HUMAN SYSTEM INTERFACE (HSI)

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Abstract

The human-system interface (HSI) is termed because the technology through that personnel act with systems to perform their functions and tasks. the various styles of HSIs embrace inform. Systems, system and alarms.

Computer-based, human- system interface styles area unit rising in power plants and management rooms. These developments could have important imp actions for plant safety in this they're going to greatly have an effect on the ways in which within which operators move with systems

This paper discusses few of the pervasive style problems discovered from these previous HFE assess. In sum, this work presents few monitored challenges like common tradeoffs utilities are probably to face once introducing new HSI technologies into NPP hybrid management rooms. The first purpose of this work is to distill these discovered style problems into general HSI style steerage that trade will use in early stages of HSI style

Keywords: human-system interface, control room modernization, interfaces design.

1. Introduction

Advanced, computer-based, human-system interface (HSI) designs are emerging in NPP control rooms as a result of several factors.

These include:

(I) incorporation of new systems such as safety parameter display systems,

(II) back fitting of current control rooms with new control and display technologies when existing hardware is no longer supported by equipment vendors,

(III) Development of advanced control room concepts as part of new reactor designs.

2. Types of Interfaces

(I) Between software components

(II) Between software and external (non-human) entities

(III) Between humans and software

3. Problems Caused by Inadequate HSI

(I) Wasted Personnel Time

(II) Employee Frustration

(III) Poor Communication and Shift Handovers

(IV) Increased Risk

(V) Reduced Team Responsibility and Accountability

(VI) Inconsistent Data Entry

(VII) Information Holes

(VIII) Labored Reporting and Real-Time Analysis

(IX) Scattered and Unconnected Data

4. Design process

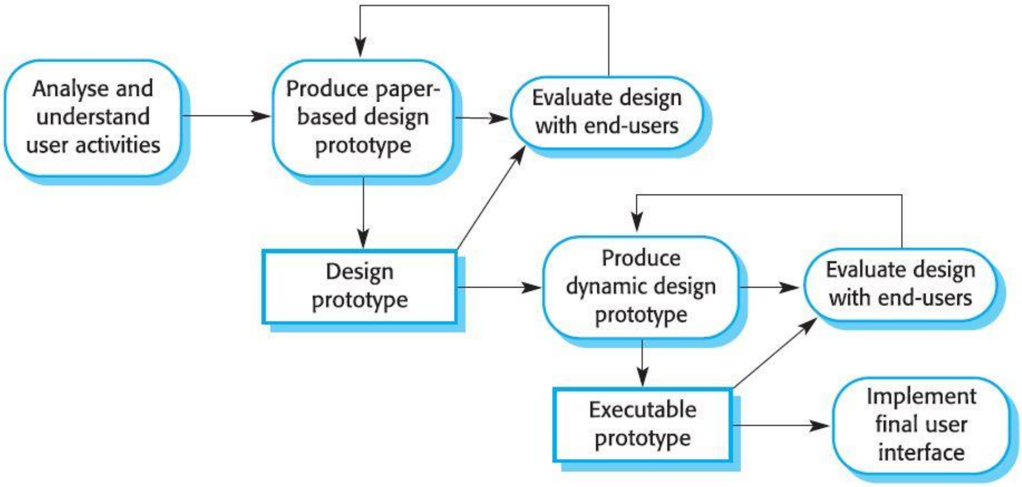

Figure 1- Figure for Design process of components

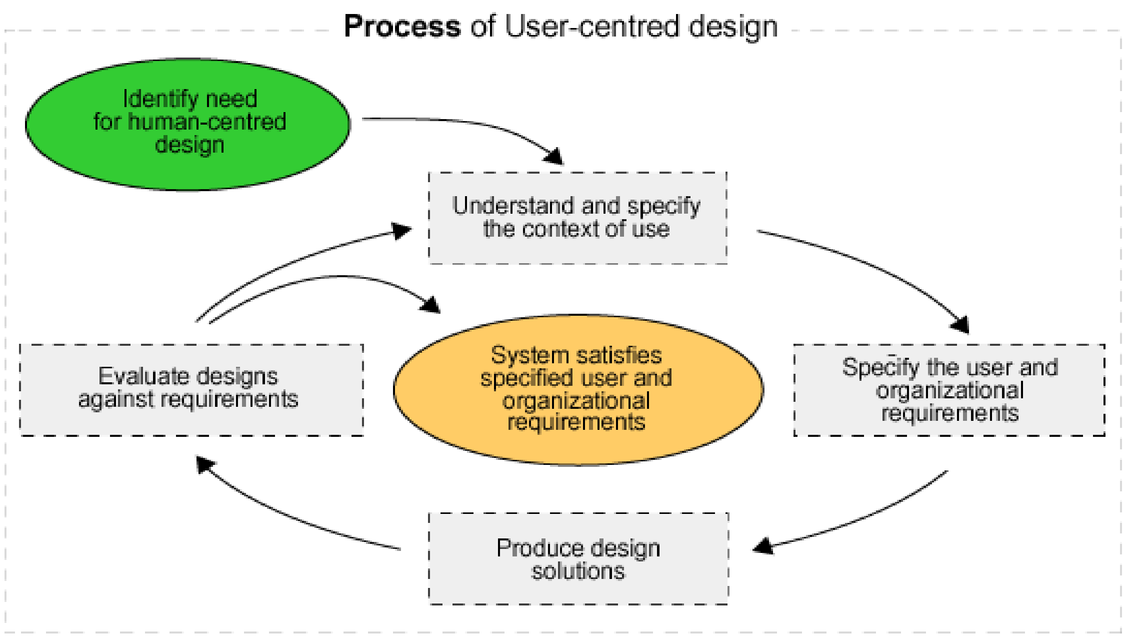

Figure 2- Figure for process of user centered design

5. HSI risk mitigation

The task of HSI is to mitigate the risk of system failure. Systems can fail for a numerous variety of reasons. Heuristically, these reasons fall into two large categories: technological issues (e.g., flaws in the system design) and logistical issues .Failure may occur during any phase of the system life-cycle. For example, a project may be cancelled during the engineering design phase because of cost and schedule overruns. Or a system may be terminated before the end of its planned life-cycle because it suffers from high operating costs and becomes too expensive to maintain.

Three of the reasons of failure :

(I) fatal compromises in computer performance from humans errors

(II) Underutilization or disuse due to complex, inefficient, or risky design

(III) High operations and maintenance prices.

6. HSI vs. Same streams

Human System Interface is related to many streams. Most notably, HSI closely resembles Systems Engineering, and formally, an effective SE method should already include HSI flow. In actual practice, well, system engineers usually inadvertently neglect human concerns. That is, “there has been a continuing concern that, in each phase of development, the human element is not sufficiently considered along with hardware and software elements” It was for this reason that HSI developed into a unique specialty area.

Similarly, from a definitional perspective, “HSI is similar with the traditional definition of human factors in its broadest sense”. Again, in real-world practice, researchers tend to visualize Human Factors and Ergonomics (HF/E) from a more limited view, emphasizing immediate operator problem and neglecting broader life-cycle, the range of applicable domains, and system-level emergent properties. Even Macro ergonomics, a subspecialty of HF/E that incorporates more strategic and systems-level perspectives, still lacks HSI’s emphasis on optimizing (trading off) among the components of a system, seeking to increase ROI across a system’s total life-cycle, and actively facilitating multidisciplinary system design.

Human System Interface fills practical gaps in both Systems Engineering and HF/E. It draws upon systems engineering view to underscore broad-spectrum system concerns and life-cycle management issues, and it pulls methodologies and good practices from HF/E, in order to give emphasis to the human in complex system.

7. HSI DESIGN GUIDANCE

7.1 Labels

Common unmet guidelines for Labels on HSI displays concerned (1) lacking of group labels, (2) inconsistent labeling formatting, (3) inconsistent placement of labels, (4) inconsistent wording of labels, (5) inadequate label separation, and (6) lacking of normal label orientation. Having group label offers an additional cue to help differentiate groups of information (e.g., collection of related I&C) from other groups. Lacking group labels presents a risk of making groups of information less distinguishable from other groups of information.

7.2 Color

Common unmet guidelines for the use of color pertained to (1) lack of conservative use of color, (2) selection of non-discriminable colors, (3) lack of unique color assignment, and (4) use of red-green color combinations. Color is an effective method used to support rapid detection, tie information together spatially separated information, as well as convey important information (e.g., plant state). However if not implemented conservatively, excessive use of color reduces its effectiveness to support these qualities and can create unnecessary visual clutter to a display. Common violations of this design guideline were observed with HSI displays that use high contrast colors for non-critical information (e.g., static labels), which take away conspicuity of key plant indications.

7.3 Alphanumeric Characters

Common unmet guidelines when displaying alphanumeric characters pertained to (1) the presentation of text that was too small (i.e., < 16 minutes of arc), (2) use of only upper case characters when presenting text to be read, and (3) too large of a inter-character spacing when presenting words or abbreviations. When presenting important information (e.g., plant parameters), the font size should be large enough to be legible given consideration of operational context. NUREG-0700 suggests that text be at least 16 minutes of arc for adequate legibility, which is a function of viewing distance and font size.

7.4 Graphs

Common unmet guidelines regarding the design of graphs pertained to (1) failure of displaying numerical values within graphs when precise reading was required, (2) lack of highlighting significant curves for limit bands and (3) lack of target area definition by defining X- and Y-axis labels. Presenting information numerically reduces risk of perceptual errors accompanied with analog displays if precise reading is required

7.5 Mimics and Diagrams

Common unmet guidelines for the design of mimics and diagrams pertained to (1) use of an unnecessary level of graphic detail, (2) lacking identification of component identification, and (3) lacking directional arrowheads to depict flow directions. Mimic displays and diagrams should contain the least amount of detail required to make a meaningful interpretation of its representation. In other words, having too much graphic detail can be distracting and take away the salience of more meaningful information. The read is referred to Hollifield and colleagues, which provides many examples of poorly designed and highly suggested mimic-based HSI displays to reiterate this point [7]. Further as with other types of displays, it is important to ensure that the components presented on mimics and diagrams are adequately labeled so that operators do not need to rely on existing knowledge for component identification.

7.6 Scales, Axes, and Grids

Common unmet guidelines for the design of Scales, Axes, and Grids pertained to lacking (1) standard intervals for axes, (2) axis labels, and (3) identification of units of measurement. The scaling of graphs sometimes used non-standard intervals (e.g., intervals of 47, 94, 141, etc.). From a human factors perspective, lacking standard intervals (e.g., intervals of 1, 2, 5, or 10) make graph interpretation difficult. Finally, axes of some graphs sometimes lacked labels and their units of measurement. While one may argue that operators should already have knowledge of the variables and their units of measurement being presented on graphs based on their familiarity of the plant, providing explicit labels can reduce cognitive.

7.7 Tables and Lists

Common unmet guidelines for tables and lists pertained to (1) lack of logical organization, (2) lack of row and column labels, and (3) inadequate row separation of tables. Common violations concerning the organization for tables regarded instances where the content was arranged alphabetically or sequentially, as opposed to being arranged by functional importance (i.e., as defined per operator feedback). Feedback from intended users should always be collected in order to verify that the information presented within tables and lists are logically arranged from an operational standpoint. Further, tables provided should contain a uniquely and informatively label that is visually distinct from entries. Creating a distinction for rows and columns helps with navigating large tables. As an example for a template, the Microsoft Excel Spreadsheet convention using letters for columns and numbers for rows is a familiar convention for users.

7.8 Numeric Data

Common unmet guidelines regarding Numeric Data pertained to (1) displaying information in an unusable format and (2) a need for select HSI displays to provide directional change of indications (i.e., via visual directional arrows) for information that must be rapidly discerned. Information presented on HSI displays should be presented in a format that is readily usable for plant personnel. For example, the units of measurement or scaling of various numerical fields displayed should be in the units that are readily useful for the task; otherwise, information that requires additional mental calculations or conversions create unnecessary cognitive burden and even present risk for human error. Secondly in one instance, critical information (e.g., RAD Release) was presented in a table as discrete values. While this information was useful for operators, it was difficult for operators to judge rate of change. Hence, the addition of directional arrows was suggested to explicitly show the directional change of RAD Release. This guideline nevertheless applies to all information that requires plant personnel to rapidly discern directionality of key information

7.9 Abbreviations and Acronyms

Common unmet guidelines regarding the presentation of abbreviations and acronyms pertained to (1) use of abbreviations that were uncommon to plant personnel and (2) inadequate distinction between multiple abbreviations when used in a single label. In general, abbreviations should be avoided unless there are space constraints on the display. This is common when presenting labels for various indications and controls. Abbreviations, when implemented, should thus be familiar to plant personnel. During analog-to-digital and digital-to-digital migration, carrying over previous abbreviation terminology is suggested to ensure proper terminology such as abbreviations is familiar. Additionally, utilities can access NRC *Collection of Abbreviations,* NUREG-0544 Rev. 4 and Rev. 5 [8, 9], as a resource for common abbreviations used throughout the industry. Lastly when multiple abbreviations/ acronyms are provided in sequentially to each other such as when in a label, each abbreviation/ acronym should be separated from each other so that they are distinctive to improve readability.

7.10 Highlighting by Brightness and Flashing

Common unmet guidelines regarding highlighting by brightness and flashing pertained to (1) overuse of highlighting (i.e., color) for non-critical information such as static labels and mimic components and (2) inconsistent use of highlighting information throughout the HSI displays. While the use of color is effective in attracting attention, its usefulness has diminishing returns when it is overly used. For instance, the attention gaining quality of color such as when presenting an alarm can be reduced and become ineffective if a display carelessly applies colors to ancillary information (e.g., low priority information, static labeling, mimic components, etc.). Per NUREG-0700, a display should limit highlighting (e.g., via color) to 10% when presenting normal conditions. As such, use of high contrast colors against background can increase the amount of highlighting and should be avoided for information that does not lend itself to immediate action. Finally, a particular highlighting method that is used should be executed throughout the HSI consistently. In some instances indications of various parameter states were presented inconsistently throughout, which creates additional cognitive burden on operators by required them to remember rule exceptions of certain indications based on differences in the way they present plant status.

7.11 Failure Indication

One issue for Failure Indication concerned a SPDS system that did not have trending capability for presenting certain plant information identified from operator feedback. Trends support situation awareness by explicitly providing parameter status in relation to historical information; this information can be invaluable when magnitude of change is important. Fig. 4 illustrates how use of trending can provide explicit (i.e., visual) historical data of various indications in relation to current state. This data can be used to depict the magnitude of change for important parameters.

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7.12 Video Display Units

One issue for Video Display Units concerned a lack of adequate luminance contrast between displayed information (e.g., plant parameters) to its background. To no surprise, other HSI research identified color contrast as a common ergonomic design principle violated [10]. Insufficient contrast can lead to poor readability resulting in potentially misreading critical information. A minimum of a 3:1 contrast ratio is recommended, and contrast ratios above 7:1 are optimal for readability. The color combination using black on white provides the absolute highest contrast ratio of 21:1.

The solid red horizontal line depicts the minimum contrast (i.e., 3:1) while the black dashed horizontal line depicts the preferred contrast (i.e., 7:1). Values above these thresholds show that the color has met a contrast threshold. In general, labeling and important information should use darker colors if using a light gray background. It should be emphasized that changing the background to a dark color (e.g., black) is not advised, as other human factors issues such as fatigue and glare are common with negative polarity color combinations. A final point worth mentioning is that care should be taken when choosing colors for various types of information. The most important information should have the highest luminance contrast (e.g., contrast ratios above 7:1). Ancillary information may yield a lower contrast, but should meet the minimum.

8. Case Study

UNMANNED AERIAL SYSTEMS

In remote-controlled aerial systems (UASs) or remotely piloted vehicles (RPVs) square measure airplanes or helicopters operated remotely by humans on the bottom or in some cases from a travel air, ground, or water vehicle. till recently the term “unmanned aerial vehicle” (UAV) was employed in the defense services in regard to such vehicles as Predators, world Hawks, Pioneers, Hunters. The term “unmanned aerial system” acknowledges the very fact that the main target is on way more than a vehicle. The vehicle is simply a part of an oversized interconnected system that connects alternative humans and machines on the bottom and within the air to holdout tasks starting from UAS maintenance and operation to information interpretation and detector operation. the popularity of the system in its full quality is regular with the evolution from human-machine style to human-system style, the subject of this report. It highlights main theme of this book: the requirement for strategies that square measure climbable to complicated systems

Unmanned aerial systems square measure meant to stay humans out of harm’s means. However, humans square measure still on the bottom playacting maintenance, control, monitoring, and information assortment tasks, among others. Reports Bottom of kind from the military indicates that twenty two folks square measure needed on the bottom to work, maintain, and appearance a Shadow UAS (Bruce , personal communication). additionally, there's a scarcity of UAS operators relative to the present want in I Afghanistan, to not mention the U.S. borders. The growing want for UAS personnel, combined with the present shortage, points to a different theme of this report: the requirement for human-system integration to accommodate ever-changing conditions and necessities within the geographical point.

In addition, this issue has robust ties to queries of manning. The manning queries square measure “How severaloperators will it desire operate every remote-controlled aerial system? will one modify the 2:1 human to machine magnitude relation Automation is commonly planned as an answer to the current tough, however the matter will be way more complicated. Automation isn't continually an answer and will, in fact, gift a brand new set of challenges, like loss of operator scenario awareness or mode confusion. Moreover, the manning question could be
a exemplar of however HSI style touches alternative aspects of human-system integration, like personnel, personnel, and coaching. That is, the question of what number vehicles per operator isn't simply one in all automation, however additionally includes the quantity and nature of the operators in question.

8. Conclusion

Human-system integration plays a significant role throughout the look method and is important within the early stages before needs ar established. It will be integrated throughout the look life cycle with alternative engineering strategies. it's conjointly clear that the HSI activities serve to cut back human factors risks on the manner and create evident the human factors problems that ar at stake, so these problems will be thought of as they trade off with alternative style problems.

This example illustrates several lessons regarding human-system integration and system design:

(I) The importance and complexity of the “system” in human-system integration compared with “machine” or “vehicle.”

(II) Design issues area unit typically connected to work force, personnel, and coaching issues

(III) Direct front examination and Human System Interface in investigation is essential.

(IV) Options can be designed to time and other constraints, but HSI knowledge is required to do so.

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