Human Machine Interface for Research Reactor
Instrumentation and Control System

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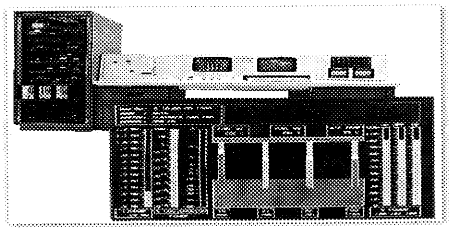
Abstract

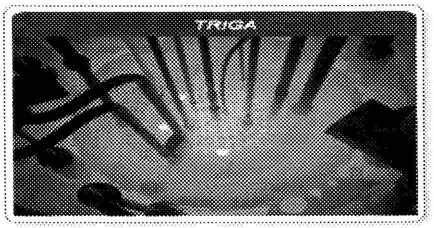
Most present design of Human Machine Interface for Research Reactor Instrumentation and Control System is modular-based, comprise of several cabinets such as Reactor Protection System, Control Console, Information Console as well as Communication Console. The safety, engineering and human factor will be concerned for the design. Redundany and separation of signal and power supply are the main factor for safety consideration. The design of Operator Interface absolutely takes consideration of human and environment factor for safety consideration of human and environmental factors. Physical parameters, experiences, trainability and long established habit patterns are very important for user interface, instead of the Aesthetic and Operator Interface Geometry. Physical design for New Instrumentation and Control System of RTP are proposed base on the state of the art Human Machine Interface design.

Key words – Human Machine Interface (HMI), Human and Environmental factors, Aesthetic and Operator Interface Geometry.

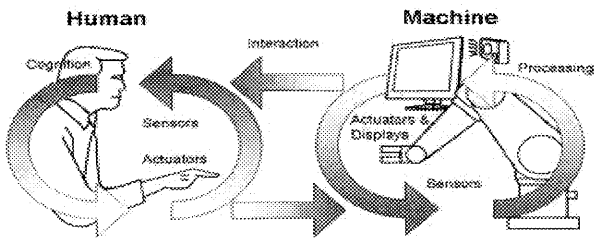
Introduction

Technology application in electronics for Instrumentation and Control field is becoming increasingly. The scope for this research paper is Human Machine Interface (HMI) application for research reactor. Human Machine Interface (HMI) is also know as Man Machine Interface (MMI) or Human Computer Interface (HCI). Interaction between human and machine is likely occur in a place or area of user interface system. The terms user interface actually refer to the layer that separates a human that is operating a machine from the machine itself. The context of operating a machine in user interface is focus on reactor operating console that exist in Research Reactor (Research Reactor Triga PUSPATI).



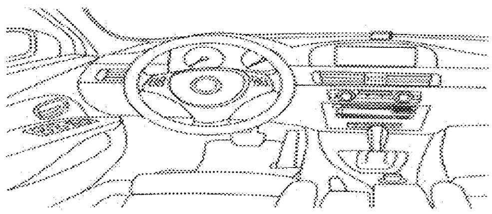


User interface includes hardware and software components that exist in a system. It is a system that have structure provide input and output to user act as a path of communication. In input, system allowing the users to manipulate it or user write by (enter by typed text or command) and produce output that allowing the system to indicate the effect of user's manipulation or user read (system show text, graphics or sound). Interaction between human and machine can include touch, sight, sound, heat transference or any other physical or cognitive function. To easy understand about HMI, example a typical computer station will have four Human Machine Interfaces (HMI) that can includes the keyboard and mouse both interact with our hand, the monitor interact with our eyes and the speaker interact with our ears.



In generally, the goal of Human Machine Interface (HMI) is to produce a user interface which makes it easy, efficient, enjoyable and safety condition to operate a reactor. In order to accomplish the tasks, human and machine needs a system to effectively communicate two ways for operation and control of machine. From that, it is important to get feedback from the machine during process control. Feedback from machine that consists the return informations or output like signals and status for helping human to making operational decision especially in handling Research Reactor.

How good communication system is working depend on effective to contact or transfer data between human and machines. The method to work with a system, users have to be able to control and assess the state of the system. For example, when driving an automobile, the driver uses the steering wheel to control the direction of the vehicle, and the accelerator pedal, brake pedal and gearstick to control the speed of the vehicle. The driver notice that the position of the vehicle by looking through the windshield and to know exact speed of the vehicle by reading the speedometer. The user interface of the automobile is on the whole composed of the instruments the driver can use to accomplish the tasks of driving and maintaining the automobile. From this example, it can duplicate to apply in operation in reactor plant with the same method to make sure the operation of Research Reactor is under control.



In recently, human are continuous working toward for better communication system by looking to design user interfaces to makes the process of using the system effective, efficient and satisfying. The design of a user interface affects the amount of effort that the user must expend to provide input for the system and to interpret the output of the system. So, by looking with design consideration involve such disciplines as ergonomics and psychology of the user can make a reliable system for Research Reactor. In term of ergonomics, it is refer to science of fitting the work and human relationship to that work. In application of ergonomics is a discipline focused on doing task comfortable, efficient and the more important is environment work place safety to the operators, plant it self and environment. Ergonomics also know as Human Factors that using proper posture and body mechanics (study of movement). Example good placement of computer eguipment, comfortable handles and grips as well as efficient layout of kitchen appliances.

In term of psychology, it is refer to science that deals with mental processes and behavior. In other hand, to design user interface must consider about scientific study of all forms of human behavior, sometimes concerned with the methods through which human behavior can be modified. Example, in situation emergency failed occur especially during operation reactor, operator need to think (Scram the Reactor), the emotion operator that could be face (Nervous), how operator act (Method by Manual Scramp) and operator counter action to conduct that situation either easy or difficult to handle it and slow or fast movement in order to safe the plant. It can conclude that, psychology is informal the mental structure of user that cause user need to think or act in the way user should do during handling Research Reactor.

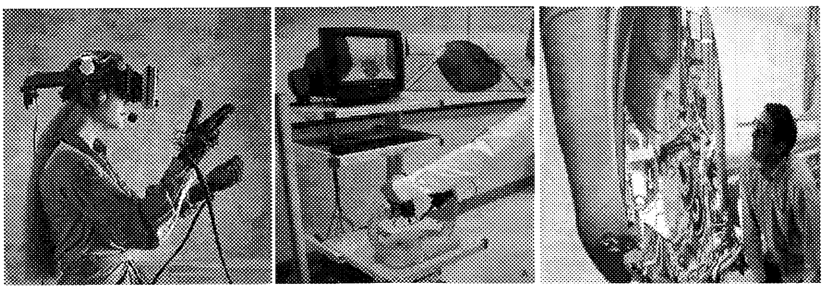
Besides that, HMI is also preferable to providing system that the operator give minimal input to achieve the desired output and also that the machine minimizes undesired outputs to the human. Meaning that, a better system has ability to minimize the complexicity of the process during communication system between human and machine. The affect from this, it will make a fast communication system action. In other ways of communication system, user interface cointaining in HMI has taken on provide quality of the graphical user interface to attract users and to help system to show meaningful data for user. All of this happens from the increased use of personal computer that commonly used by industrial panel and machinery control design now days.

From explaination previously, there is a clear about relationship between User Interface and HMI. The term user interface is often used in the context of personal computer systems and electronic devices where a network of equipment or computers are interlinked through Host (Reactor Operation Console). Whereas, HMI is typically local to one machine or piece of equipment (Basic) and is the interface method between the human and the machine or equipment. HMI can consider as an operator interface. Operator interface (Multiple HMI) is define as the interface method by which multiple equipment that are linked by a host control system is accessed or controlled.

Talk about a network of equipments or computers, HMI system is preferable to design that may allow several user interfaces to serve different kinds of users (must authorized operators). To make the system are security and safety, HMI can develop a computerized library database can provide two categories of user interfaces, one for library patrons with limited set of functions, optimized for ease of use and the other for library personnel with wide set of functions, optimized for efficiency. The advantage the HMI system have more than one user interfaces to serve especially in reactor plant, is because to backup if one user interfaces can not access. Besides that, it can allow users to program both user interfaces to make system redundancy and reliable. If one of both user interface can not operate, Research Reactor can scram by manually (Shutdown) and if both user interface can not operate, Research Reactor will scram by automatically without ask permission.

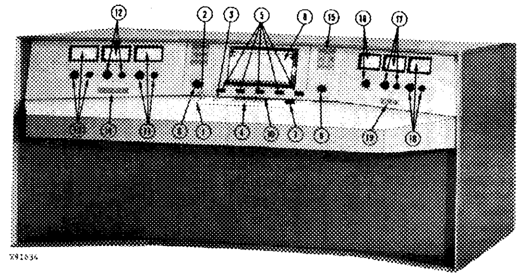
The good criteria of user interface design in HMI is consistency. A mean that, the controls for different features should be presented in a consistent manner so that users can find the controls easily. For example, users find it very difficult to use software when some commands are available through menus, some through icons, and some through right clicks by using mouse computer. A good user interface might provide shortcuts or synonyms that provide parallel access to a feature, but users do not have to search multiple sources to find what they are looking for. Various features should work in similar ways. Other, user interfaces should not change version to version user interfaces must remain upward compatible. Good user interface design is about setting and meeting user expectations.

In more advance technology in HMI for operation Reactor Plant in future, some circumstance computers might observe the user, and react according to their actions without specific commands. A means of tracking parts of the body is required and sensors noting the position of the head, direction of gaze and so on have been used experimentally. It can refer to immersive interfaces (Virtual Reality). It is not discuss in this research paper, either this technology application is suitable or not to handling reactor plant in future generation is still become question in our mind.



Methodology

Physical design for new Instrumentation and Control System of RTP (Reactor Triga PUSPATI) are proposed to upgrade the old reactor operationg console in Agensy Nuclear Malaysia. Introduce human machine interfaces (HMI) application, operator interface terminals with which operator interact in order to control Research Reactor. Human machine interfaces (HMI) coming features includes knobs, levers, and controls. Others provide programmable function keys or a full key pad (not preferable and looking to minimize the input requirement). Devices that include a processor or interface to personal computers (PCs) are also available. Many human machine interfaces include graphic displays. For ease of use, these displays are use standard messages. When selecting human machine interfaces (HMI), important considerations include devices supported and devices controlled. Device dimensions must provides a means monitoring and displaying of all reactor parameters such as, neutron flux or reactor power, fuel ,tank inlet, outlet as well as bulk water temperature, control rod position, period or rate of power increase and chart or hard copy recording of power are important factors to considers.



Many human machine interfaces include flat panel displays (FPDs) that use liquid crystal display (LCD) or gas plasma technologies. In LCDs, an electric current passes through a liquid crystal solution that is trapped between two sheets of polarizing material. The crystals align themselves so that light cannot pass, producing an image on the screen. LCDs can be monochrome or color. Color displays can use a passive matrix or an active matrix. Passive matrix displays contain a grid of horizontal and vertical wires with an LCD element at each intersection. In active matrix displays, each pixel has a transistor that is switched directly on or off, improving response times. Unlike LCDs, gas plasma displays consist of an array of pixels, each of which contains red, blue, and green subpixels. In the plasma state, gas reacts with the subpixels to display the appropriate color.

Human machine interfaces differ in terms of performance specifications and I/O ports. Performance specifications include processor type, random access memory (RAM), and hard drive capacity, and other drive options. I/O interfaces allow connections to peripherals such as mouse, keyboards, and modems. Common I/O interfaces include Ethernet, Fast Ethernet, RS232, RS422, RS485, small computer system interface (SCSI), and universal serial bus (USB). Ethernet is a local area network (LAN) protocol that uses a bus or star typology and supports data transfer rates of 10 Mbps. Fast Ethernet is a 100 Mbps specification. RS232, RS422, and RS485 are balanced serial interfaces for the transmission of digital data. Small computer systems interface (SCSI) is an intelligent I/O parallel peripheral bus with a standard, device independent protocol that allows many peripheral devices to be connected to the SCSI port. Universal serial bus (USB) is a 4 wire, 12 Mbps serial bus for low to medium speed peripheral device connections.

Human machine interfaces are available with a variety of features. For example, some devices are web enabled or networkable. Others include software drivers, a stylus, and support for a keyboard, mouse, and printer. Devices that provide real time clock support use a special battery and are not connected to the power supply. Power over Ethernet (PoE) equipment eliminates the need for separate power supplies altogether. Human machine interfaces that offer shielding against electromagnetic interference (EMI) and radio frequency interference (RFI) are commonly available. Devices that are designed for harsh environments include enclosures that meet standards from the National Electronics Manufacturers' Association (NEMA).

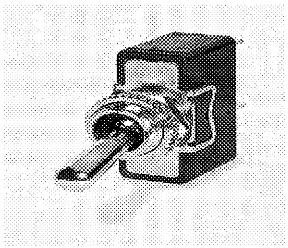
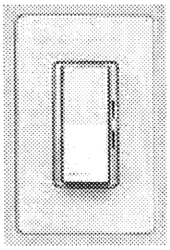
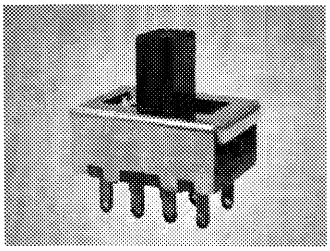
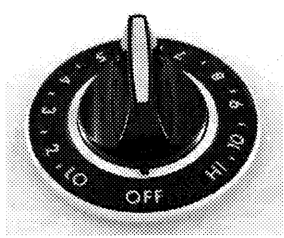
Result and Discussions

The interface between machine and operator or HMI is the principal means for providing conservation and for introducing human judgement into (Manual System) an otherwise automatic system in handling Research Reactor. Although signal arrive at the interface and once an operator judgement is made, it will leave the interface at electronic speeds. The operator responds at a much slower communication rate compare with machine responds. From that, it is a major restricted access in the overall system because of human limitations. The interface structure of a reactor operating console in Research Reactor, must be designed with the principal objective of shortening operator response time. The interface must be custom made to the operator and through a serious training program, the operator must adapted to the interface. In fact, HMI description must considers the interaction between hardware and software interface. Inadequate interface design usually is a result of considering the interface late in the overall system design process, giving short explanation to human factors and procuring off the shelf interface configurations that have been comprised for generalized application rather than for specific needs. Cost cutting at the interface level of a system carries large risks of later problems and dissatisfaction.

Interface design falls within the particular area of knowledge or interest of human factors, which is sometimes referred to as human engineering or ergonomics all of which be appropriate to the very specialized technology of designing products for efficient use by people in Research Reactor. Human factors is concerned with everything from specific characteristics of interface components to the total working environment (Research Reactor) of the operator. An excellent starting point for the interface designer is that of providing a functional desciption of the interface and then a job description for the operator. These two descriptions should come together precisely.

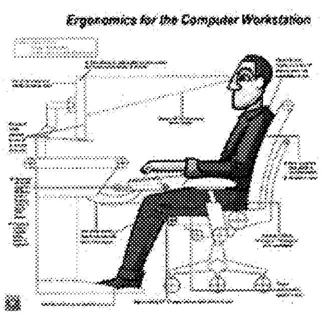
The principal characteristics of the operator in designing an interface Research Reactor are physical parameters, experience, including trainability, and long established habit patterns. The physical aspects can be illustrate in terms of experience, the amount of instruction required to efficiently use the interface as proposed clearly depends on the complexity of the process or machine under control and of the interface by itself. There are big differences, ranging from the simplicity of operating an average machine (Research Reactor) to a complex machine (Power Reactor). When forecasting the amount instruction that an operator will require for a given interface, the designer should create the specific content of a training program as part of the overall interface design task before running to actual situation for handling Research Reactor.

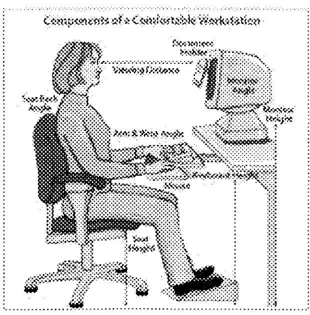
People (Operator) as the result of past experience, look forward to controls and move in certain ways. These expectation are called population stereotypes because they are so universally accepted the way they react. Where possible, component selection for an industrial control interface should be something that develops of these stereotypes or habit patterns. For example, a habit pattern can view from tuning on the lights by the wall mounted toggle switch in houses. The upward or right flipping motion is associated with "on" and downward or left flipping motion is associated "off". From this learning habit, It can be utilized with other instrumentation type of switches. This same familiar action may be adapted to any control panel for an extension of a normal habit pattern in console reactor. The range of a slide switch or potentiometer should show an increase as the switch is moved upward or to the right is better than multiple push button application in high frequently used. These control actions require the least amount of conscious effort to learn and are well established in our daily lives. The purpose to controls and display arrangements in Research Reactor from these habit patterns, to reduced reaction time, to make sure control movement by an operator is always correct, an operator can perform faster and can make adjustments with greater precision and an operator can learn control procedures faster.

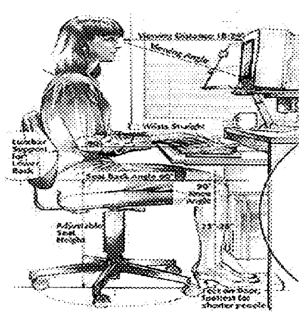





After discuss about habit pattern, the next to go through is about operator interface geometry. Extensive use of computer data terminals has generated a wide variety of interface architectures. Typically, an operator will use a keyboard (switch and button), a display unit, and a document station (a work holder for printed material). These all element in HMI require careful attention to their positioning with refer to the operator. From that, ergonomic analysis must be a part of interface design consideration to ensure that lines of sight, reach, lighting, access, and angular relationships are addressed properly.

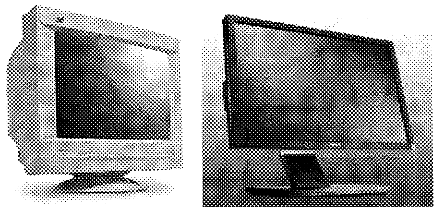
The features ergonomic design recommend for reactor console to follow these criteria, the line of sight from the operator to the center of a display should be as near to perpendicular as possible. The top of the display should be at or below eye level. Height, tilt, and swivel adjustment of seat, keyboard, display, supports, and footrests must be provided, since they are all parts of an interactive workplace system. Adjustments for operator posture should be easy to make and without requiring special tools, skills, or strength. If an operator cannot maintain a comfortable posture, there will be complaints of feeling tired related to the eyes, neck, shoulders, arms, hands, trunk, legs, and feet. In current operating time in research reactor, operator need to sitting in reactor console (control room) in 6 hours with backup one opeator standby.



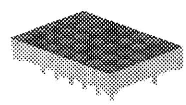




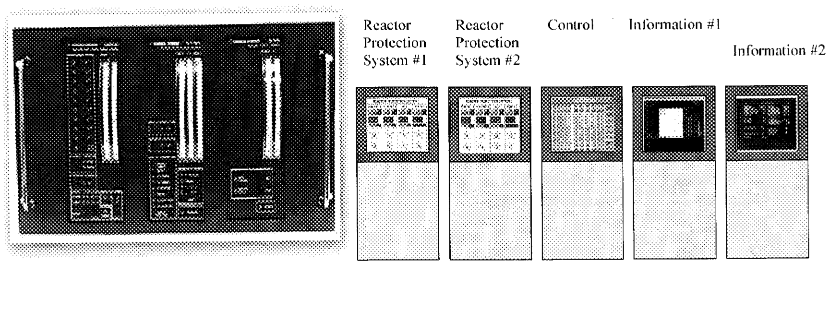
In more detail, HMI providing data display system especialy focus on Research Reactor. Alphanumeric displays is a combination of alphabetic and numeric. The alphanumeric character set consists of the numbers 0 to 9 and letters A to Z. Data display terminals that use cathode ray tubes (CRTs) are commonly referred to as video display terminals (VDTs) or video display units (VDUs). Data display systems also may use gas discharge, light emitting diodes (LEDs) and liquid crystal displays (LCDs). Although LCDs systems are often attractive because the interface screen can be relatively thin, different CRTs system wide usage because of its versatility in terms of graphics, use of color and cost.



In VDTs, it is possible to display alphanumeric data on a single or abbreviated line display. By using references material in the same format as the displayed information, the visual interaction between the two (HMI) is compatible and operator perception problem are minimized. Many word processing display screens do not have full vertical page capacity, but they move type upward (scrolling) when the lower line has been reached. Alphanumeric dispaly on VDTs are typically dot matrix construction because of the discrete addressing mode which they use. For example, both 5 by 7 and 7 by 9 rectangular dot groupings are used with the largers sides vertical. A practical working height for these characters is 2.5mm minimum. With adequate spacing between characters and lines, a typical display screen with appropriate standard size height and width can reasonably accommodate many lines and characters that can be displays.



Although light characters on a dark background are most common in VDTs, testing has verified that there is improved ablility to read with dark characters on light backgrounds. By having the same contrast format for both reference document and display, there is considerably less eye strain as an operator shifts back and forth between two surfaces. It is good practice to have CRT displays include the capability of image reversal from positive to negative in full or selected areas. Dark characters on a CRT light background display (positive image) present less contrast than equivalent light characters on a dark background (negative display). In effect, backlighting of the positive image “washes” around the dark characters to make them appear narrower. To counteract this phenomenon, the stroke width of the positive image should be approximately 20 percent heavier than that of the equivalent negative image.

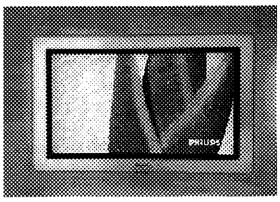


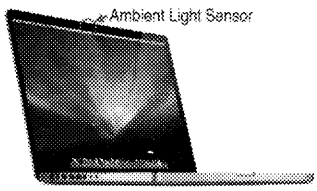
Glare on the face of CRTs is one of the most frequently cited problems associated with VDT operation. Glare from uncontrolled ambient light reflects into the operator's eyes, making it difficult or impossible to distinguish images on the screen, as well as producting eye strain and fatigue. High ambient light also reduces the contrast between background and displayes characters, since it adds its energy to both. Antireflective coatings, tinted windows, louvered screens (made of narrow glass pieces), and various other filter media can be used to minimize this problem.

Some of these glare control solutions reduce ambient light bounce at the expense of contrast and image sharpness. The effectiveness of these various means should be evaluated carefully prior to making a commitment to use them. Further, the location and diffusion of ambient light sources should be investigated. A wide range of image color is available on VDTs, but most use green, white, orange, or yellow contrasted with black. Any color image will satisfy the visual requirements of the display, so long as it does not fall at either end of the spectrum. Multicolor displays at these extreme wavelengths are also poorly perceived by the eye and should be avoided.

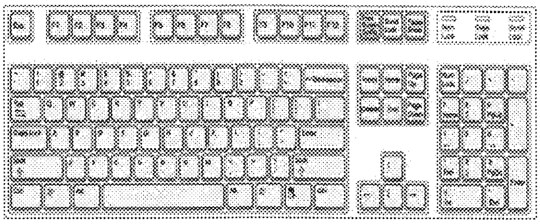
External interface lighting almost always will either enhance or downgrade display visibility. As the ambient light level decreases, the visibility of self illuminated displays will increase. For example, low output lamps and projected color or "dead front" displays require low ambient light. Conversely, a brighter display is needed for recognition in hight ambient light. By way of illustration, full indicator brilliance may be called for in the bubble of an aircraft cockpit exposed to direct sunlight, whereas a minimum glow from a display will be most appropriate at night. A situation like this will call for a brightness control for the indicator. Wherever possible, the designer should customize display brilliance to accommodate a wide range of brightness in any similar circumstances.

Glare becomes a particularly detrimental factor when the light comes from undiffused or concentrated sources, as in locations exposed to sunlight or from poorly located overhead lights that spot rather than diffuse the light source. A minor change in the panel angle can assist in reducing this problem. If the ambient lighting can not be planned in advance, as many be the case of a separate integrated control room, then a survey of the existing lighting should be made and, if practical, altered to favor the control interface to be installed. Also, this will enable the interface designer to plan whatever light hoods, shields, baffles, or diffusers may be needed and thus included with the projected costs. Control surfaces that are matted rather than polished also will help to alleviate the ambient light problem



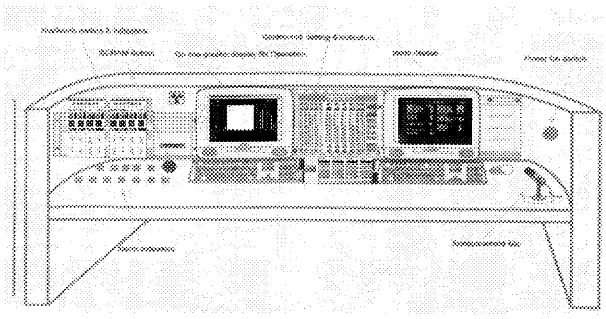


To interact and give instruction from operator to machine (Research Reactor) need programmable electronic data storage and retrieval systems by using keyboard. Key groupings for special functions and numeric entry have taken their place alongside the basic keyboard format. Full function intelligent keyboards with integral microcomputer based electronics may be encoded to meet user requirements. The physical effort required should be consistent with the speed and efficiency of the operator and the duration of the operation in Research Reactor. Without focus to these needs, the operator's performance may drop because of have a perticular illness or physical problem and become not safety to handling hazardous environment.



Introduction the standard QWERTY keyboard named by the arrangement of the first six keys on the upper row is a prime example. An alternative arrangement, the simplified keyboard was developed by Dvorak in 1936. It distributes the key according to the comparative strength of the fingers and the frequency of letter occurrence in common English usage. This improved design has more than doubled typing speed and it is said to reduce the average typist's daily keyboard finger travel from 12 to 1 mile (19.3 to 1.5km). Adopting of the system has been and most likely will continue to be difficult because of the number of QWERTY machines in existence and by the extensive retraining of operators that would be required.

In more detail about keyboar design in HMI proposed to use in new reactor console, operator can write (Entering input data) with the optimum keyboard angle for efficient use. There have been keyboard layouts designed to operate at every angle between horizontal and vertical. However, there is a general consensus that keyboard angle from side between 10 and 20 degree is a comfortable workplane. By providing a keyboard with an adjustable setting for use between 10 and 25 degree, the needs operators to do work can be better by provide place for operator to stay in doing their jobs. The height of the keyboard measured at the middle key row should not exceed 30mm above the counter top. Although there are a number of low profile keyboards thin enough to allow meeting this requirement, the combination of the keyboard enclosure dimensions and the 30mm DIN Deutsches Institut für Normung, the German national standards organization height standard may restrict the keyboard angle to 10 degree or less.



DIN, also recommend that if a keyboard is mounted at a height of more than 30mm, then a palm test must be provided to reduce static muscle fatigue. A palm rest may be desireable for some low speed data entry, but a high speed typist does not rest palms on anything. The use of a palm rest could only promote inefficient any error likely to occur during typing. In addition, a palm rest will require more desk space, which is usually at a premium. For rapid keyboard entry, to traveling keys are preferred to low travel touch panels, which are better suited for low speed random entry situations. When used with a data display terminal, it helps to have keyboard enclosure separable from the display, so the user can position it for maximum comfort. Some of the more ambitious human factors efforts have created keyboards with a slight concavity, running from front to back on the surface of the combined key faces and reflects followed by the fingers moving up and down the key rows.

After through the human factor, the next two of the most important of these are the local environment and ambient lighting. Industrial environments frequently pose a threat to the life and reliability of interface components. Controls and display may be splashed by water, oil, or solvents. They may be powdered with a layer of shoot and dust, including metal particles, stickly vapors, and various granulated, gritty substances. However, even under these harsh circumstances, a resistant yet still attractive interface can be designed that will take advantage of oiltight manual controls, protective membrane touch panels, and adapt something for hard use keyboards.

Even if not installed in an airconditioned space, interface components in reactor console are designed to operate at temperatures in excess of those that can be tolerated by an operator. However, where surges of high temperature may be possible, then all metal manual controls, such as toggles, may be specified instead of devices that incorporate plastic materials. In such cases, switches and controls equipped with large buttons, knobs, or levers should be considered. Also, an extra measure of positive tactile (concerning the sense of touch) feedback will help the operator feel when a switch operation has occurred. Low temperatures also may affect the operating performance of manual switches. Seals or lubricants may stiffen, causing a switch to stick or to stay open or closed. These matters should be made known to the components maker well in advance of procurement.

The last factor discuss about aesthetics factors. Although designing an effective control interface is a specialized example of industrial design, the basics of good industrial product design apply. These principles, in particular, affect the aesthetics of an interface design and as will be shown, are also human factors.

Several decades ago, pioneer of American industrial design, Henry Dreyfuss, developed a "performance creed" that applies equally well today: We bear in mind that the object we are working on is going to be ridden in, sat upon, looked at, talked into, activated, operated or in some other way used by people. If the point of contract between the product and the people becomes a point of friction, the industrial designer has failed. On the other hand, if people are made safer, more efficient, more comfortable or just plain happier by contract with the product, then the designer has succeeded.

As pointed out by James A. Odom, this creed applies to engineers as well as to industrial designers, and it exemplifies the goals of any conscientious approach to design. It is interesting to note that before anyone even touches a product, an opinion is formed based solely upon apperance. Thus is done with a sensitive use of form, color, and comparison of components. First impressions are important. By creating a good visual impression, potential users are more likely to form a positive image, that is, of a friendly device rather than of a threatening device. For equipment manufacturers as well as ultimate users, this is very important, not only for interfaces, workstations, and the like, but for ancillary equipment that must be fitted into the control room or mounted on the manufacturing floor.

Along these lines, manual controls that are clean and simple in apperance should be preferred over those components that are ornate, decorative, or intricate. These qualities generally detract from functionality as well as apperance. Where practical, it is good practice to limit the number of components on any given panel. There is a point of diminishing returns when, by sleer weight of numbers, panel elements begin to confuse the visual definition of functional groups. The confusion can cause hesitation and error.

As an example, it is of value to note the differences in panel density and appearance between a strip of ganged interlocked push button switches as contrasted with a single rotary selector switch that performs the same function. A multifunction illuminated rotary push button control may be the solution when panel space is at a premium. The designer should review numerous alternatives prior to freezing a design. The "heavy handed" approach that uses visible mounting screws or other practical but unattractive solutions that may downgrade panel apperance should be avoided. A statement of quality is made by the astute selection and use of appropriate well designed interface components.

An effective interface can only be designed with a proper balance between human factors and aesthetics. To simply "plug in" human factors without regard to aesthetics (also a human factor) often can markedly detract from appearance. In contrast, a good looking device that is difficult to use is unacceptable. With the large variety of all manner of components available today, an excellent acceptable compromise can be made. Interface components should be considered early in the design process from both human factor and apperance standpoints. Components added to a device after it has been defined as a three dimensional from may look lika an after thought and they may not be arranged for maximum operator efficiency. Too often a machine, for example, may be fully designed with only the functional process in mind. Then a standard, off the shelf electrical enclosure with be added with out first having been integrated into the basic form. In such instances, even if the control and display components are outstanding in apperance and human factors relationships, the total design will suffer.

In as much as processes and machines frequently will be altered some time after their initial start up, the interface designer, whenever possible, should give some thought as to how such changes can be made without resulting in a "patched up" monstrosity. The interface designer should always keep simplicity uppermost in mind. Stress should be given to those controls that do or may require immediate attention and reaction of the operator. Oversized, infrequently used maintenance controls and exposed hardware (screws, latches, handles) or access knobs that resemble rotary controls should be avoided. Guards or barriers should be considered only for controls the inadvertent operation could produce an irrevocable adverse effect. Guards should not be used as decorative frames. Unnecessary guards simply contribute to visual clutter. Any "extras" of this type tend to distract the operator from the mainstream of more critical data. Equipment designers and vendors should preserve operator familiarity by not making frequent styling changes simply for the sake of change.

Interface panels become overly complex for two principal reasons; the number and types of components and the failure of the designer to explore alternative arrangements. Panel arrangment can be assisted through the use of cardboard cutouts made to actual dimensions, which can be repositioned a number of times prior to making a final panel diagram. The control panel should be approached as a unified concept. The sequence of operations that the operator will follow should be studied and observed with the intent of minimizing (and eliminating) unnecessary visual "jumps" and "rebounds" across intermediate panel elements. James Odom makes the following suggestions:

Frequently used components should be the most accessible. For manually operated controls, somewhere between elbow and shoulder height is the best location. Controls and displays should be arranged for a conventional sequence of operation, from left to right and top to bottom, as one normally reads. Functional groups should be defined on the panel by allowing some space between them. Where practical, common centerlines and common edge lines throughout. Element to be avoided include borders, separate color patches, and brackets extending from group titles except in cases of extreme component density.

Emergency controls and displays should be located prominently on panel faces to ensure easy viewing and access by the operator. Where large panel layouts are required, the workload should be distributed between both of the operator's hands for ease of operation and increased operator efficiency. Displays should be located above (preferably) or to the left of the corresponding manual controls to prevent visual interference while the manual controls are being operated. When manual controls are at the extreme left of the panel, the associated display ahould be located above the controls.

Conclusions

In conclusion, Physical design for New Instrumentation and Control System of RTP are proposed base on the state of the art Human Machine Interface design. In designing of Human Machine Interface for Research Reactor must consider 3 main factors, human factors, environment factors and aesthetic factors. To propose new console reactor by using HMI system, must redundany and reliable system to fulfill the safety consideration. Physical parameters, experiences, trainability and long established habit patterns are very important for user interface, instead of the Aesthetic and Operator Interface Geometry, in order to control and monitoring Research Reactor. As already discuss in this research paper, designing such interfaces is a challenge, and requires a great deal of work to make the interface functional, accessible, pleasant to use, and logical. This design is must fulfill operator need by take care developing human machine interfaces and changing the ways in which people interact with machines and systems.

The technology behind the human machine interface (HMI) is constantly improving but is new for apply to Research Triga PUSPATI. As many people have noted, a poorly designed human machine interface can be extremely frustrating. On one end of the scale, the interface may be buggy or nonfunctional, causing difficulty because it does not work as intended. On the other end of the scale, the interface works, but it is designed in such a way that it is confusing and challenging to operate because it is not intuitive for users. The art of designing intuitive interfaces requires a deep understanding of how humans interact with their environment and an awareness of the psychology of designing interfaces in a way which will be accessible to a broad spectrum of humans.

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