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VISUAL IMAGERY AND THE USER MODEL
APPLIED TO
FUEL HANDLING AT EBR-II

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Abstract

The material presented in this paper is based on two studies involving visual display designs and the user's perspective model of a system. The studies involved a methodology known as Neuro-Linguistic Programming (NLP), and its use in expanding design choices which included the "comfort parameters" and "perspective reality" of the user's model of the world.

Neuro-Linguistic Programming (NLP)

NLP is a methodology which entails using a set of specific, easy-to-learn techniques for gathering precise information, assimilating that information into useful patterns, and then using the information toward completion of explicit outcomes or goals.

> *"When NLP was first used to study subjective experience, the structure of meaning was found to occur in the specific sequence of the representational systems a person used to process information. These representational system sequences are called* ***strategies.*** " (Bandler and MacDonald, 1988)

For example, seeing and hearing sounds in pictures, or feeling and seeing the hammer hit the nail for the first time are performed based on specific strategies. The representational systems themselves: *Visual, Auditory, and Kinesthetic* are the modalities of the strategies with which we use to access and process information internally. By knowing a person's strategy, we understand how a person builds his or her model of the world, and utilize this to realize the needs and comfort parameters required of the users for optimum reliability and performance. This is accomplished by using a person's successful strategies and applying them to adverse outcomes or performance.

NLP involves such methods as observing neurologically based responses of the eyes to ongoing stimuli provided by the investigator. Continued observation with respect to linguistic patterns paired with the eye accessing patterns elicited during an information gathering session, coupled with recognition of the use of favored predicates, reveal a person's representational system preference: *Visual, Auditory or Kinesthetic.* These sensory based categories are represented in the brain and fed back in the form of pictures, sounds, feelings, smells, and tastes, respectively.

Once general patterns can be detected, then more explicit distinctions can be generated which reveal strategies that are outside the normal, conscious awareness of the subject. These strategies can then be utilized in assessing a variety of necessary categories of information with respect to the user's total experience of the system. The means by which all this information is gathered from a user is through the utilization of two by-products of NLP known as ***Meta Modeling and Synesthesia*** .

Meta Model

> *This model "is a linguistic tool for using portions of a person's spoken or written behavior to determine where he has generalized, deleted, or distorted experiences in his model of the world."* (Lewis & Pucelik, 1982)

Meta modeling makes explicit those semantic and syntactic contexts, in which meta model violations occur under three categories: **gathering data, expanding limits and changing meanings.** Within each of these categories is a set of eight linguistic variations: *referential index, nominalizations, unspecified verbs, modal operators, universal quantifiers, mind reading, cause and effect and lost performative.*

These processes limit the user's ability to provide high caliber responses during the description feedback process or interview. The meta model works to replace or repair the deficient communications with more explicit, accurate descriptions that are then used in the construction of the design model of the system being experienced.

Below is an example of an *unspecified referential index* violation under the *gathering data* category.

Speaker: They are gray.
Response: What are gray?

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Speaker: The components are gray?
Response: What components are gray?

Synesthesia

Synesthesia "is the crossover connections between representational system complexes, such that the activity in one representational system initiates activity in another system." (Bandler, Dilts, DeLozier and Grinder, 1980)

Seeing a fuel subassembly and *sensing* that the subassembly will be cold to the touch is a visual-kinesthetic synesthesia. Hearing a football game and visualizing the plays as they are executed is an auditory-visual synesthesia.

These synesthesia patterns constitute a large portion of how the human processes the information while communicating with others. The correlations between representational system activities are at the root of such complex processes as **knowledge, choice** and **communication.**

"By making these correlative patterns explicit, neuro- linguistic programming provides a working model, an applied technology for the strategic utilization of correlative patterns to secure any behavioral outcome. By identifying synthetic sequences that lead to specific outcomes and by making them available to those who desire to achieve those outcomes, we can, in essence, replicate any user behavior." (Bandler, Dilts, DeLozier & Grinder, 1980).

Summary

By replacing the missing information in its sharpest most specific possible form, concise details are gathered that can be incorporated into a model. This endeavor provides the optimum in reliable knowledge that can be extracted from willing users and provides a foundation from which calibration of the paired relationship of language and nonverbal behavioral indicators can be accomplished.

Derived from all these efforts is the expectation of developing a general model that can be applied to the design of visual displays based on the user's perspective of a system.

Research Study I: Visual Displays (on CRTs)

A general research study was conducted that focused on encompassing the general comfort parameters of all users in visual displays. These comfort parameters were determined by how the participants accessed and processed information based upon their favorite representational system: *Visual, Auditory or Kinesthetic.*

The study consisted of forty-two participants (subjects) whose favored representational systems were determined through a video-taped interview and calibrated against both a written instrument and visual examination of the tapes. The focus of the examination was the establishment of individual-specific eye accessing patterns associated with other non-verbal cues and linguistic usage patterns (predicates). The survey that was used provided a crude profile of the person and a basis for speculation from the information that was obtained.

The participants were asked to complete a survey, answer questions that were used to establish individual strategies, and evaluate six different visual displays from which their comments were correlated with their favorite representational system. The results revealed areas that overlapped between the three modalities and areas that were divided.

Findings

The study showed that the representational systems overlapped in areas of color contrast, standard color and iconic coding, consistency in and between displays regarding color, symbols and text sizes and fonts, and displays in which the information could be quickly accessed, scanned and interpreted.

It was also found that all three representational systems preferred illustrative (iconic or symbolic) visual displays over text or document style displays, though the visually oriented group reported they were comfortable using both. Colors that were "easy-on-the-eyes (less fatiguing)" seemed to be an issue more for the auditory and kinesthetic groups than for the visual group.

Visually Oriented Individuals

Individuals that were visually oriented did not favor any specific realm of colors. They seemed to concern themselves with the acuity and resolution (brightness) of the colors being used, and colors that were "easy-to-see" (no fussiness around geometric figures and text). This group considered seven to nine colors comfortable to work with.

Visually oriented people found it comfortable to work with "busy" displays that were not "complex." These users defined "complex" displays as having to consciously construct or create additional geometric pictures in their minds to complete what was being depicted on the display.

Auditorily Oriented Individuals

Individuals that were auditorily oriented favored "pure" earth-tone colors of yellow, green, blue and orange, and disapproved of colors that were "muddy" (lower levels of saturation), e.g., yellowish-green, greenish-brown, bluish-green, and so forth. Colors had to be clear (distinct) and of good contrast within the spectrum of "pure" earth-tone colors. They were comfortable working with no more than four or five different colors per display.

This group preferred a single system be shown per display and the information be expressed in an illustrative format. Labeling techniques needed to be used in ways that would explicitly describe the system. Fluorescent colors were a consideration of this group as well as sound.

Kinesthetically Oriented Individuals

Individuals of kinesthetic orientation also leaned towards colors that were earth-tone base and made them *feel bright* (happy, soothing, relaxing, and pleasant), e.g., greens, yellows, yellowish-green, light blues and so forth. Most seem to disapprove of black backgrounds, because of the "negative" feelings it generated. Acceptable number of colors on a display ranged from five to six, and they preferred displays that illustrated the information of a system in a dynamic, flow pattern. This group specifically liked tactile feedback responses, i.e., touch screens.

Conclusion:

In developing visual displays for the EBR-II fuel handling system, the focus would be to incorporate the comfort parameters that overlap from each of the representation systems: *visual, auditory and kinesthetic,* then incorporate the comfort parameters of the most prominent group of the population, and last, blend in the other two representational system comfort parameters.

Another method would be to incorporate all the comfort parameters that overlap from each of the representation systems, then allow each individual the means by which to select their choice of comfort parameters.

By using the users' comfort parameters, the positive outcomes that will be attained are: short learning curves in the use of newly developed visual displays, less frustration and resistance by the user in accessing and utilizing the displays, the elimination of or less emphasis on ***adaptability*** from the user, and the guarantee that the designer will obtain more reliable and precise information from the user at the conceptual stage of the design model.

Research Study II: Virtual Reality Models

The focus of this informal study was to use the techniques of meta-modeling and synesthesia to develop a virtual environment that closely resembled the operator's perspective of the fuel handling system of Argonne's Experimental Breeder Reactor - II. An informal study was conducted using NLP as the behavioral model in a virtual reality (VR) setting. No formal data (recordings, surveys, questionnaires, and so forth) were collected on the participants.

Background

An AutoCAD model of EBR-II was used as the test model for determining whether a VR environment would be feasible in the operation and training of operators in fuel handling.

Operation of the fuel handling system at EBR-II is based primarily on tactile feedback during fuel handling operations, and conceptual visualization as seen in photographs and outlined in operational procedures. This is due to the configuration of the reactor which does not allow for direct visualization. So, in an attempt to provide the operators with a visual perspective of the system and process in real-time that was dynamic and "life-like" a VR model was constructed in a CAVE environment. The research started at the University of Illinois-Chicago (UIC), and was completed and evaluated at Argonne National Laboratory-Chicago.

The word CAVE is not an acronym, but refers to the time when man-made fires would project images on the cave walls.

The CAVEs at UIC and Argonne are projection-based VR systems that surround the viewer with four-screens that are arranged in a cube with three rear-projection screens for walls, and a down-projection screen for the floor. A head tracking device is attached to the viewer so that the computer can calculate for each wall the correct perspective and stereo projections as the viewer moves freely around the CAVE. A sensory based wand is held by the viewer which provides interaction with the virtual environments. The CAVE simulator updates the position of the simulated wand as the viewer moves the wand position with his or her hand. (CAVE User's Guide, 1994)

The human factor study of the VR model is to interview nine operators with different training and learning experiences of the fuel handling system. The operators describe their experiences and understanding of how and what the primary tank, the primary vessel and fuel handling system *"looks, feels and sounds like to them."* By using the techniques of the meta-model and synesthesia, a detailed description of the reactor will be revealed from each participant, then applied to the VR model. The objective is to create a model that includes both the users' comfort parameters and their perspective of the system.

An informal study was conducted with two participants. Each participant was asked to describe from experience their perspective of the primary tank and vessel, and fuel handling system.

Participant One

This participant was one of the original operators who had worked inside the primary tank and vessel before the sodium fill in the early 1960's. The favored representational system of the individual was established to be *"detail"* visual. This is where the subject communicates experiences in very explicit details. The system described by the individual was portrayed in different shades of color, shapes, sizes, component locations, spatial relationships, and the feel of the environment. Colors ran from dull grays to bluish-grays, and it was remembered that lighting had to be provided in the tank and vessel areas, otherwise it was pitch black. "Without any light, it was similar to being inside of a cave where the sunlight does not reach."

Texture was described with respect to the physical touch of the components and equipment. The pipes were shiny or glossy looking and were smooth to rough in texture. An example of size was illustrated by the extension of the subject's arms around the storage basket.

This individual described the metal mesh around the storage basket, the catch basin, the fuel handling equipment, the fittings, the metal brackets for mounting and much more by their sizes, shapes, colors and texture. The fuel handling process was recounted in just as great detail.

Participant Two

This participant has operated the reactor over the last fifteen years, and the favored representational system of the individual was established to be "*general*" visual. This is where the individual communicates experiences thoroughly, but not in explicit or precise detail. The overall system was described from the photographs, design blueprints and the verbal training received over the years. However, the individual concentrated more in describing the fuel handling system and primary tank based on the process rather than in terms of physical characteristics or layout of the reactor components and equipment.

Instead of shades of color for the equipment, color equated to temperature. The subassemblies were imaged to be bluish-gray in color, except for the top of the subassemblies which were red and yellow corresponding to the heat generated by the fuel pins. Distance between components were with respect to what had been seen in the design blueprints, i.e., the basket was as wide as *probably* his two arms extended.

The individual felt that lighting would be visible inside the reactor tank and vessel if the covers to both sections were retracted. The participant also thought he could hear an audible sound generated, because of the vibration induced when the transfer arm and subassembly connected.

Evaluation

After describing their perspective experiences of EBR-II, the participants were asked to evaluate an EBR-II virtual reality model. The model consisted of three sections: the primary tank, the primary vessel, and the fuel handling components. Each of the sections were created as general models with minimal details. Surface lighting effects (produced by the computer) gave the illusion of different shades of metallic gray.

The first participant described the VR model as very recognizable, the shades of gray were close to what was remembered, certain areas needed to be a little more shiny or glossy, and there needed to be more detail to such areas as the storage basket and the neutron shield. The dynamic segments of the VR model required minor changes.

The second participant described the model as "just what he had imagined the internals of EBR-II would look like if he could see it;" however, more color should be added to the fuel pin area of the subassembly. The dynamics of the model made the image in his mind more realistic and uniform. He felt that overall the model was what he had described, and that sound would be a significant attribute to the model.

Both participants expressed unequivocally that the model would be an excellent tool for training and operations. The experience of stepping around and into the reactor was captivating for both participants. They remarked how important and less frustrating this type of model would be in helping them to explain to new operators and engineers how the system worked, and that the learning curve would be greatly enhanced through the visualization feature.

Conclusion

The work for this study is ongoing. A formal investigation is still warranted using nine operators. What has been found through this informal evaluation is that the user can be asked to describe in detail his experience of a model in which all deletions, distortions and generalizations are filled in or explained using NLP.

The feasibility and usability of a virtual reality environment for training, operations, research and development is a positive step in the direction of system modeling for understanding how a concept can be applied through seeing, hearing and feeling. All modalities are taken into account, thereby encompassing all the representational systems that people use to model the world around them.

Summary

Implementing Neuro Linguistic Programming techniques for design purposes is feasible. The challenge comes in developing the model that is capable of matching each user's model of the world, and this, too, is slowly being incorporated. However, success can only be realized if the designer is flexible enough to change his or her own opinion and assessment of the model in order to remain in harmony with the user's.

Evaluations of the results from the studies also suggest that a number of follow-up studies regarding NLP and specific areas of human aspects are required, e.g., colors, information layout, virtual reality applications, successful strategies, decision making and much more.

Remember, that in gathering one's information,

> *the meaning of any communication is the response that is elicited by the listener, not what was intended by the speaker.* (NLP)

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