TECHNICAL REPORT

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Electronic imaging — Human and organizational issues for successful Electronic Image Management (EIM) implementation

Imagerie électronique — Aspects humains et organisationnels pour la mise en œuvre réussie de la gestion d'image électronique

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this Technical Report may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 14105 was prepared by Technical Committee ISO/TC 171, *Document imaging applications*, Subcommittee SC 2, *Application issues*.

Introduction

Computer technology has unequivocally contributed to the efficiency and speed of data processing. Automated systems reduce staffing requirements by eliminating the need for human intervention and facilitating increased human productivity. Ironically, the intense focus on increased productivity of both systems and operators has traditionally limited creative methods for sustaining long-term human productivity. However, recent advances in the understanding and implementation of ergonomic principles have produced a comprehensive framework for human-engineered computer systems design, implementation, and work practices.

The proliferation of computer technology has impacted a majority of the work force. It is predicted that by 1997, 50 % of workers would be using VDTs (Visual Display Terminals) at work. The significant increase in the use of VDTs has caused the research community to investigate the impact to humans of working with VDTs. In 1988, in a collaborative effort with an organization specializing in the area of human factors, a standards organization published a document for Human Factors Engineering of Visual Display Workstations. This document, written for those VDT applications described as text processing, data entry, and data inquiry, “specifies conditions that have been established as representing acceptable implementation of human factors engineering principles and practices in the design of VDTs, associated furniture, and the office environment in which they are placed.” More recently, the International Organization for Standards (ISO) has initiated a 17-part standard (ISO 9241) that identifies requirements for both hardware (parts 1-9) and software (parts 10-17) associated with VDTs.

This trend in the development of standards and legislation responds to the lack of widely accepted and practical guidelines associated with the design, implementation, and use of VDTs. These voluntary and legislative guidelines would provide recommendations and requirements for the selection and operation of VDTs. It should be noted that the ergonomic requirements associated with electronic image management (EIM) systems do differ somewhat from those associated with standard VDTs. These differences come primarily from image-initiated re-engineered task requirements (that is, requirements for tasks in which humans interact with the image workstation with minimal paper) that create unique implementation and environmental considerations.

A growing body of research points out that the potential of information technology to transform businesses remains largely untapped not because of technical problems but because of failure to address human and organizational issues. According to some management experts, “The effective management of people is critical to the successful implementation and use of new technical systems. Unfortunately, the “human” resource receives only cursory or after-the-fact attention when technological decisions are considered.” Experts in this area note that “a recent study of 20 organizations with new office automation systems found that 16 systems had failed in some way. The reasons: MIS departments missed project deadlines by months. Costs mounted beyond projections. End users operated systems improperly or not at all or even sabotaged them openly. What variables lay behind these reasons? Most common were the following human factors: the system didn’t match the organization’s needs; supervisors didn’t promote use of new systems; senior management didn’t fully understand how systems should be implemented.”

The issue of implementing new technology was perhaps best summarized by a case study of five office automation projects: “Implementation: it’s not so much what you do, but how you do it.”

This Technical Report systematically identifies and reviews the ergonomic and organizational issues and considerations associated with the selection criteria, implementation criteria, and work practice criteria for EIM systems.

Electronic imaging — Human and organizational issues for successful Electronic Image Management (EIM) implementation

1 Scope

This Technical Report provides a framework for understanding and maximizing the human factors associated with successful implementation of Electronic Image Management (EIM) systems.

It focuses on cognitive, physical, organizational, and human factors as they apply to usability criteria for imaging technologies development, selection, and implementation. It provides a fundamental framework for understanding the basic issues and concepts of organizational factors, human factors, and ergonomics for EIM systems. The principles of sociotechnical systems theory are applied to the introduction of EIM into an organization. The principles of human factors and ergonomics are applied to usability criteria for the development and selection of EIM equipment, to environmental and implementation issues, and to training for long-term productivity benefits.

2 References

ISO 9241-10:1996, *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 10: Dialogue principles*

ISO 9241-11:1998, *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 11: Guidance on usability*

3 Terms and definitions

For the purposes of this Technical Report, the following terms and definitions apply.

3.1
culture
pattern of beliefs and expectations shared by the organization's members

NOTE These beliefs and expectations produce norms that powerfully shape the behaviour of individuals and groups in the organization. An organization's culture defines the ways in which people behave as encouraged by the organization's values and beliefs.

3.2
ergonomics
human factors
applied science that studies, designs, and adapts the equipment, the work, and the environment to meet human capabilities and limitations and to enhance safety and comfort

3.3
flicker
image instability caused by the fading and refreshing of the phosphors that create the characters on a display screen

NOTE Flicker-free images give the perception of stable images.

3.4
glare
visual discomfort, legibility impairment, or both caused by excessive variations in luminance between objects within the visual field

3.5
invisible grid
specific indents for various levels of information and blank lines or spaces that group related information

3.6
operations
business process used to carry out the objectives of an organization

3.7
readiness
willingness of employees to adapt to changes in their jobs and work environment

3.8
repetitive strain injury
class of medical condition of the joints caused by repetitive motion, which is often rapid, forceful, and/or extreme motion

EXAMPLE Examples of repetitive strain injuries include tendinitis and carpal tunnel syndrome.

3.9
visual display terminal
VDT
electronic device that consists of an input device (for example, a keyboard or mouse), a monitor unit (for example, a cathode ray tube), and a connection to the central processing unit of a computer and that visually presents information communicated to or stored in the computer

4 Usability and Ergonomic Interfaces

4.1 General

This clause provides a framework for evaluating the ergonomics of user interfaces associated with electronic imaging systems.

4.2 End-User Analysis and Usability

To tailor any image application to fit user behaviour, the developer must understand the general capabilities and limitations of the human being in the areas of perception, learning, memory, and attention. This analysis is a fundamental component of the re-engineering process associated with the move from conventional paper processes to EIM systems implementation. ISO 9241-11 was developed to ensure this understanding as part of the VDT development protocol. ISO 9241-11 addresses usability requirements specifications, providing a format for the communication and shared understanding of the factors that determine usability. ISO 9241-11 stresses the importance of end-user requirements analysis, because the tasks for which a product is used, the characteristics of the user, and the environmental conditions are as important as the characteristics of the product itself as determinants of usability.

ISO 9241-11 provides guidance on how to describe the context of use and the measures of usability in an explicit way. The resulting usability requirements specification typically includes the following sections:

a) name and purpose of the product;

b) context of use, including

1) intended users (skills, knowledge, and physical attributes),

2) environmental requirements, and

3) specification of tasks;

c) usability measures for particular contexts:

1) effectiveness;

2) efficiency;

3) satisfaction.

The consumer of imaging systems technology should carefully review EIM-system vendor proposals to ensure the inclusion of a system-specific end-user analysis. This analysis should be the basis for conceptual design of the system's user-interface as well as the criteria for usability verification testing.

4.3 Ergonomic Criteria for Selection of Electronic Imaging Systems

The principles in this section are based on five fundamental qualities that make application interfaces usable and easy to learn. These five qualities follow:

— consistency;

— simplicity;

— flexibility;

— user control;

— system responsiveness.

4.3.1 Consistency

To design for consistency means to produce an application that is predictable in appearance and behaviour. Consistency in user-interface design has two dimensions: internal consistency and external consistency. *Internal consistency* refers to consistency of look and of behaviour of screens throughout the application (and even across applications). *External consistency* refers to the users' conceptual model of how an application should work. A leading computer manufacturer suggests that "the user interface should confirm the conceptual model by providing the outcome users expect for any action. This occurs only when the application model is the same as the users' conceptual model."

Consistency in user interactions

— reduces the memory load on the user,

— reduces the time it takes to learn the application,

— enables the user to perform tasks more quickly and easily, and

— minimizes the confusion of the user who must navigate between multiple applications.

4.3.2 Simplicity

To design for simplicity means to produce an application that the user finds both easy to learn and easy to use. The fewer concepts, commands, and menus the user must know or traverse to perform an operation, the simpler is the operation for the user. The substantial variability of image applications and platforms reinforces the requirement of the above end-user analysis. For example, it is often appropriate to hide Graphical User Interfaces (GUIs), with their multiple access task-swapping capabilities, in image workstations that are dedicated to limited image tasks. This reduces the learning requirement of operators who do not require the capabilities of GUIs.

4.3.3 Flexibility

Flexibility in an application is reflected in how well the application responds to the needs of different kinds of user expertise. For example, to perform a given task, a flexible application provides menu-based commands for novice users to reduce their memory load and equivalent shortcut, keyboard-based commands for expert users to reduce command input time and increase their task efficiency. Because some imaging tasks are fairly complicated, requiring operator training and expertise, providing multiple-input or access mechanisms enables the sophisticated operator to modify interaction styles based on specific task or situational requirements.

4.3.4 User Control

User control is the degree to which the user perceives himself or herself to be directing the interactions within the application. In general, the more the user feels in control, the more satisfied with the application he or she feels. Users should be allowed to initiate actions and control the interaction, including terminating any command, easily reversing or undoing unwanted actions, or setting the pace of interactions. For example, some bank and remittance-processing image systems allow operators to select the key ahead option. This option increases operator speed by presenting the next imaged item after the operator has entered only a portion (selectable by number of key depressions) of the currently displayed item. However, a mandatory requirement for systems implementing this key ahead option is the ability of the operator to recall an imaged item once it has disappeared; this provides control for the user, which positively affects satisfaction and performance.

4.3.5 System Responsiveness

System responsiveness is the degree to which the system responds to the user's input. Whenever a user performs an action, the system should — at minimum — provide basic feedback acknowledging the user's command. The system should never leave the user wondering whether the system has accepted his or her input. This responsiveness is especially critical when long delays (in excess of two seconds) occur between screen transmissions. Ergonomic studies have shown that displaying some visual indicator of progress (such as an hourglass) greatly increases the user's acceptance of variable length delays.

The impact of system delay varies greatly depending on the task. Imaging applications used for document management work generally have tolerances for longer delays than image systems dedicated to high-speed data entry. Image systems dedicated to high-speed data entry should have the ability to display images faster than the human operator can process them. Exception-based delays should always be accompanied by some visual acknowledgement or status message.

4.4 Software Usability Checklist

The following software usability checklist provides explicit usability criteria for software development and selection. Although these usability heuristics are not EIM-specific, they are relevant to EIM applications.

When evaluating EIM software interfaces, ask the following questions to ensure that related criteria are satisfied; usable interfaces fulfil these criteria.

a) *Is display information organized and presented in a clear and useful manner?* Criteria include whether

1) information appears in an expected, natural, and logical (task) order,

2) readability is optimized (text is of mixed case, use of abbreviations is minimal, and menus and user-entry areas are visually distinct from other displayed information),

3) the command names or menu items are meaningful and distinctive,

4) use of colour is appropriate (four or fewer colours are used consistently, and an optimal contrast combination is used),

5) when available, on-line help or documentation is formatted for easy scanning,

6) pull-down menu options are formatted as single column lists and logically grouped, and

7) irrelevant or rarely needed information is displayed on request only.

b) *Is the language of menu items, commands, error messages, and on-line help appropriate?* Criteria include whether

1) the language uses task-related terms familiar to the user rather than system-oriented terms, and

2) the language does not use jargon that is difficult to understand and translate.

c) *Does the application minimize the amount a user must remember?* Criteria include whether

1) information appears in a familiar and directly usable form,

2) the application does not require the user to remember information from one display to another,

3) the application visually maintains the conceptual thread when a procedure requires that the system display ancillary screens,

4) at the user's request, the application provides prompts for command syntax, and

5) the application makes available text labels for screen icons.

d) *Is the user interface consistent?* Criteria include whether

1) the user interface uses the same term for a given item, action, or concept throughout the application,

2) the user interface is consistent in the format and placement of information in the displays,

3) the user interface provides a standard display area for command entry, and

4) the user interface makes the behaviour of objects on the screen consistent with the user's mental model.

e) *Does the application provide sufficient feedback?* Criteria include whether

1) the application highlights items that are selected,

2) the application acknowledges processing delays,

3) the application informs the user of the success or failure of a requested action, and

4) when an error does occur, the application provides understandable information that includes both a statement of cause and a suggested remedy that the user is able to perform.

f) *How easy is it to navigate and exit the application?* Criteria include whether

1) the application provides a home menu or display,

2) the means of navigation is visually distinct,

3) the structure of the application is optimally organized for the most common or most important user tasks and reflects a natural sequence (according to experience, cultural norms, and the like),

4) the menu structure does not require the user to transverse more than three levels to perform a task or to access information,

5) the user can return to the next higher level of menu with a single keystroke,

6) the user is able to exit at any point in the application, and

7) the means of exiting is clearly identified.

g) *Does the application provide shortcuts for the knowledgeable user?* Criteria include whether

1) the application allows the user to abbreviate command names, and

2) the application allows menu selections to be bypassed with command entry or rapidly processed keystrokes.

h) *Is the application robust; does it act to prevent unintended results?* Criteria include whether

1) the application requires the user to review and confirm destructive commands,

2) the application requires the user to review and confirm global actions,

3) exiting the application does not result in the loss of data without confirmation from the user, and

4) the application accepts user input no matter what case (upper, lower, or mixed case) the letters are in.

i) *Does the application observe human factors principles that make data entry tasks easier to perform?* Criteria include whether

1) the application captures data at first entry (user does not need to re-enter),

2) the application breaks long strings into manageable chunks for data entry,

3) the application does not require the user to enter leading zeros, and

4) when an error is detected, the user needs to rekey only the information that needs correcting.

5 Workplace Ergonomics

5.1 General

By their nature, document image systems represent a significant change in the workers' environment. Workers who have primarily used paper-based documents to complete their work have developed certain individual routines for working with and managing paper documents for completing their work.

While office environmental conditions (such as conditions of lighting, glare, afternoon reflection, seating, and work surfaces) were adequate or tolerable when work was paper-based, these same conditions may present significant problems to workers who are stationary in front of a workstation for long periods of time. Workers who had a workstation with a low-resolution display and used the workstation infrequently may have been able to avoid or tolerate lighting and physical problems for short periods of use. These same conditions may become intolerable when a worker uses a workstation as the primary means of completing his or her work.

Cognitive ergonomics plays a major role in the design of electronic imaging systems and in the associated productivity benefits. Human-engineered systems always consider the cognitive processes associated with use of a system or completion of a task. Effective and commonly accepted systems development protocols always begin with an analysis phase. This phase typically incorporates an end-user analysis or task analysis that identifies cognitive and physical requirements for the existing work practice. Conceptual models are developed that translate the user's task strategy or cognitive structure into a framework used as the basis for the new user interface design.

Cognitive ergonomics plays a critical role in the development of user-centred computer interfaces. Human engineered interfaces reflect an understanding of user behaviour, knowledge, and preferences.

For example, in an EIM system, it is possible to help people during the scanning and the storing of documents by giving semi-automatic indexing. This semi-automatic indexing can be based on the organization of the people in the office where documents are sorted by type and by origin before scanning. With each document type a code can be assigned. During the indexing process, the user assigns the code for the document type and the EIM system displays the appropriate screen. If two or more documents come from the same originating office, the system will retain part of the information (for example, in an invoice the details on the company which has produced the invoice) in order to avoid recapturing this information. This type of indexing system may not be useful in every organization. For example, in a parcels transportation company, customer orders must be immediately scanned to the management system. Cognitive ergonomics can help to match user requirements to the business organization and easy-to-use software and hardware.

Physical ergonomics applies industrial and operations engineering principles to workstation and tools design. Also referred to as *occupational biomechanics*, it can be defined as "the study of the physical interaction of workers with their tools, machines, and materials so as to enhance the worker's performance while minimizing the risk of future musculoskeletal disorders".

Applied to electronic imaging systems, physical ergonomic considerations involve both computer hardware and environmental requirements. Ergonomic criteria for hardware include the quality (and legibility) of the image display and the key force required by the system keyboard. Environmental considerations include requirements for ambient and task lighting and workstation layout (for example, work surface, chair, and the like).

The rest of this clause systematically addresses standards for system hardware and environmental recommendations for workstation layout while providing guidance for considering the physical workplace and its ergonomics.

5.2 Image Systems as VDT Workstations: Image System Hardware Requirements

A country-specific standard for Human Factors Engineering of Visual Display Terminal Workstations officially pertains to VDT tasks or applications including text processing, data entry, and data inquiry. From a task and application perspective, image system workstations are VDTs. Taken from the document, the following systematically identifies both hardware and environmental requirements for VDTs.

The image system hardware requirements include the following:

— image display requirements;

— resolution requirements;

— keyboard requirements.

5.2.1 Image display

The display should be flicker free for at least 90 % of a sample of the user population under conditions representative of actual use. It is suggested that the claim of flicker free should be supported by either controlled experiments or physical measures. Generally, image displays with refresh rates greater than 70 Hz (regardless of polarity) produce stable, flicker free images.

Legibility requirements for imaging systems are driven by task requirements. The image legibility requirements for medical imaging systems (that is, x-ray systems) are dramatically different from those for high-speed data entry systems. An exceptional image-processing approach (involving, for example, resolution, grey scale, thresholding, and the like) designed specifically for the medical application could, by its design, produce unacceptable image quality for the high-speed data entry task. This re-emphasizes the requirement for systematic end-user analysis for both developers and consumers of imaging technologies.

An important distinction should be made between image legibility and image quality. Often, image representations that appear aesthetically superior produce inferior operator performance. It is critically important that the selected image processing and display approach reflect the task-specific requirements of the operator. In general, based on principles of Signal Detection Theory, image representations for high-speed data entry tasks should suppress backgrounds and accentuate the information to be entered. This is often accomplished by reducing the levels of grey, creating a light background with dark characters. However, a potential problem of bi-tonal systems that only display black and white comes from the reliance on thresholding. For example, a “9” character can potentially be displayed as a “4” character if the top of the “9” character is thresholded to white.

Regardless of the image application task requirements, an evaluation with specific acceptance criteria should be pursued before the implementation of a new image system to ensure adequate task-specific image legibility.

5.2.2 Resolution

The resolution of a visual display is a measure of its ability to display the smallest discernible details. The commonly accepted measure chosen is the Modulation Transfer Function Area (MTFA). The MTFA metric of a display shall have a value of at least 5. Research has demonstrated the correlation between MTFA of a visual display and associated visual performance on that display.

5.2.3 Keyboard

Considerable research and engineering attention has been recently given to alternative design keyboards. These alternative design keyboards attempt to increase biomechanical and neuromuscular efficiency by altering the shape, configuration, and key force requirements. These keyboards are still being investigated to validate their proposed benefit.

Numeric keypads have two basic configurations: the configuration with the characters “1”, “2”, and “3” at bottom (standard numeric entry configuration) and the configuration with the characters “1”, “2”, and “3” at top (telephone configuration). The configuration with the characters “1”, “2”, and “3” at bottom has been adopted as the *de facto* standard for numeric data entry.

Keyboard surfaces and keycaps should have minimal reflectance to minimize glare. Key travel shall have a maximum vertical displacement that is between 1,5 mm and 6,0 mm with the preferred displacement between 2,0 mm and 4,0 mm. Key force shall range between 0,25 N and 1,5 N, with preferred key force between 0,5 N and 0,6 N.

5.3 Health Issues

The requirement for workstation adjustability comes from human variability in physical dimensions. The study of this variability is called “anthropometry”. This science identifies two overlapping bell-shaped curves to describe the range in all physical body dimensions from the smallest woman to the largest man. Adjustable workstation furniture should provide adjustability. Figure 1 graphically supports the need for three independently adjustable components of an ergonomic workstation:

a) chair;

b) keyboard surface;

c) display surface.

The first adjustment to be made at an adjustable workstation is that of the chair. When sitting in your chair with your feet on the ground, a 90° angle should be formed at your knee. Next, adjust the height of the keyboard surface to create a 90° angle at your elbow. Finally, adjust the height of your display surface so that, looking straight ahead, your eyes are approximately level with the top of the image display. It is important to note that ergonomically adjustable workstation furniture provides no benefit to an operator who is not educated on proper adjustment.

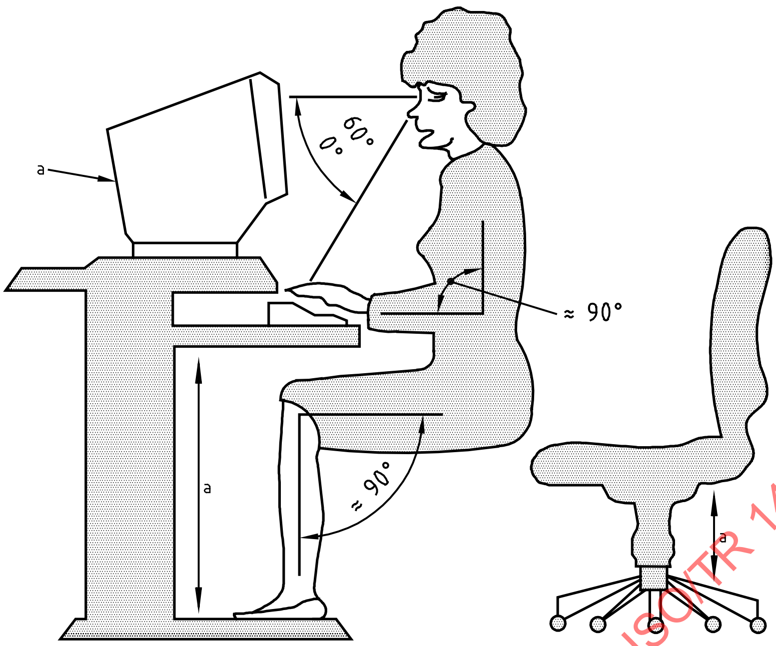
The environmental requirements covered by this clause are concerned with the following:

— illumination;

— acoustics;

— work surface;

— work chair.



a Adjustable

Figure 1 — Workstation chair, keyboard, and display

5.3.1 Illumination

Perhaps the most important environmental consideration for computer entry systems is illumination. The philosophy of "more is better" is not true in this case. VDTs emit light. As the level of ambient illumination increases, the contrast, and consequent legibility, of information being displayed on the VDT decreases. This can have a significant effect on productivity. Therefore, the computer entry environment should be somewhat darker than the typical paper-based operations environment. Furthermore, ambient illumination is not the only lighting issue to consider. Glare is also a major consideration that can be easily corrected with proper placement of VDTs relative to light fixtures and windows.

Illumination parameters should fit the task at hand; image environments require less ambient illumination than paper-based work environments. A range of 200 lx to 500 lx for paper-based environments is recommended. An ambient illumination range of 200 lx to 400 lx is recommended for imaging environments. Overhead lights should provide primarily a vertical or downward distribution of light. The luminous flux angle should not exceed 45° to the vertical; this is often accomplished with built-in louvers, curved mirrors, or prismatic pattern shields.

5.3.1 Acoustics

Ambient noise range of 45 dB to 55 dB is recommended for office environments.

5.3.2 Work Surface

The height of the desk or table top should be adjustable, preferably, with a separate height adjustable keyboard.

5.3.3 Work Chair

The work chair should be fully adjustable and cloth covered, and it should have a five-legged base. The chair should be able to be inclined between vertical and 120° and provide lumbar support that is adjustable and slightly concave at the thoracic level.

5.4 Handicapped User Accessibility

Legislation in some countries requires that handicapped persons and persons who are not handicapped shall have equivalent access to electronic office equipment. This requirement extends to database and application program access, the ability to manipulate data and related information resources to produce equivalent end results, and communication with other system users by transmitting and receiving messages.

There are four classes of handicaps that imaging systems need to accommodate:

a) vision handicaps;

b) hearing handicaps;

c) sensory-motor handicaps;

d) cognitive handicaps.

Redundancy is one strategy for providing accommodation. Input redundancy permits the use of alternative devices (such as a keyboard, a speech recognition device, or a head-mounted pointing system) rather than requiring a mouse. Information redundancy presents information in more than one modality (presenting visual equivalents of all auditory messages and auditory equivalents of all visual messages). In redundant systems, the user should be able to select the modes of information input and output.

Other means of providing accommodation are outlined below:

— Provide a sequential activation alternative for functions that require multiple simultaneous key presses (for example, CONTROL and SHIFT functions).

— Allow users to set the repeat rate for keyboard presses, the repeat rate of mouse keys, the tracking speed of the mouse, and the time window for multiple mouse clicks.

— Provide tactile aids to assist users in finding specific keyboard keys.

— Provide a detachable keyboard.

— Provide key-guards for the keyboard.

— Ensure that copy protection schemes do not prevent the use of special devices.

— Ensure that all warning and error sounds are in the 500 Hz to 2 000 Hz frequency range.

— Provide the means of enhancing text size, reproducing text verbally, and modifying display characteristics such as contrast and colour.

— Provide the ability to translate the screen contents into speech or Braille output.

— When colours must be distinct to enable understanding of the information on the display, provide a means for colour-blind users to select the colours to be displayed.

— Allow replacement of colours with user-selected patterns.

— Where cursors or other display indicators blink, allow the user to adjust the blink rate.

— Provide all documentation in a usable electronic format.

— Make controls touch-activated or lever-type devices rather than knobs that require both grasping and turning. Make controls with tactile, audio, or visual feedback. Flat plastic membrane or glass capacitance controls should not be used.

— Place all control functions, including the power on-off function, no more than 51 cm from the front edge of the machine.

6 Designing Forms for Use with Electronic Image Management Systems

6.1 General

Implementation of an imaging system typically requires redesign of the forms that serve as input to the system. In some cases, certain fields are no longer required. In other cases, two or three old forms can be combined into a single, multipurpose form. Form redesign might be required for other reasons, such as use of the forms in optical character recognition (OCR). Good forms design helps to optimize the quality of the images captured and read by the system and to promote processing efficiencies. Design the forms to meet the requirements of those who will complete and process them and the system specifications for scanning and OCR. Consider the following:

a) the ease with which someone can complete the form;

   1) the clarity of field labels and instructions;

   2) the sequencing of information;

   3) the amount of writing required;

   4) the advisability of constraining answers to a predetermined set of responses;

   5) the circumstances in which the form is typically completed.

b) the requirements of those who view and process the completed form;

   1) the ability to detect errors;

   2) consistency in the presentation of information (format, labelling, and so forth) between the paper form and any associated application screens;

   3) the location of information.

c) the physical characteristics of the form that facilitate scanning and OCR.

6.2 Creating Field Labels and Instructions

Each field on the form needs a clear and concise label. In addition, include instructions on how to complete the form. Use language on the form appropriate to the educational background of the persons using the form, and accurately reflect the jargon of the particular business or application. If someone misunderstands the wording on the form, then they might provide erroneous or incomplete information. Ask yourself if there is more than one meaning for a given word and if the person completing the form will grasp the intended meaning of a sentence or question.

Each form needs a short, descriptive title regarding the subject or purpose of the form and an identifying number. Also, indicate the revision date next to the form number, as in “Form 1234 (1/92)”. Place this information at the top left or right corner of the form where it can be used for other purposes, such as registration or skew correction.

As a general rule, locate brief instructions about who should complete the form, when, and how directly under the form’s title. Specify when a particular writing instrument (such as a typewriter, a No. 2 pencil, or a black ink ball-point pen) or a restricted character set (such as all capitals or digits only) is required. If hand-printed entries must match a particular style, then be sure to include examples of acceptable characters. If you plan to use OCR to read the completed form, you need to provide additional instructions regarding acceptable fonts and type sizes.

Place specific instructions for the completion of an individual item as close as possible to the caption to which they apply (such as under a column head). Avoid placing instructions on the reverse side of the form or in footnotes at the bottom of the form.

The preferred placement of field captions is above and to the left of the fields. Placing captions below the entry line means they are not visible when data is being typed on the form. A caption on the same line as the entry wastes space and limits the use of typewriter tab stops because captions vary in length. Locate captions so that a typist completing the form does not need to space through a caption or roll the form up to see the caption and back down to make an entry.

For readability of instructions, use mixed upper and lower case letters with a typeface size of 10 points to 12 points in an upright (roman rather than italic) font. Also, use an unjustified paragraph (left, centre, or right) alignment that produces equal spacing between words.

6.3 Sequencing Information

The sequence of information on the form is important because by creating a specific pattern, it can influence the way a person responds. For example, consider a list of medical history questions followed by a question on citizenship. If the person completing the form selects “No” repeatedly for the medical history questions, that person may incorrectly respond with “No” to “Are you a citizen?”

Sequencing can also affect the speed at which someone completes the form. If the fields flow in a logical order, the person is likely to correctly anticipate the next request and be ready with his or her response. Similarly, those viewing and processing the completed form may need to act according to the relationship between the pieces of information in various fields. Grouping these items in a logical order for processing becomes important.

Some conceptual relationships are obvious. For example, it is useful to ask for the source of income and the amount of income at the same time. Other relationships are not as obvious and depend on the information needs of the user. For example, an insurance underwriter may assess the risk of extending coverage to an individual according to that individual’s amount of income, type of employment, and geographical location and according to whether that individual smokes.

Those who are reading and evaluating data on the form appreciate the grouping of items to assist them in locating information. Also, placing related information on the same page can improve productivity by reducing the number of pages retrieved and displayed.

Regardless of the relationship between fields of information, changes in the format of information require some relearning by those using the form. Whenever possible, minimize the amount of relearning.

In general, the overall structure and flow of the form should proceed from the upper left corner to the lower right corner. Provide substructures within the form for various types of information such as demographics, employment history, and education.

Where possible, provide ways for the person completing the form to bypass irrelevant questions and complete the form quickly. If for a given question, multiple responses (such as providing information about multiple members of a household) are required , place the questions in rows so that the reader only has to interpret the meaning of a question once and then apply it to each item in the column heading.

6.4 The Use of Lines

One way to organize information and set the expectations of the person completing or processing a form is through the use of lines. Some suggestions for using lines are listed below.

— Hairline rules are useful in dividing individual data blocks horizontally and vertically. Alternatively, they can serve as a guide on columnar or tabular forms.

— Half-point rules are heavier lines that you can use to subdivide major sections of the form.

— One-point rules can emphasize or display specific sections of the form (for example, areas to be left blank).

— Parallel or double rules provide a method of subdividing the form into major sections or of subdividing it vertically into two identical sections.

— Leader (dotted) lines can guide the human eye from the preprinted caption to the data.

You can also use an invisible grid (made of specific indents for various levels of information and blank lines or spaces that group related information) to provide organization or coherence. Such invisible grids can enhance the overall appearance of the form by making it less busy.

6.5 Defining Individual Fields

A key goal of form design is to minimize the number of incorrect or missing responses. Thus, including a “Don’t know” response reduces the amount of guessing, and guessing incorrectly inflates the rate of incorrect responses. Using a simple check-mark response system results in fewer errors than having the person code a mnemonically related letter. In general, increasing the complexity of the way a person records his or her response increases the error rate.

Another goal in designing a form is to reduce the amount of writing required of the person completing the form. This is particularly true for forms that will be completed by people in environments that are not conducive to form-filling (for example, forms that will be completed by an insurance examiner in the field or a parts person taking an inventory of materials in a factory). When a field has two or more predetermined responses, use a check box design or a machine-readable mark sense box design. Preprint the required entry in background ink so that the user must simply trace over information to indicate his or her response.

Related to the goal of reducing writing is the general desire to reduce the time it takes for someone to complete the form. As mentioned previously, providing ways to bypass irrelevant questions and placing multiple response questions in rows make completing the form a more efficient process. The spacing of items on the form can also influence completion time. For example, reducing the distance between the end of a question and its response box reduces response time.

Character separators do not necessarily increase the legibility of what is written. In fact, fields with separators increase completion time and may make the form more difficult for a person to read. However, you must consider the form design from an overall system viewpoint. If a particular design decision increases form completion time but yields faster processing and higher-quality page images, then the requirements of one class of users conflict with those of another class of users, and a trade-off decision must be made.

6.6 Spacing

The spacing requirements for fields depend on whether the responses are handwritten or typewritten. The spacing requirements for OCR may vary depending on equipment manufacturer. However, the following guidelines may be useful:

— For typewritten data, allow six lines per vertical inch and ten spaces per horizontal inch. For zone OCR, a maximum of three lines per vertical inch (double-spaced text) is recommended. For full-page OCR, a single-spaced document (six lines per inch) is usually permissible.

— For handwritten data, allow four lines per vertical inch and five spaces per horizontal inch. For hand-printed information that is to be read with an OCR device, allow three lines per vertical inch.

Other spacing guidelines include the following:

— Create a 7,5 mm border from each edge of the page. Additional restrictions may apply to the usable form area if you use micrographic patches or bar codes.

— Place the first line to be entered by typewriter at least 25 mm from the top of the form; place the last line at least 13 mm from the bottom of the form.

— Place check boxes as close to their related captions as possible to minimize errors.

— Allow sufficient space between items to eliminate possibility of an error in determining which entry area relates to which caption.

— Align check boxes beneath other data items to permit the use of typewriter tab stops. If boxes are offset on a multi-part form, imprecise copy-to-copy registration can make it appear that a different box is checked on different copies of the form. Consider providing two alignment boxes to aid in setting tabs and spacing.

— To ensure human readability of written entries, make individual writing boxes at least 5 mm wide and 8,5 mm deep. Provide at least two character spaces on either side of the data.

— If the contents of a field or box are to be read by machine (OCR or mark sense machine), then provide additional clear space, typically three times the character height at the top and bottom and two character spaces on each side.

6.7 Additional Considerations

Some additional considerations for forms design follow:

— Avoid placing entry fields near the corners and edges of the document where the form is most likely to be handled and become smudged or damaged. Also, if the form is to be folded and mailed, then space the fields so that entries do not fall in the fold areas, and place fold lines on the form.

— To improve response legibility, place handwritten or hand-printed fields clear of form edges, particularly the bottom edge.

— Indicate how to correct mistakes (such as the omission of letters); encourage retyping OCR zone data rather than typing over or erasing errors. Caution against writing in the margins (skewing of the page during scanning will result in lost data) or in OCR zones. Extraneous writing on the form has a negative impact on image quality and OCR read rate.

— Since shading is often used to discourage unauthorized writing in certain areas of the form but can reduce the readability of the electronic page image, if you need to use shading, consider the use of drop-out (non-read) inks.

— As signatures often take more than their allotted space and can interfere with other scannable data, keep user signature areas away from OCR fields.

— Standardize the placement and formatting of common information across forms. Consistency generally improves processing efficiency.

— The use of glue is not recommended, but if the forms are printed in a pad, place the glue at the form bottom or on its side to avoid tearing and residual glue on the leading edge. Glue will often interfere with the automatic feeding of a stack of documents, so it is best to perforate the forms for easy removal from the pad.

— The paper size you select depends on how much information the form needs to contain. Make the form large enough to present the needed information, but try to use standard-size forms where possible.

7 Recommendations for EIM implementation success

7.1 General

Understanding the issues described in this paper is not enough. Implementation success will depend on how these issues are anticipated, planned for, and creatively addressed. Unfortunately, too many line managers and technical project managers have tried to avoid the issues, only to experience disappointing results. The best way to resolve these issues and control the fate of an installation is to augment project plans with activities designed to focus on the human and organizational aspects of imaging. This can be done by establishing a foundation of user participation that will be the methodology underlying strategic planning, organization assessment, and change management activities. To see how these activities fit into the project plan, see Table 1.

Table 1 — Success through project management

Phase 1 — Planning	Phase 2 — Design and Preparation	Phase 3 — Implementation	Phase 4 — Evaluation
Hardware/software strategy	Application development	System installation	Post-implementation review
Functional/technical requirements	Functional/technical specifications	Pilot system	Continuous improvement
Strategic planning	Orientation/communication	System tuning	Fine-tune operations
Conduct Organization Assessment	Development of reward and recognition	Reorganization	
Develop Change Management plan	Change Management activities	Training	
	Validation meetings	Validation meetings	
	Work/job redesign		

7.2 Participation and Integration

The key to success in implementing EIM systems lies in integrating the key elements described so far: Technology, Readiness, Operations, and Culture. The best way to accomplish this integration is through the active participation and involvement of users.

Participation of all levels of employees in the implementation process is an underlying theme of the following recommendations. The benefits of employee participation are increased motivation, higher productivity, and improved quality. In one study in which resistance to work changes was lower in groups that participated in making those changes, researchers identified two key points:

a) Participation is a necessary but not sufficient means of reducing resistance.

b) Participation is “a feeling on the part of people, not just the mechanical act of taking part in discussions”.

This study cautions against giving lip service to participation and against using participation as a gimmick to make people feel better.

Organizations that have left the users out of the planning, problem solving, analysis, and redesign or that have only marginally involved employees through random conversations and presentations have been unable to tie together the four key elements: Technology, Readiness, Operations, and Culture.

One of the best ways to ensure participation is through a Design Team. Selected by senior management, this team should comprise representative individuals from all levels and all key job functions as well as members of the technical project staff. The goal of this group is to jointly design the new workflow and jobs to best utilize the EIM system and human resources. The formation of this team will alleviate many of the us-versus-them problems that arise when the technical staff works separately from the business unit in designing a system. This Design Team should begin its work with a one- or two-day training session that would review the following topics:

— team charter, roles, and responsibilities;

— change parameters established by senior management;

— methodology for work redesign that looks at both the social aspects of work and the technical aspects of work;

— problem-solving techniques such as brainstorming, flow charting, using cause-and-effect diagrams, and the like;

— development of effective teams;

— effective team behaviours.

The Design Team should continue to meet on a regular basis to accomplish the following tasks:

a) **Customer analysis:** identify customers, determine the extent to which their needs are being met, and identify actions that can be taken to increase customer satisfaction.

b) **Technical analysis:** document how work flows, where problems occur, and where these problems are first discovered. Also determine how imaging can impact the current workflows and which variances will be eliminated or reduced by imaging.

c) **Work redesign:** according to information already gathered, recommend new workflow designs.

d) **System design:** according to information already gathered, finalize system specifications.

e) **Organization design:** according to new workflows and system capabilities, determine structural changes that need to be made in the organization, if any.

f) **Implementation plan:** identify the steps and resources required to move from the current organization to the new image-enabled organization.

7.3 Strategic Planning: The Organizational Change Strategy

The most important contribution senior executives can make early in the project life cycle is to participate in a strategic planning session. The purpose of the session is to articulate clear goals for organizational change. Most organizations develop a Technology Strategy of which EIM is a part. Usually this is tied to a Business Strategy. The third component of this Strategic Triangle is the Organizational Change Strategy. In many cases, this third critical strategy is non-existent. Failure to articulate an Organizational Change Strategy can lead to failure to manage the human and organizational impact of EIM. Trying to manage the human and organizational issues without a coherent strategy will result in an unfocused and ineffective change management effort.

A Strategic Planning Session should focus on answering the following questions:

— What aspects of our culture are effective?

— What aspects of our culture are ineffective with regard to EIM implementation?

— In what ways will EIM impact our employees and key external organizations?

— What structural changes in the organization are likely to result from EIM?

— How much change do we want in this organization? When examining the continuum of control versus commitment, where are we now with regard to management style? Where do we want to be?

— Do we simply want to automate existing processes or do we want to fundamentally change workflows?

The outcome of this meeting should be clearly stated objectives for change management and a set of guidelines for change that can be used by implementation teams. For example, are there any sacred cows that cannot be changed? Can we eliminate certain positions; alternatively, must all job titles remain in the organization? Do we want to increase employee participation a little bit; alternatively, do we want to move toward self-managed work teams?