalities that users and customers pay for but are never accounted for through traditional system costs (Ryan & Harrison, 2000).

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's domain by distinguishing cognitive, physical, sensory and functional affordances. 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). For example, paper documents allow readers to make notes or other marks on them, allow flexible navigation and manipulation, allow users to position or lay out the paper for different purposes, facilitate the coordination of action among organizational members, etc. Groleau (1995) found that even after computerization, office workers continued to use paper files which the new system was supposed to replace, both because the complex system commands made it difficult to locate and retrieve the computer versions, and because users could not compare documents side-by-side on the screen. Teller (1998) suggests other 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 are primary printers.

There are, of course, many limits to paper such as it cannot be used in multiple places, remotely accessed, used by more than a very few people at once, easily revised or integrated with other documents, or display multi-media or dynamic content (pp. 31-32). Besides improving storage, retrieval, and accuracy, shifting from paper to a computer system also has the unglamorous but significant benefit of reducing storage and delivery costs (Sellen & Harper, 2003, p. 28) (such as misfiling, filing cabinets, retail space, human labor, fuel, transportation, mailing, etc.). 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).

But just because a designer intends for a new medium/system to have certain "affordances", and even if some people perceive that technology to exhibit those "affordances", and even if objective measures indicate that a technology does offer those "affordances", a particular user in a given context may not perceive, use or value that affordance. Instead, they may continue to use familiar technologies that seem to provide the affordances they need to accomplish their tasks, even if those familiar technologies create significant costs, errors, and interdependencies. Certainly physical, especially visible, artifacts – such as paper notes – are crucial for the conduct of work, especially when tasks are interdependent (Suchman, 1995). 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).

Goals of this Study

This study considers the implementation of a document imaging and customer service database system with three main goals in mind:

1. to identify some ways in which users and a new system need to adjust over time
2. to identify and analyze types and uses of paper-based desktop artifacts (as manifestations of this adjustment), which could help guide future research
3. to show how understanding the forms, uses, misuses, disadvantages and significance of desktop artifacts, designers, training and support personnel, and managers can foster better-designed systems, and more informed and supported adjustment during implementation.

Methods

Site and System

The individuals who participated in this study work for a large company called "Syndicate", owned by a large multinational corporation. The study's participants worked at a division of Syndicate called "AKA", which provides customer support for business users of calling cards. AKA has two locations, one for customer service and the other approximately one hundred fifty miles away for the developers of the new systems. Participants in this study were located at the customer service site.

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. Of course, there would then be multiple occasions to retrieve the files, as both specific processes and the AKA-customer relationship continued across time.

In analyzing productivity and work procedures, the company determined that it had a problem with distribution and storage of paper and tracking errors. The company realized the opportunity for fax imaging technology (see Sprague, 1995, for a review of electronic document management, and Aborg & Billing, 2003, for a discussion of associated physical and psychosocial disorders such as increased workload, less autonomy, less physical movement, and system use problems). They contracted with an outside vendor for an imaging system. 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. They also decided to upgrade their customer service database processing system and hardware. Previously, employees had remote terminals on their desks connected to a mainframe system (hereafter called OCS for "old customer system"). These were replaced with personal computers (PCs), a company-wide local area network (LAN), and a client-server system (hereafter called NCS for "new customer system"). All information about each "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 (requiring typed commands) connected to a mainframe, while NCS provided a PC/graphical windows interface. The system also would interface differently with the systems to which it was connected. For example, OCS was used to enter data, but the actual transaction processing was done by batch processing at night, whereas NCS was designed to almost instantaneously process and update records. This would enable card holders to get usable cards in two to 24 hours (NCS) as opposed to a couple of days (OCS). AKA users 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.

Participants

The small sample of five people was chosen to represent different job functions from the five primary processes affected by NCS and Imaging. These five processes were identified by organizational contacts as representing the areas most likely to experience changes from the new system. The participants were one volunteer from each of the five processes: Robin (customer service representative, responsible for card management); Marie (customer service representative for a different set of customers, and liaison with another card

service company); Tom (handles any changes in features and coverage of cards, both from new and ongoing companies); Stephanie (fax coordinator in the telecommunications area, responsible for receiving, scanning, and distributing faxed information to the appropriate people); and Ann (in charge of product protection services, such as de-activating cards and updating card changes in the system). The gender ratio was consistent with the personnel of the company. No two participants had the same job function; the nature of the accounts the two customer services representatives handle was significantly different so as to require different procedures for accomplishing work. We used this purposive sampling strategy to maximize the variance in possible adjustments to the system and use of artifacts across five participants.

Research Design

We made five visits (June, September, December, February and March) to the AKA company. The Initial visit was intended to develop relationships with the participants and a better understanding of their organization and tasks. The other four visits were conducted during Pre-Implementation, Use of the Pilot/Trial System, Implementation, and Post Implementation. During each visit to the company, we interviewed the participants for one hour and took pictures of their desktops. The interview questions were identical for each participant and were similar on each visit. The interviews were semi-structured with a few questions. These questions were derived from the work of Kendall and Kendall (1992), Malone (1983), and Weick (1985), who discuss the analysis of organizational elements, especially desktops. Users 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. Participants were encouraged to discuss issues that were of concern to them, allowing insights into issues not initially identified on the structured interview guide.

Implementation Phases and Desktop Contexts

Here we will describe only a few (due to space limitations) of the desktop contexts and problems noted by the participants or identified through our observations, which generated the use of desktop artifacts, to provide an idea of the grounds for summarizing problems during each phase, and the subsequent conceptual analyses.

Initial and Trial/Pilot Phases

The organization, during the Initial and Trial/Pilot phases, announced that it hoped to eliminate large amounts of paper and the errors and retrieval problems associated with it.

However, all participants reported concerns that the amount of paper they had seemed to be increasing, with new binders and multi-page handouts of

system update information. For example, some post-its place on or near computer monitors were one visible indication that the new imaging system in fact offered no quick or easy reminders as to how to perform certain functions. Tom reported that he still needed to look in his old paper files and suggested the value of a central repository of data. Another problem Tom discussed was that the previous message in the office had been “Don't make hard copies” on paper, whereas the message now was “Don't clog up the LAN”.

Marie reported that the initial trial system, while easier to view (because of its graphical interface) than OCS, required double and triple entry of the same information (such as customer contact name), whereas the old system automatically filled in the repeated fields. The design of this online form did not take into account repeated content across fields.

Ann reported that finding filed faxes through the imaging system was difficult. This problem was particularly ironic as one of the motivations for the imaging system was to overcome difficulties in finding paper faxes. The problem was that when the fax was scanned into the imaging system, it was electronically “stamped” with a sequential case number that was in no way logically related to the confirmation numbers possessed by the client contacts who called with questions. These confirmation numbers included the date and time the fax was processed and which individual at AKA did the processing. Both the customer service representatives and the clients used the same confirmation numbers and everyone was used to them. So the new system-assigned sequential case number created new rather than solved old retrieval problems. The problems Stephanie reported were all related to faxes – ranging from the system going down and creating a backlog, to faxes which were missing company names and numbers, to system accessories (e.g., electronic mail) not working correctly.

Implementation Phase

Robin reported that finding faxes had not gotten easier. The search mechanisms for imaging were inadequate given the information possessed by the rep and the client. Searching required time and patience for trial and error, or a great personal memory for the specifics of an incoming fax. This went directly against a goal that management had for imaging and NCS: making the information on every account available to all reps (on the LAN and no longer tied to one copy of paper) so that any rep could process any client. Marie reported that it took longer to find information on NCS because she was less familiar with where the information was stored. In addition, the system prompts would not allow the user to exit without completing every field on the screen. Yet, without a deep enough understanding of the system, filling out the screen completely required considerable trial and error (and remember that the screen would not automatically populate equivalent fields).

Post-Implementation Phase

At this point, the conversion of accounts had been completed. Tom's desktop changed dramatically. He was to finish working at this company two weeks after this visit. The most drastic change was that he discarded approximately 18 of 20 binders (some had been there for three or four years) in his cabinet. The only binders left were of the new system and a project binder. Tom said that he probably would have cleaned out the binders eventually, but because he was leaving, that task received a higher priority. Another small change was Tom's use of a daily post-it note stuck to his phone table surface. This note served as a reminder of which packages of information he sent or expected to receive from the out-of-state group with whom he was communicating. A change that involved more than just Tom's desktop area alone was that the "out board", formerly a whiteboard list of employees out for the day, was put on the system. This eliminated the need for the team leader to go and check the board and produce a list for his team of people who were out. Another addition to the system was the peer review. AKA's employees used 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).

Robin's desktop underwent some subtle changes over time. After several months, the implementation of imaging eliminated faxes arriving to Robin in the form of paper. Her old "hot bin", which previously received important faxes via 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.

Marie had some changes to her desktop. The first was a pile which she stored slightly in front and to the right of her phone. This pile contained pieces of paper from scrap-size to letter size with all kinds of information. Marie said that she didn't know if she would need some of that information and that there was no good way to store it while keeping it at hand. Marie mentioned that if she had a paper recycle bin which was emptied weekly, she could throw out the paper but still be able to retrieve it should she wish; one cannot do that using the traditional wastepaper basket which is emptied daily. Another change was that Marie put a post-it note on her PC as a reminder for an experiment 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 then became a reminder to check the system for a different reason, but for the same client contact. Marie's desktop landscape was accumulating paper and post-it notes.

Ann had removed all but three of her post-it notes. Two of those were from pre-implementation (e.g., her team leader's pager number). Ann used her “hot bin” to temporarily store completed forms which she used when entering data and managing accounts. The organization discouraged use of old forms, but Ann continued to use them for personal security reasons. Ann also removed from the wall the lists of restrictions for which accounts she was and was not allowed to input information, as these restrictions no longer applied under the new system. Ann 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 imaging: a flaw in system design generated the need for temporary paper artifacts.

Robin 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 customers to access their accounts online).

The main problem Marie reported was that due to the unpredictability of opportunities to input information into the system, a backlog of paper for input and filing had accumulated. This problem resulted from the low reliability of information coming into the system by electronic feed. The technology team was not sure they had fixed the problems with the feeds. As a result, the reps had to do every transaction over the phone (as opposed to receiving information via the feed) and on paper (as opposed to entering it directly into NCS). Here, the new system created additional, media-based, transactions and media transformations that had not existed before.

Ann reported a similar problem of low reliability of electronic feeds. She also had to keep paper records because the process was supposed to allow for input into one particular system first and then near-immediate input into NCS. However, at this visit, this second input could not be done until the following day. Another problem was that not all contact names for each account transferred in conversion between OCS and NCS. As a result, if a client contact called in a request but that request was not a pre-established choice on the screen, Ann could not select the name in NCS. This problem required that Ann 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 accomplished and who actually made the request.

Thus system and design flaws created some situations that generated not only more information, informal paper, and desktop artifacts than the traditional process, but also more opportunities for error and delay. However, it did remove nearly 10,000 paper faxes being carted throughout the organization every week!

Conceptual Analyses

The rich over-time detail (only barely hinted at from the above descriptions) from the interviews, observations, and photographs provided the basis for two kinds of conceptual analyses: a typology of seven desktop information artifacts, which complements Sellen and Harper's (2003, p. 83) typology of work-related uses of paper for reading (such as to skim, remind, learn, cross-reference, support discussion, etc.), and four conceptual dimensions of these information artifacts: paper/electronic, materiality/complexity, forms as organizational media, and meta-information.

Typology of Desktop Artifacts

System and task-related information was usually provided by AKA management in the form of paper in binders (such as the M&Ps). This information was, for the most part, conceptualized as unchanging or static. In fact, the M&Ps not only changed as solutions to problems were disseminated, but one of the goals of the new system was to make changes in M&Ps available more quickly, eventually online. Personal items ranged from the static awards and family photographs to frequently changing notes about errands and social events (including co-worker birthdays). Temporary information was generated by AKA management as well as the individuals themselves. The items from management were memos or one-page notices while the items created by individuals were most often in the form of post-it notes. Such information was relevant only for a short period of time, such as 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. 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. Frequency of use of a set of information was indicated in many cases by how close or far it was relative to their central focus point, the PC. Unsupported by the system describes those items (usually post-it notes) that individuals used to keep track of information which either was not available on the system, was deemed "difficult" to access, represented an error or a temporary solution, or was unable to be seen or stored in the system.

Reminders were created by the individuals and could be designed to last for one day or for many months. They were typically in reference to a particular event or idea. It would be incorrect to conceptualize organizational information as something one could simply store and retrieve when needed. Some information needs to be constantly available, both for immediate use as well as to indicate the value or need for some other information at a later, perhaps unpredictable, time. The ability to find and understand information is developed through experience, personal memory, associations, and cues from other artifacts (Rice, McCreadie & Chang, 2001). However, people, because of their

cognitive processing limits, cannot remember everything, especially in the context of implementing a new system and the associated updates, changes, corrections, and adaptations. But information systems, because of their symbolic processing limits, cannot know when or in what context any particular information might be needed by that person. So reminder artifacts physically represent one kind of gap between human and computer systems. As with "frequency of use" indicators, the closer the reminder is placed to the central focus of the desktop (in this study, the PC), the more important it seems to be for the user (Malone, 1983). Some permanent reminders were paper attached directly to the PC. So the PC becomes sort of a window on information, literally and figuratively, representing not just a focal point for information access, but also a symbolic landmark for indicators of the importance of information.

Reminders were typically small in size. All participants created their own lists of important phone numbers (in one case, accessible to all employees through the LAN) and these were shorter versions of the ones issued to employees in a binder. 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 another reminder for themselves on a smaller piece of paper. 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. 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. Participants emphasized the importance of the visible attribute by pointing out that a reminder on the notepad feature wasn't really a reminder, because you couldn't always see it. One participant joked that she would need to put a post-it reminder on her PC to remember to look in the computer notepad for the reminder!

Table One provides examples of new or disappearing artifacts in each of these seven categories of desktop artifacts over the different implementation phases.

Conceptual Dimensions of Desktop Artifacts

Paper vs. electronic information. In spite of the move to the Imaging system and the graphical customer service system, paper still existed on the desktops of the participants. The participants continued to keep the binders and any other paper given to them by AKA management even though it was no longer truly relevant to their jobs. All participants expressed reservation at the thought of disposing of the paper. The only individual who did dispose of unnecessary paper and binders was Tom, primarily because he was leaving the organization. Overall, the amount of paper was only slightly reduced, much less than expected. Further, it seemed that the paper reduction came from less paper input into the whole AKA system (because of the imaging and archiving of original

Table 1. 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**
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**	
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*
Reminders-NCS				**Post-it notes with procedures and passwords**
Reminders-non NCS	**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 for customer-specific issues** *Wall lists of accounts with input restrictions*
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**
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"**

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

faxes instead of carting the originals to each representative) and not significantly from discarding old and irrelevant paper. In other words, the passive inertia of the physical presence of paper often outweighs any active re-evaluation of the value of old paper. Perhaps excess space (to store even worthless paper) is a cheaper resource than scarce time (to filter and evaluate and toss old paper). 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.

Materiality and complexity of physical and electronic information. Electronic artifacts are no less pervasive or important than paper-based artifacts, just less visible and tangible. Both represent two conceptually different aspects of information: materiality (amount/presence), 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 bandwidth, or disk storage), retrieval (finding and indexing) and delay (time to find, convert to a useful format, delivery). Note that similar problems of retrieval take on different forms in paper versus electronic landscapes: not being able to find a paper fax during a customer phone call corresponds, in some ways, to when the system "goes down" or "locks-up", or "response time is poor" and the rep cannot retrieve the customer's records. One advantage of paper-based information is that, given it is present, the delivery system (the paper) generally needs no additional functionality, while the obvious disadvantage is that the information takes up physical space and is confounded with its material delivery system (Rice, 1999). One advantage of electronic information is that it separates the substantive information from the material artifact, but a disadvantage is that the information requires sometimes considerable additional system functionality in order to access, display, and interpret the content. So, printed phone lists were reduced in size and displayed around a desktop telephone, making the phone more usable.

The other aspect is complexity/uncertainty. An artifact may represent a simplification of an inherently complex situation (such as information about a system error or an unfamiliar procedure). It may indicate the unpredictability yet immediacy of some information (such as a reminder to call an important customer when a certain transaction occurs). Artifacts may also represent a temporary, necessary but not optimal media transformation (such as writing down on a piece of paper a system-generated case number or information from a computer database field, that has to be used in a subsequent procedure in a different medium, such as a phone call) (Rice & Bair, 1984). They may even represent poor synchronization across processes, actors or sources (such as when information varies across locations at the same time or across time at the same location).

Paper and electronic forms as communication media. Artifacts are, in some ways, a medium of relationships – between information elements, people, task processes, work units, interfaces, systems and organizations. This is especially true of forms – here, the forms faxed in, or the forms appearing on the computer monitor to guide data input. Forms represent not just ways to record information, but are transformation and transaction interfaces between different systems, processes or entities, and even "create" the nature and content of organizational information as they require, constrain, and filter inputs. (Similar, more general points about the dual role of information technologies in integrating as well as controlling work and information flow have been made by many others – see, for example, Clement, Parsons, & Zelechow, 1991; Orlikowski, 1991). For example, a customer or organizational user has to fill out a form to represent the necessary content in a necessary format, and then fax that to the company, for later entry into a database.

On-screen forms, especially in real-time processing systems, may fail because they often presume the user has all the necessary information at the time of display and thus are designed to demand completion of the form in one session. Paper forms have the advantage of being decoupled from system processing, so that incomplete paper forms can be temporarily stacked, visible reminders of missing information. However, paper forms may also represent symbolic issues. Some users 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 security during a time of uncertainty. Sless (1988) argues that while multiple actors must use and are constrained by organizational forms, few people have any role in creating, evaluating or adapting forms, so most forms evolve through "administrative sedimentation". Thus forms – both print and electronic – are part of the desktop landscape, often serving multiple purposes and representing areas of concern, limits and inflexibility for system designers, implementers, and users.

Artifacts as meta-information. Desktop artifacts themselves are, in general, indicators of other issues, problems or phenomena – that is, (meta) information about information. Some desktop artifacts (such as post-it notes listing the steps required to make a new system feature actually work) are visible and idiosyncratic commentaries on system design or training, created by the individual user and generally not known by other users or system implementers. Changes in the location of artifacts may be meta-information about the changing relevance of certain kinds of information. As some procedures are affected by, or affect, the use of a new system, information about those new procedures may be located more centrally, such as directly on the PC, or appear or disappear. The shape, size, color, and artifacts and even how they are attached to surfaces

provide (more or less useful) meta-information about the utility and transience of different information.

Other artifacts are “tips of the iceberg”, indicating something about the mostly invisible electronic landscape lurking under, around and beyond the desktop landscape. These artifacts are both information about, as well as symptoms of, errors, inconsistencies, poor design, user preferences, flaws in implementation processes and training, and technological problems.

In this sense artifacts also signal what Gasser (1986) calls “augmentation” (taking on additional work to compensate for misalignment, complicating the production lattice, generating articulation work) or “workarounds” (“intentionally using computing in ways for which it was not designed or avoiding its use and relying on an alternative means of accomplishing work”, p. 216). Artifacts may be evidence of how people work around inadequate computing systems, by adjusting data, adjusting procedures, or using backup (manual or computer) systems, rather than changing their systems via maintenance or enhancement. A post-it note can serve as a backup system.

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 reminding a rep that a particular customer contact's phone number has changed may persist even when the new number has been updated in the online phone database, because now the rep uses the note to remind her that she wants to follow-up on a different problem relating to that same contact's company. That is, the post-it actually represents the customer, or, better yet, the relationship between the rep and the customer. Conversely, an artifact may continue in its material form, but be used to represent or store different information, even allowing users to store more paper, because their old uses have been transformed by a new information system.

Conclusion

Organizational processes are not simply separable from the medium, and new information systems may create serious conflicts and misalignments for work practices. While the organization needed all of its employees to conform to a strict way of doing things in order to accomplish the change, the participants partially expressed themselves and their work practices through their desktop artifacts. So understanding artifacts is central to understanding work practices and the design of potential new systems, and how both users and system adjust to their new relationship during implementation. The items placed or posted on or near the new computers showed what was not working well, what information was missing, and what processes were causing the individuals difficulty, to name just a few functions of these artifacts. They may take the form of system and task-related information, personal items, temporary

information, process-related items, frequency of use indicators, information unsupported by the system, and reminders. They may represent underlying differences and tradeoffs between paper vs. electronic information, materiality and complexity of physical and electronic information, how forms and formatted information communicate constraints and needs, and meta-information about system flaws and relationships between users and the system. Indeed, system implementation strategies should consider evaluating and tracking desktop artifacts, both as part of needs assessment and systems analysis, as well as part of system evaluation and ongoing adaptation.

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