INTERNATIONAL JOURNAL OF INNOVATIVE TECHNOLOGY AND CREATIVE ENGINEERING (ISSN:2045-8711)
VOL.3 NO.7 JULY 2013

HUMAN ERRORS: AN INVESTIGATION INTO RESTART

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Abstract **— Human error is an assumed cause and a contradiction to ones intention at the psychological level. In addition criticality implied by human error is not directly measurable, rather inferred from the performance scale. Such erroneous acts of violations are the processes of mental aberrations that lead to an unintended outcome. To overcome violations of principles, the design of a system should come to the rescue. This motivates the research to conduct a laboratory study to investigate the slips made after restarting the sequential actions to lessen the error commission because of the non-stochastic slips, the practical issues of design are addressed. Further this paper hypothesizes the effectiveness of a visual hint at restart mitigates the error occurrence, and considers activation of intended goals which otherwise have been in-active. The slips are blamed to occur because of working memory load incurred by the system at the time. A structured micro-world task was constructed using Sudoku gaming system, with certain variations, to test the association of visual hints with slips manifested after an interruption. The results proved the effectiveness of visual hints to mitigate the error commission under high working memory load.**

Keywords: Human errors, Restart errors, Initialization errors and Post completion errors, Interruptions, Cues, Gaming Mirco-world.

I. INTRODUCTION

Human intervention is often prone to mistakes, errors and the like. Errors lead to backtracking, hence in a field requiring expertise to handle the delicate situations, errors play important roles. Consider, in aviation a minor error can lead to catastrophic consequences. On the other hand, an error made while heating a meal using a programmed chip can be neglected relative to an air mishap. Moreover an error in a set of systematic procedure affects the performance of users in a common way, thus resulting in low efficiency and often failure to achieve the desired intention. Involvement of human behavior has attracted attention from cognitive psychologists to study mental process during the procedure. Previously such an error occurrence was considered to be stochastic; therefore, no attention was paid to manifest the particular cause. However, with the recent developments in the theories of cognition and human behavior, science has put-forth plausible explanations for commission of an error.

This pervasive behavior of computers delivering high performance in everyday life of a common man makes computer scientists more responsible towards the system design and reliability. The computer scientists should understand the human psychology and believe the mental error can be made by the user of a system, and turn them pale. Paul Curzon in 'The Dog, Hen and Corn' argues that the software developer should come out of stereotype natured development and take an extra step to understand psychological issues of design. Moreover cognitive knowledge of

system still is losing edge over the slips made. [1] Introduced the slip errors within the procedural set even when expert knowledge is involved behind the task. To support the slip error commission, [4] demonstrated experimentally the post completion error occurrence as a slip within the procedure. The work blamed slip errors to be consequence of high working memory load, and declared that often under high working memory load person doesn't remember the sequence and omit the finalizing step. [1] Studied the effect of interruption position and the duration of interruption. The study reported duration should be enough to incur a substantial decay in memory so that a participant can be prone to slip. The literature further investigated interruption positions while studying post completion errors. Study reported the interruption occurring before the task completion step resulted in maximum errors within the procedure. Moreover, the authors also studied the implications of cues for future actions. The implications reported cues to be strong to open a window of opportunities for a user to leave sensory notes for future action and commit errors less likely.

Procedural errors have gained much attention of researchers, and deep insight has been gained in research of post completion errors, initialization errors, interruptions, and cues. But most of the research has overlooked the restart errors being committed. Restart error is omission of a step while continuing the procedure after interruption of a certain time interval at a particular step. The interval turns the psychological state of mind to other side, and incurs a substantial decay of memory corresponding to procedural task. The decay disturbs systematicity of the procedure and it is more likely for a user to commit an error at this stage. However the design should allow user to put future action visual/sensory cues, thus lessen error rate and increase the safety and performance of system and user.

II. RELATED WORK

Interactive system design study is about the design of human computer interaction systems developed by none other than a human. Finding a design flaw in controlled conditions is a step towards improving effectiveness and efficiency of a system. But commission of an error in uncontrolled situation, makes design flaw open to users of a system. To increase the system's robustness and reliability, it is concern of the designers to look for the needs of the users. Engineering a system to be design proof, needs a deep insight into the possible human errors. [6] Identifies some of the design flaws where computers showed their dominance over usability needs of a user. [10] Describes the same design flaws prone to Human Error, reporting it in terms of unsuitable behavior that can affect system efficiency and safety. [6] Identifies an insight in design procedures in terms of the user goals. Literature argues if an application hubs thousands of features but not satisfying the basic goal of a user, that application is void. Designing for features makes an application error prone.

[11] Investigated the statistics of 34 incidents, and reporting 92% of the deaths in those incidents were due to the human computer interaction and other 3% were credited to software error in application. Such reports show the criticalities of design issues within a highly reliable system. Thus human errors have been concern of research over last few decades [12], where models of cognition and experimentation of human error are being performed. [13] Gave categorization of error on the basis of the intention as *"If the intention is not appropriate, this is a mistake. If the action is not what was intended, this is a slip."*

[14] Introduced a cognitive error classification framework as: skill-based slips and lapses, rule-based mistakes and knowledge-based mistakes. Whilst studying information processing, [7] drafted an influential classification system of information processing in HCI. Latter identified the system of

information processing related to degree of consciousness and hence derivable of an error. Based on his classification of degree of consciousness, processing systems were diversified into Skill, Rule and Knowledge based. Brief definitions of above mentioned processing systems is noted as:

Skill based processing category, the smoother execution of a highly expertise task, in response to an event.

Rule based processing category, a user performs a task with transitional conscious control and executes the usage of rules learnt in training.

Knowledge based processing category, a user performs a task with high consciousness scaling as if he is new to activity.

[4] Introduced the term 'Post Completion Errors' in research methodologies of human error. The report argues human are capable of doing certain things in a right way and proper manner. However introduction of one extra step in a procedure, after main goal is achieved, makes it prone to errors. Researchers credit this kind of error to working memory load at that particular instance. The findings of their research reported the participants doing the same task in a procedural way without committing errors but when working memory load is low. This created a relationship between Post Completion Errors (PCE) and working memory load. However to lessen the omission of last step (slip) due to high working memory load, [5] Studied the introduction of visual hints (cues). The study reported to have eliminated slip error when a specific visual cue was drawn out just in time. This illustrates the role visual cues play in controlling the procedural errors. Furthermore to investigate deeply into effect of interruptions, which is more often logical cause for PCE? [9] Analyzed the effect of interruption position and duration on the rate of PCE. The results of the experimented methodology reported most post completion errors were committed when interrupted at penultimate step of the task completion, compared to when interrupted at any other step. [2] Introduced an

insight into systematicity concept with the hypothesis questioning*" Does being motivated to avoid procedural errors influence their systematicity?"* The corresponding findings of research methodology implied user's performance is prone to PC type of errors.

Nevertheless evident from the literature, there has been a little lapse in concentrating on other kind of error namely: *Restart error*. This project is concerning the research methodology to study restart errors. Method requires the user working on a game like environment. While under high memory load user has to be paused for some time interval and asked to restart performing the same task. Control of the 'in between' group experimental research is noticeably in cue generation. Whilst users will be interacting with goal oriented microworld rather than feature hub application, environment will be studied to calculate the restart errors occurred within the microworld variations of design.

Research observations will imply the error rate to be calculated. Project goals are set to reduce the errors by

studying *slips*, *cues* and working memory load. Variations in design will provide comprehensive knowledge for the interactive system design issues and factors of human error.

III. PROBLEM

Paper concerns research study of Restart type of Procedural errors. The research is based on firm literature of procedural error research in the past. Thus the independent variables e.g. position of interruption, duration of interruption are not taken in concern. The methodology of previous research has provided infrastructural basis for future research in these areas. Nonetheless the problem of incurring a high working memory load needed the project to study a game-like environment. Whilst working under high memory load,

the user evaluation was not selected to be '*think aloud*' evaluation, because of the reason that speaking while

performing would affect the performance of users. Therefore discarding the reason to increase the error rate, application was designed to generate the reports of errors committed rather incurring extra memory load on participant. Further the problem of selecting the control between the two designs needed to be simple enough to notice the errors. For the reason to make errors noticeable, control was chose to be within the number panel as cue. Moreover the microworld state cannot be made goal motivated/driven for each participant because of the consideration of ethical issues.

IV. METHODOLOGY

Project majorly considers the restart errors using Sudoku gaming application as the microworld. The recruited participants will be trained to gain exposure towards particular microworld. In the training session no cue usage will be implied, hence not making users to get used to cues. Moreover participants will be asked to speed up timely. During interruption a similar secondary

arithmetic task will be performed which deviates their attention from high memory load game to another game. The participants will have to remember the color of balls appearing in sequence with numbers appearing on them. Users will have to re-write numbered sequence of colored balls.

A. MICROWORLD PROCEDURES:

1) Step 1: Click on 3*3 inner Matrix A of 9*9 Matrixes:
Select a particular 3*3 matrix to fill up the

numbers within it.

2) Step 2: Click on a box within 3*3 Matrix B:
Choose one box in a 3*3 matrix. On the same screen a number panel appears providing the options of clicks that will fill up that particular box corresponding to number clicked in panel.

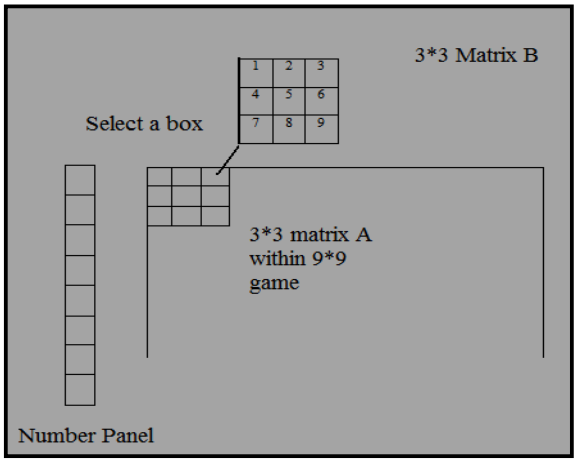

Fig.1. Micro-world Description

In matrix B user can cross out the options those are not valid to be filled in that particular box within matrix A. i.e. cross the numbers in matrix B which are declined for choice to be filled in particular box.

3) Step 3: Lock the choice of number to be filled in box within Matrix A:

Crossing out numbers in Matrix B leaves user with one choice of number to be filled within the box of Matrix A. Thus, finalize the content of a box within 3*3 matrixes (Matrix A). Same pattern be repeated for each box within the 3*3 matrix.

4) Step 4: Confirm the number to be filled:

In-order to confirm the number which emerged after crossing out numerals from Matrix B, user can now insert the number within the box by pressing corresponding numeral (1-9) from number panel. Thus, confirming the box contents.

5) Step 5: Commit the step:

User has to press the commit button to finalize the insert operation. This commit can help user to be sure about whether the number is committed to be in the

right place. Whenever user rolls mouse over the uncommitted box, cloudy message appears that tells user the particular button is committed or not. That's user can be sure about the choice of number and corresponding box, while he is committing every box after full consideration.

6) Step 6: Rollback:

If user somehow makes a mistake and needs to un-commit some number which is wrongly filled in a box, he can press rollback button over that box, resulting in an empty box which is now ready to go to stepwise procedure again. However roll back of a step can result in increase in steps taken to complete the game.

Control lies in the *number panel*. Users will be interrupted by the end of Step 3, when they would have

decided which number to insert within the box. Group1 users will have to unlock the number panel when they return to play. Duration of interruption will be 30 seconds so as to enable a substantial decay of working memory from step 3. That is, after a certain time interval number panel will be locked to clicks. Moreover the research conducted by [3] considering the interruption duration reported duration of interrupt being independent of global task performance of user. Though the study accounted similarity of interruption, complexity and memory load an interruption delivers are determining factors of performance.

Although [9] states that the interruption duration shall last long enough to incur a decay of goal to be resumed and has to be prevented from being rehearsed. In this experiment 30 seconds interval will incur enough decay in memory so that the effects of interruption can be noted. The effects of interruption mean the occurrence of slip when game is resumed. Control between the groups decides whether the slip occurred or not.

Control is decided to be the click on number panel. For one group experiment, the number panel is locked and for the other it's not. If the users directly start trying to click on the Matrix A, a pop up message will appear reporting error. The Visual cues, like blinking number panel, are used to help the users of locked number panel gaming interface, as a hint. Whereas, the users who don't get a locked number panel in the application will carry on without receiving a cue over the locked panel.

Two groups of 30 participants each will be studied for 5 gaming session each. The errors reported in two different environments (with cues and without cues) will be statistically analyzed to deliver results and test the hypothesis.

B. EVALUATION

Evaluation of the microworld will be conducted between the groups, based on the stepwise procedure drafted above. Report of errors will be generated for each participant, and the data will be stored as per ethical norms. Experimental hypothesis "*Does Restart in a Procedural Step Imply more Issues in the Design of a System?"* will be tested over the basis of experimentation results. Position of interruption and time of interruption is not studied as already considered in literature by [9]. However conducting an experiment with large number of participants will provide qualitative methodology for future research. Moreover to establish firm qualitative basis for design implications, data collected will be statistically analyzed. Analysis of variance (ANOVA) tests will be selected based on the common procedure for future verification of research results.

V. CONCLUSION

Conclusively previous literature has drawn major conclusions considering just-in-time cues and low working memory load on participants. [8] Established a goal model based implication of omission errors. The study notes omission errors are low at self activation influence and might fail due to environmental influences. This infers criticality in design issues of omission errors The stereotyped development focuses on increasing complexity of the system hence increasing the rate of omission. However the study confirms the issues and implications of design. Further the results solidify the significance of high working memory load, personalized cue creation and its effectiveness. Beyond the above implications the study investigates their influential behavior on restart errors and overall capability of lowering the error prone behavior of interactive system design.

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