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Chairman's Editorial: Control Alt Delete

IT WASN'T THAT LONG AGO that I was a computer newbie, trying to learn the basics of how to operate a computer without destroying it or myself in the process. Fortunately for me I had a very patient teacher and friend in Eliot Siegel, who has taught me many things about computers and their applications over the past few years. Whenever I found myself in trouble and unable to exit an application I would consult Eliot, much like the cartoon characters Tooter Turtle and Mr. Wizard. Tooter would get into all sorts of crazy predicaments, and call out for assistance by shouting, "Help, Mr. Wizard!" Mr. Wizard would in turn invoke his magical powers and get him home by uttering his magical chant, "Drizzle, Drazzle, Drizzle, Drome. Time for this one to come home."

When I found myself in a digital conundrum I again sought out the assistance of my personal wizard, Eliot. I was puzzled when he told me to simultaneously hit the computer keys "Control, Alt, Delete" in order to stop a badly behaving or unresponsive program. It was certainly not something I would have thought of on my own, and just chalked it up as another secret in Eliot's bag of tricks. As I became more experienced I learned that the "Control, Alt, Delete" scenario was a universally known short cut practiced by everyone who had unwittingly overloaded the computer.

There are many times in everyday life when I wish I could invoke the "Control, Alt, Delete" keys and shut down portions of my brain, in a fashion similar to the computer. When we are asked to "multi-task" in an increasingly complex work environment, we run the risk of task and information overload. Instead of panicking, wouldn't it be nice to just say those three simple words and wipe everything clean and start fresh? Maybe there's an analogy there for all of us to consider when trying to intelligently transition from our traditional film-based imaging world to the new computer-based digital imaging world.

If you asked the vendors, they would invoke a vision of Shangri-La, where their computers create a Utopian system resulting in 100% uptime, maximum efficiency, and idealized patient care. The previous frustrations inherent in film-based imaging are transcended with computers that provide enhanced image quality, improved image display, intelligent software to improve radiologist and technologist productivity, decision support to enhance diagnosis, and an electronic archive and network that renders all imaging information instantaneously accessible. One no longer has to deal with passive-aggressive clerical staff and file room personnel. Computers replace these "non-essential" personnel and never talk back, call in sick, or go on extended coffee breaks. The radiologist simply sits down, turns on the computer, and everything takes care of itself. There are no delays, no system malfunctions, and no diagnostic errors. At least, that's what the vendors would like you to think.

Now let's fast forward and travel to a real-life imaging department, which is going through the trials and tribulations of "going filmless." The hospital has made a commitment to being digital, realizing that this is an inevitable and necessary prerequisite to the electronic medical record. After an exhaustive RFP process, a PACS vendor is selected, acceptance testing is performed, and the digital transformation begun. The better prepared institutions have a PACS Planning Committee in place, typically comprised of a mixture of physicians, IT personnel, technologists, and administrators. Their job is to coordinate the transformation, ensuring that everyone is appropriately educated as to the wisdom behind this endeavor, as well as the benefits to be gained. These institutional thought leaders embark on an enterprise-wide educational process, establishing policy and procedures for technology implementation and integration, training, and compliance with industry and government standards and regulations.

The problem with this approach is that it is far too vulnerable to the cultural prejudices and biases resulting from the collective experience of the users derived from their film/paper-based medical practice. The same people who are invoking this monumental change in the practice paradigm are basing their decisions on the wisdom and experience gained through years of film-based operation. Every important function, from physical design, to workflow, to staffing, is based on this collective experience with film and paper. Ironically, it is this inherent bias that limits the enterprise from maximizing its investment. Orthodoxy results in a process in which conventional thought becomes the rule. In reality, if we are to truly achieve the monumental gains in productivity, workflow, and decision making that computers offer, facilities must open themselves to a fresh approach to this transition.

To develop a new approach to the implementation of a digital department, it is important to meticulously analyze existing film-and paper-based operations. This approach was taken at the Baltimore Veterans Affairs Medical Center (BVAMC), where we conducted a workflow analysis before implementing PACS, which documented a very inefficient paper and film-based process. For example, 59 steps were required to order, obtain, and report an inpatient chest radiograph. After the transition to an integrated digital department and enterprise, we were eventually able to reduce those 59 steps to only 9.[1] One must realize, however, that this was an iterative process that required years of workflow analysis, looking for new ways to automate and integrate. The greatest limitation to this metamorphosis was the simple fact that workflow was initially designed to emulate the manner in which film-based operation was practiced. In the beginning of this transition, scheduling was still done by clerical staff using paper requisitions. Patient demographic and exam information was still manually entered by the technologist into the workstation. Radiologists were still displaying and interpreting images in a similar manner to film, using four-monitor workstations with tile mode display protocols. Reports were dictated using digital transcription, inherent with reporting errors and delays.

Workflow and operational efficiency continued to improve over time as many manual steps were eliminated through automation, while disparate information systems and modalities became integrated through standards like Digital Imaging and Communication in Medicine (DICOM) and Integration of the Healthcare Enterprise (IHE). At the same time, vendors became more focused on developing workflow-enhancing software and new computer-based applications to further the cause of improved timeliness and productivity. Examples of these software developments included electronic scheduling, modality worklist, automated pre-fetch and hanging protocols, and structured reporting. These developments were typically reactionary in nature, as end users became increasingly frustrated with the lack of simplicity and intelligence inherent in the computer-based technologies. Vendors are also guilty of the same bias as they have continued to develop products that seem to be tailored for film-based operation.

As operational experience and research in digital imaging continues, more and more of our film-based "knowledge" has been found to be unsuitable. Technologists and radiologists have consistently strived to mimic image display in a manner similar to film. This has the untoward effect of compromising many of the potential benefits of digital imaging. While film-based interpretation is a relatively static and fixed process, digital image interpretation should become a proactive process through the use of workstation tools, advanced image–processing techniques, multi-planar reconstructions, and decision support software. In the end, the film-based notion of "single best" image display becomes replaced by the digital concept of multiple display presentations of a single image. Recent studies[2-4] have shown that disease-specific image-processing techniques offer the potential for both improved diagnosis and radiologist productivity. By incorporating these image-processing techniques directly into the keyboard through radiologist-specific presets, images can be quickly reviewed and interpreted. This effectively maintains radiologist productivity while providing "multiple looks" at a single image, highlighting different anatomic regions and specific types of pathology. The single greatest impediment to this approach, however, is the existing radiologist bias toward a "single best image presentation," which represents an anachronism from the film-based imaging experience.

Another example of "wasted digital potential" within the radiologist interpretation paradigm can be illustrated with cross-sectional imaging modalities, such as computed tomography (CT) and magnetic resonance imaging (MRI). Radiologists experienced with film-based interpretation of these studies attempt to emulate the same interpretation process, using tile mode display and static images. At the same time, the radiologist typically abdicates any additional image reconstruction to the technologist. This has the negative effect of decreasing technologist productivity (which also decreases patient throughput), while limiting radiologist interpretation and understanding of the reconstruction process. Outside of the academic ranks, most radiologists have little or no familiarity with multi-planar reconstructions (MPR), and this technologist dependence only exacerbates the process. While radiologists currently maintain control over the reconstruction process of CT and MRI examinations, this will not necessarily continue into the future as other physician groups (i.e., surgical subspecialists) begin to have direct access to MPR workstations. If radiologists do not maintain expertise in the interpretation process, they could potentially lose economic and political control, similar to the phenomenon experienced with cardiac imaging.

By understanding the technology and its applications, radiologists have the potential to re-invent the interpretation process through the use of multi-formatted display and computer-generated reconstructions. Using an integrated MPR/PACS workstation, the radiologist can display a complex multi-slice CT exam on a single workstation in simultaneous coronal, sagittal, and axial planes (as opposed to the solitary axial plane currently employed), along with 3-D reconstructions. The computer has the added capability of incorporating decision support, such as computer-aided detection (CAD), into the interpretation process. This allows for combining the strengths of man and machine into an efficient, accurate, and more consistent process. This synergistic approach using the computer to serve as facilitator, integrator, and interpreter is alien to most radiologists, who are reluctant to give up their traditional passive approach to image interpretation.

This "lost opportunity" with digital imaging is not exclusive to radiologists alone. Technologists are also creatures of habit, maintaining many of the archaic principles from their bygone days of film-based imaging. Technologists continue to congregate in centralized work areas, often sharing QA workstations, ironically often attempting to create an image that looks as close as possible to the way it used to look on film. If technologists are to maximize efficiency and image quality, new approaches need to become the norm. This is magnified in the current technologist staffing crisis, where technologist supply/demand imbalances are projected to worsen well into the future.[5] An obvious manner of addressing this shortage is to improve technologist productivity and workflow, well beyond existing levels.

In a recently published national survey,[6] the percentage of technologist time actually spent in the process of image acquisition is only 60–72%. In the optimal working environment, 100% of technologist time would be spent on image acquisition, with ancillary functions delegated to lesser trained aides or automated through new computer applications. Data recently obtained in a multi-center trial evaluating digital radiography workflow[7] provides an example of how technologist productivity could be dramatically improved. In this study, 30–50% of technologist time was spent on post-acquisition processing for general radiographic exams. Redesign of technologist workflow by removing this time-consuming process from the technologist could result in dramatic improvements in technologist productivity and patient throughput. In such a scenario, technologists would remain within the digital radiographic room, and be tasked with the sole responsibilities of image acquisition. Time previously "wasted" by patient transport, data access/input, and waiting time would be effectively eliminated. Image quality assurance (QA) responsibilities could be re-allocated in a batch mode to a single QA specialist, which could potentially improve consistency and overall quality of images. Although this approach can be easily justified on multiple levels, it is currently not employed by imaging departments, which maintain operational workflow in a manner similar to film.

This film bias plagues imaging departments on an administrative level as well. Departments undergoing the transition from film-based to filmless imaging are often electing to replace each film-based general radiographic room with a digital radiographic room, on a one-to-one basis. In doing so, administrators have created gross over-capacity due to a combination of productivity improvements associated with filmless operation, without comparable gains in utilization. Based on data from the aforementioned multi-center trial on productivity/workflow,[6] existing digital radiographic room occupancies are only on the order of 10–36%, resulting in unused capacity of 64–90%. This is another example of the film-based bias and experience serving as a negative influence on imaging operations and economics.

The solution to this dilemma may be to develop selective amnesia and try to forget or unlearn some of the previous lessons learned through film-based operation. If digital imaging is going to reach its true potential on an operational, economic, and interpretive level, we must effectively unlearn all of our previous knowledge and begin to think in novel and relatively unorthodox means. In computer terms, we need to collectively hit the Control, Alt, Delete keys and stop some of those old programs that won't shut down gracefully by themselves. Then and only then can we attain the true potential that digital radiology can provide.

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Bruce Reiner, M.D.
Department of Radiology, Veterans Affairs
Maryland Healthcare System
10 North Greene Street
Baltimore, Maryland, 21201
Department of Radiology, University of
Maryland School of Medicine
22 South Greene Street
Baltimore, Maryland, 21201

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