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Paper Session II-D - Checkout and Launch Control System as a Case Study for Human Factors Education

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Checkout and Launch Control System as a Case Study for Human Factors Education

1.0 Introduction

The Checkout and Launch Control System (CLCS) Project is being used at FIU as a tool for improving the transmission of engineering education. This use has two goals. The first is to use exciting projects to inspire and motivate students in the pursuit of their engineering degrees. Excitement about education has been shown to captivate a greater percentage of a student's attention, leading to better learning. The second is to enhance the visibility of NASA projects with future engineering professionals. This can lead to a more widespread appreciation of the needs of the aerospace industry within the general community of engineers. It may also encourage engineering students to pursue NASA related careers.

CLCS-related units have been included at FIU in several ways. A major milestone of the CLCS project is an evaluation of four console workstation designs. This evaluation requires several detailed analyses to assess postures, productivity, and layout. In a Work Design and Ergonomics course, CLCS has been used as a case study through which to study these job evaluation methods.

Another major initiative of the CLCS project is to evaluate the software development process in CLCS for the presence of user inclusion in the design operation. This involves working with users of the software systems in CLCS to gauge their requirements and expectations prior to software development and then involving those users in formal usability testing of the software throughout the design cycle. User inclusion from the perspective of CLCS is being used as a case study in a course called Cognitive Engineering in Human-Computer Interaction.

2.0 The Work Design and Ergonomics course at FIU

2.1 Goals and Objectives of the course

Work Design and Ergonomics (WDE) focuses on the design of any workstation that may be used by a human worker during employment, including industrial, service, government, military and other sectors. There are two broad areas of concentration, productivity and ergonomics. The course teaches students how to design jobs and processes to maximize productivity while at the same time minimizing ergonomic stresses. The philosophy of the course is to evaluate workplaces from a systems perspective, considering productivity and ergonomics issues simultaneously rather than as separate functions. This eliminates the unfortunate circumstances where ergonomic changes hurt productivity or vice versa. When both are considered together, the overall success of the job is maximized.

2.2 Concepts from CLCS that were used in the course

One of the major efforts of the CLCS project was to create a console that supported the physical interaction of the system engineers and the CLCS hardware. In order to accomplish this effectively, it was critical to consider both productivity and ergonomics issues. Thus this part

of the CLCS project fit ideally into the WDE course. CLCS hardware includes several computer systems including monitors, keyboards and pointing devices (mice), legacy hardware including a communication system (OIS-D), video monitors and controls (OTV), and a safing system. Integrating this into one effective console that provided an environment that maximized the user's ability to achieve his or her goals quickly without creating a significant risk of cumulative trauma was a serious challenge. It was also a sufficiently complex problem to provide a rich opportunity for students in the WDE course to apply what they had learned.

2.3 Integration of CLCS material into the WDE course

CLCS was used to support course activities in two ways: in-class assignments and special projects. The in-class assignments were used to support the learning process by providing brief examples that could be tailored to provide only the details necessary for that concept. Using CLCS material for these examples afforded an exciting subject area to encourage students to participate fully. The special projects were used as a unique opportunity to provide a smaller group of highly motivated students with additional experience in the field of Ergonomics. The purpose of this effort was to encourage these students to fully appreciate the applicability of Ergonomics and possibly to pursue graduate work in this area.

2.3.1 In-Class Assignments

As the students learned specific Work Design and Ergonomics concepts or tools, they were asked to apply this to the CLCS situation in a general way. This took the form of class discussion where the professor, Dr. Marc Resnick, would present the specifications of the CLCS console relevant to that concept, and the class would spend fifteen to twenty minutes discussing the implications of the concept and/or how to apply a particular method to the situation. The benefits of using CLCS here was that NASA missions are exciting for students and can increase the motivation for participating in the discussion, leading to an increase in the retention of the material.

An example of a typical class assignment from CLCS can be seen in Figure 1. This assignment was presented to students during a unit on anthropometry. Students had been provided with the methods and statistical theory required to apply anthropometric data to workstation design. To support the learning process, the students needed an opportunity to apply these methods to an appropriate situation. The CLCS console was ideal for this purpose because it satisfied several criteria. It was a standalone workstation, thus reducing the interactions with other workstations that would have made the design too complex in scope for a small assignment. It also was more complex than a typical computer workstation, thus providing an appropriate level of difficulty to fully engage students in problem solving. Finally, as a NASA project it had an inherent level of excitement associated with it.

2.3.2 Special Projects

The second way in which the CLCS project was used to enhance learning in the WDE course was the creation of a special team of five students to do more detailed analyses of the CLCS console as part of FIU's contribution to the project. These students were selected through an application process that evaluated their abilities and commitment. This team was required to work five hours per week conducting analyses of the CLCS console using the tools

Consider the console at the left. This is the console planned for the new shuttle launch system at NASA. Determine the ideal dimensions for the worksurface, the location of each monitor, the height of the keyboard and other design dimensions. Use the anthropometric data provided in class and design for the 95th percentile male and the 5th percentile female.

Figure 1. In-class assignment applying anthropometry to the design of the CLCS console

from the course. They were provided with actual data from the task-based evaluation being conducted at Kennedy Space Center (KSC). For example, they observed many hours of video-tape from the task-based evaluation at KSC and performed a posture analysis of the users' interactions with the console prototypes (see Table 1). From this analysis they assisted in the development of layouts for the console equipment (see Figure 2). They were also exposed to the managerial and environmental aspects of the CLCS project. CLCS was an excellent way to enable a group of highly motivated and capable students to expand their knowledge and gain real experience in applying Work Design and Ergonomics concepts. These students are being encouraged to pursue careers in the Ergonomics area, possibly beginning with graduate studies.

Table 1. Results of a posture evaluation conducted by a special team of undergraduates in the Work Design and Ergonomics course

	Mild posture	Moderate posture	Severe Postura
Neck	27	65	7
Right Shoulder	31	22	10
Left Shoulder	6	4	0

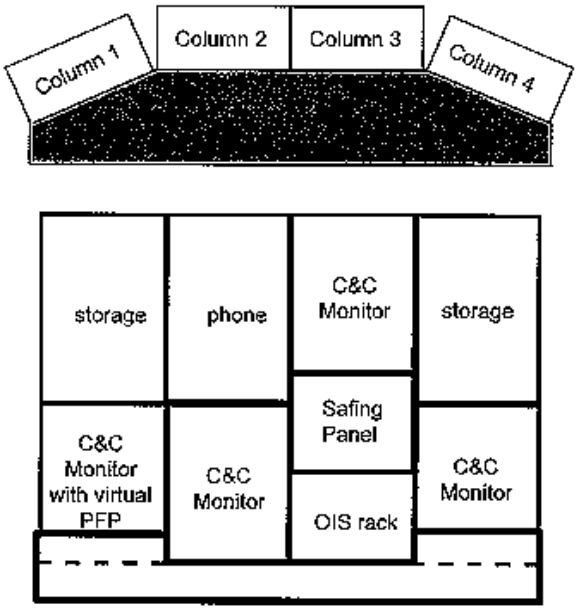


Figure 2. Design produced by a special team of undergraduates in the Work Design and Ergonomics course

3.0 Cognitive Engineering in Human-Computer Interaction at FIU

3.1 Description of the Course and its Content

Usability is a coveted entity in software development. It pertains primarily to how well the visual interface of a computer application supports computer users' needs in terms of effectiveness, efficiency, and appealability. Generally, designers value usability in a conceptual sense and ponder what would make a visual display more usable as displays are developed. Unfortunately, user inclusion is not recognized as the primary vehicle to achieve usability because it is not understood and it is mistakenly perceived as time-consuming and costly.

Cognitive Engineering in Human-Computer Interaction (CEHCI), a graduate level course at Florida International University taught by Dr. Julie A. Jacko, stresses the importance of the design of good computer interfaces. User interface design is taught from within the context of including the computer user in the design process in order to maximize the quality of the interaction that will occur between the human user and the application that is being developed. Particular emphasis is placed on developing a knowledge of how human cognition, memory, problem solving, and language relate to and condition the interaction between humans and interactive computing systems.

3.2 The Role of CLCS in CEHCI

In order to discuss how CLCS was integrated into the CEHCI course, a brief background is provided. CLCS at KSC combines personnel from United Space Alliance (USA), Lockheed Martin, Boeing, and NASA. Software developers in CLCS are engaged in a large scale software development effort that involves creating visual displays for a large variety of applications and tasks. The user interface development tool that is being used is *SL-GMS,* a data visualization tool that provides dynamic data representation and visualization within a graphical user interface. First, designers use a drawing editor to design static displays with standard or custom objects. Then, dynamic behavior is attached to the objects. Given the current CLCS environment, a unique opportunity exists to instantiate fundamental usability engineering methods into the visual display design process.

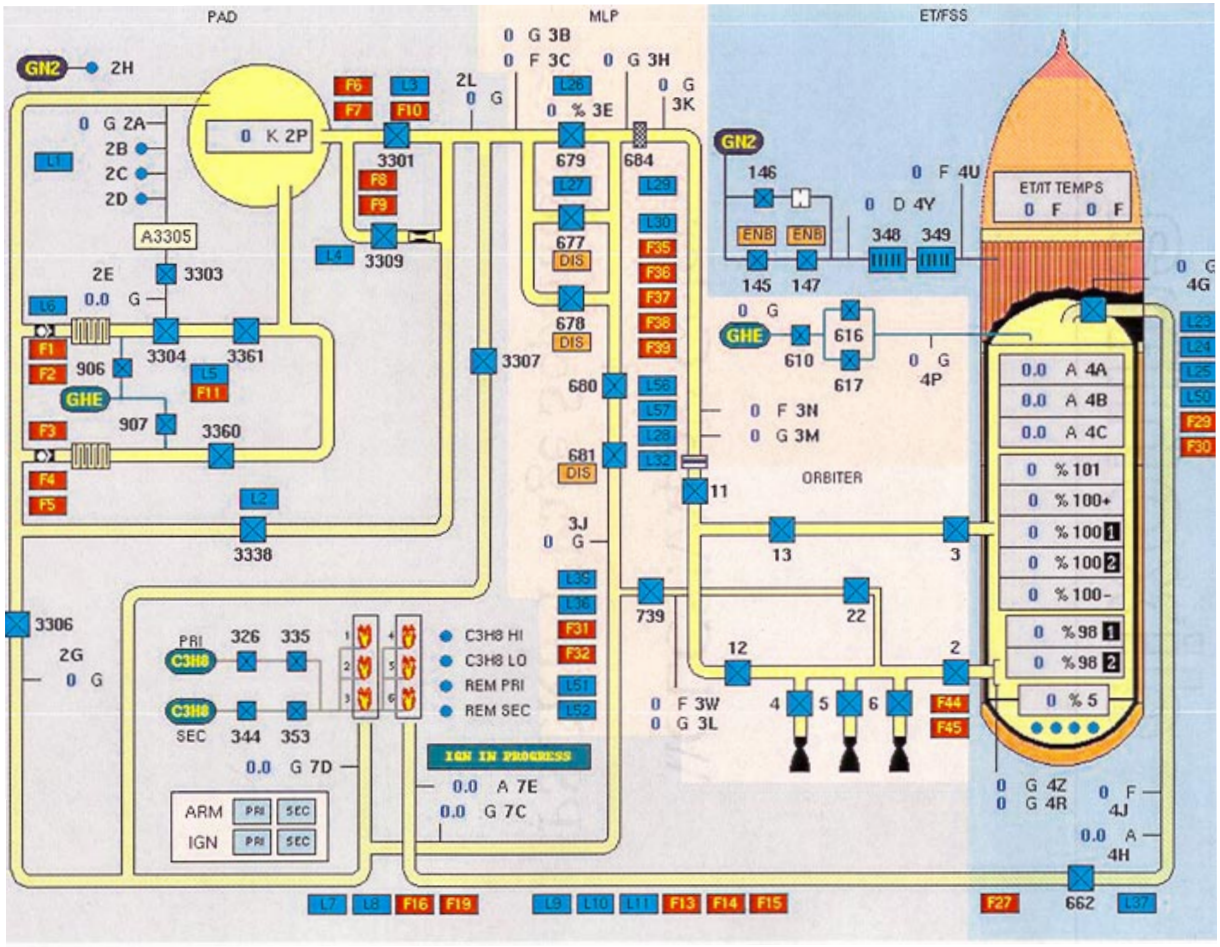
Given this background on CLCS, it is apparent that using CLCS as a case study for the CEHCI course could significantly enhance the students' learning experience through exposure to an actual large-scale software development effort underway at NASA. More specifically, this course was centered around the concepts of developing the product concept, performing a research and needs analysis, designing screen prototypes, performing iterative design, and conducting software implementation. These segments were taught more effectively by presenting the material from within the context of CLCS.

3.2.1 Product Concept Development and Needs Analysis

The students were exposed to the concept of product development through discussions of determining and verifying functionality, user profiles, and computer profiles. CLCS was useful in this process due to the varied backgrounds and skills possessed by the operators for which the software is being developed. Students were required to extend their textbook knowledge of user profiles by leading discussion groups of how this knowledge could be applied in an environment like CLCS.

3.2.2 Designing Screen Prototypes

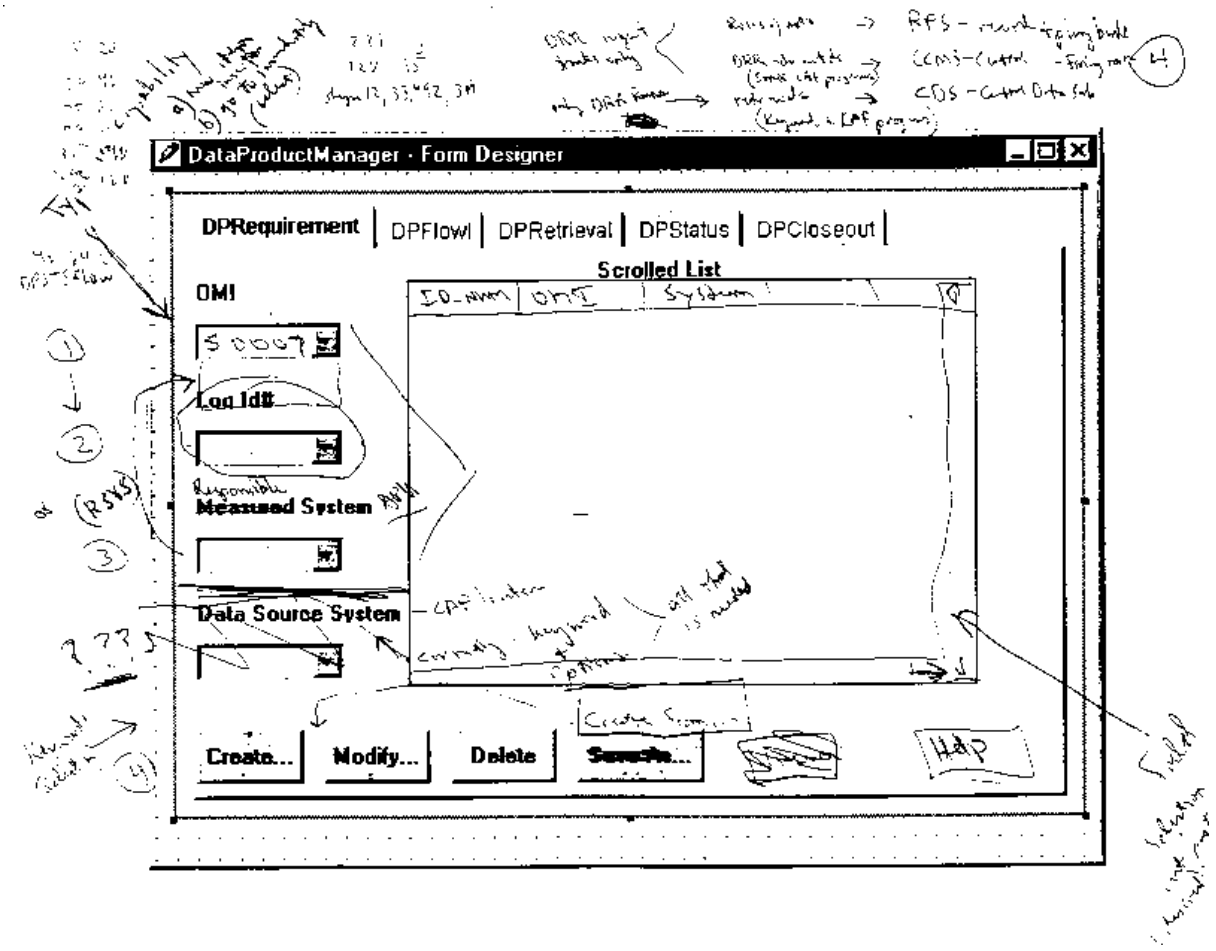
In this course, students were involved in constructing low-fidelity prototypes of actual application systems. Thus, low-fidelity prototypes that had been rendered by software developers in the CLCS environment were used as examples of real-world prototypes. Students studied these renderings during the design process to ensure that their prototypes captured the dimensionality necessary for this type of prototyping. In addition, students read a variety articles on sophisticated prototyping tools, including *SL-GMS,* to extend their knowledge of prototyping into the moderate- and high- fidelity domains. Figure 3 is a portion of a display constructed in the CLCS environment, using *SL-GMS,* that was used in the course as an example of a high-fidelity prototype and around which lectures focused on proper screen design.



3.2.3 Iterative Design

The CLCS experience was particularly useful in this segment because of the extensive iterative prototyping process that is necessary in the CLCS environment. Specifically, students were presented with five versions of one application in the CLCS environment and were asked to apply their knowledge of iterative prototyping to identify and specify the evolution of the

application screens. During this activity, discussions ensued that concerned not only elements of design, but also managerial challenges of iterative prototyping, especially during large-scale development efforts. Figure 4 illustrates one of the iterative designs from the CLCS environment that was integrated into the CEHCI course.



3.2.4 Software Implementation

The students were not directly responsible for software implementation due to constraints of time and resources. However, the students were exposed to issues concerning software implementation, specifically the usability testing of final software products. Issues in experimental design, surveying, and performance assessment were all presented from within the context of the CLCS.

3.3 Venues For Dissemination

The Professor's exposure to, and work within, the CLCS environment provided an excellent opportunity to lead discussions and lectures that centered around the CLCS application area. At various points over the course of the semester, students were required to lead small discussion groups that were focused on the application of specific principles in HCI to the CLCS environment. In addition, one of the graduate students enrolled in the course had acquired experience with the CLCS through a summer internship at KSC. Thus, he was called upon routinely to engage the other students in compelling examples generated from his work at KSC.

The CLCS experience provided a vast array of material with which the CEHCI course

could be enhanced. Through CLCS, students were able to apply their newly-acquired knowledge about HCI in an application environment to which they would not have been ordinarily exposed. In addition, CLCS provided the opportunity to structure exam questions that required students to synthesize information from the textbook and apply it to a large-scale software development project.

4.0 Conclusion

In conclusion, the CLCS project provided an opportunity to improve the education of students in two classes, as well as expand the visibility of NASA needs and priorities among a group of future industrial engineers. The benefits that accrued to both NASA and the students easily compensated for the effort required to implement these learning initiatives. The results of this effort are promising for future actions to use NASA projects in the learning environment.