Designing the Digital Reading Room

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While much attention has focused on the global benefits of electronic medical information management, many of the details of designing digital work environments remain elusive. A case in point is the design of digital radiology reading rooms. It is not uncommon for healthcare providers to invest millions of dollars for state-of-the-art image acquisition equipment while simultaneously overlooking some of the basic physical requirements necessary to properly design the spaces where digital images are reviewed, examined and reported on. Yet, the reading room – radiology's central command station – is at the very heart of medical imaging. The sole purpose that million dollar acquisition devices (such as MRI, CT and PET scanners) exist in the first place, is to enable image reading, and ultimately diagnosis which occurs in the reading room. For this reason, it seems inappropriate that these mission-critical spaces be overlooked as priority areas for appropriate human factors design. Furthermore, todays (and tomorrow's) digital reading rooms demand very different design interventions than did their film-based predecessors.

After years of considering Picture Archiving and Communications Systems (PACS) as a philosophical concept not yet ready for cost-effective implementation, many radiologists and radiology administrators are now becoming acutely aware of how unprepared they are for soft-copy reading without a properly designed reading room. In recent years, radiological organizations throughout the nation have begun transitioning from film-based to digital practices at an unprecedented pace. Some industry experts predict that by 2006, 60% of all US hospitals will have adopted some form of digital imaging system . In most cases, the absence of a properly designed reading room remains as an impediment to realizing the potential benefits of automated image management.

There are numerous reasons that both designers and radiologists alike have historically focused their attention on the design of spaces other that reading rooms:

- Funding for PACS implementation is frequently biased in favor of tangible capital costs, such as the purchase of image acquisition and storage systems. When image display compo-

nents areconsidered, emphasis is often placed on equipment selection – such as computer hardware – with little consideration for designing the physical environment in which the equipment is placed. Ironically, image interpretation is arguably the most important step in the multi-phased process of image management. Reading an image and generating a report is the ultimate reason an image is acquired in the first place.

- A poorly designed traditional film-based reading room (although undesirable) is less detrimental than a poorly designed soft-copy reading room. As a result, "non-designed" reading rooms have become an accepted practice. In contrast, reading soft-copy images in an improper reading environment can lead to eye fatigue, repetitive strain injuries, headaches, decreased reading efficiency and even decreased reading accuracy. Ongoing pressures to read more and complex images, and for longer reading sessions will exacerbate work-related injuries.

- Many designers do not fully understand the process of soft-copy reading. As a result, they are rarely trained to implement design interventions that mitigate the detrimental effects of reading in an inappropriate space. Many architects consider the reading room as an office-like space. As such, they improperly design it with standard office lighting, furnishings, finishes and accessories.

- Contradictory space requirements are inherent in the reading process. For example, there is frequently a need for visual and acoustic privacy (spatial enclosure); while at the same time there is a need for intense collaboration among colleagues (spatial openness) . Solving either need usually results in compromising the other. A hybrid environment – in which both soft copy and hard copy reading occur simultaneously – combines contradictory lighting requirements in which light emitted from film illuminators or alternators creates unwanted glare on computer monitors.

Enclosure

How big should a reading room be? How many people should each workstation accommodate, and how many workstations should be in each room? Although the answers to these questions vary based on individual user preference, most reading workstations should accommodate at least 2-3 primary users with an option for up to 6-8 people to occasionally review cases together. Exceptions include teaching institutions where even larger groups may need to be accommodated and private radiology practices where images may be read in private single-occupancy offices.

Individual reading rooms can accommodate either single or multiple workstations. However, if a single room contains too many workstations, lighting and acoustics will be difficult to control. One approach is to place several 2- or 4-workstation rooms in proximity to one another. Within each room, individual workstations should be screened from the others for visual and acoustic privacy.

Lighting

Lighting control is the reading room's single most important design requirement. Control of lighting becomes more difficult when reviewing both softcopy and hardcopy images simultaneously. Most hardcopy films can be eliminated (or at least reduced) by digitizing previous film images into a digital format for comparison with current digitally acquired studies.

Two distinct types of lighting are needed in the reading room. Dimmable ambient lighting provides low levels of evenly distributed background illumination for reading softcopy images (with higher illumination levels available for maintenance and housekeeping activities). Supplemental task lighting enables manual tasks (such as writing and paperwork) without disturbing others in the room. Ambient lighting should be broadly dispersed and indirect (bounced off ceilings or washed along walls) if

possible, while task lighting should be narrowly focused. A ceiling height of at least nine and a half feet above the floor surface will facilitate indirect light fixtures hung from the ceiling. If this height is not available, indirect light fixtures can be wall-mounted or integrated within the workstation assembly.

Sources of light (such as film illuminators, light fixtures, etc.) should not be visible within peripheral view of anyone sitting at the workstation. Veiling glare – the reflection of light sources – on the monitors' surface should be minimized. Flat panel monitors, liquid crystal displays (LCD) and plasma screens tend to be less glare-prone than are cathode ray tube (CRT) monitors.

Ergonomics

Ergonomic design in the reading room is concerned with three points of contact; where your eyes meet the monitor, where your hands meet the input device, and where your bottom meets the chair . For this reason, movable adjustable computer furniture and work surfaces are preferred over built-in casework. Recognize that most reading workstations are shared by several individuals during the course of a day . Thus, users will vary in size, weight, age and visual acuity. Adjustability is also beneficial in single-user workstations to avoid muscle fatigue. Ideally, adjustability should range from sitting to standing positions. The height and angle of input devices and monitors should be adjustable as should the distance between the user's eyes and the monitor surface.

Acoustics

As voice-recognition systems become an integral component of softcopy reading, acoustic control within the reading environment also grows in importance. Complete acoustic control is only possible in a private office – a solution that does not foster collegial interaction. However, some measure of acoustic control is possible through the strategic application of

Figure 1 *Non-radiology modular furnishings adapted for use in a radiology reading room (courtesy of HermanMiller for Healthcare)*

sound absorbing floor, wall and ceiling finishes. Modular systems furniture – designed for non-radiologic workplace installations – can be adapted to meet the acoustic needs of the reading room (see figure 1). Confidential conversations should also be confined within the reading room for HIPPA compliance.

Connectivity

Wire and cable management is often an afterthought in reading areas that may otherwise be well designed. Management of telephone, data, power and other lines is often best solved by integrating raceways within modular furniture systems – a concept common in workplace design. Wireless communications systems may solve cable management problems, however they may in turn introduce security and transmission interference challenges.

Appropriate soft copy reading environments – although seemingly illusive – are easy to achieve if appropriate attention is given to their design. The greatest challenge is often getting the design tram to comprehend the physical and functional requirements of the space. Considering the importance of reading and report generation coupled with the radiologist shortage crisis, a small investment in proper design can quickly be amortized through improved reading efficiency, reduced work-related injury and user satisfaction.