Digital Educational Knowledge Assets (DEKA)
- An NJIT and Industry Sponsored R&D Project

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Abstract: The goal of this NJIT (New Jersey Institute of Technology, USA) and industry sponsored R&D project is to develop a series of methods, case studies and lecture material that encourages interactive and team oriented problem solving, enables virtual classroom contact between students, as well as between students and faculty, and most importantly that supports several topics and courses due to its modular, openly “interchangeable” (i.e. object oriented) nature (hence the title of the project). Furthermore, we are making the material 100% electronically stored and accessible over the Internet, the NJIT Intranet and/or CD-ROM, as well as to be used with the Virtual Classroom software system available at NJIT. The area of interest, under development includes the following: Design Specification and Manufacturing/ Assembly Process Design in the Concurrent Engineering Context; Product Design Case Study with Special Emphasis on Pro/ENGINEER Solid Modeling Software and Its Functionality; and Learning Ergonomics Interactively for Improving Human-Machine Interface Design. The project focuses on direct applications of the latest advances in information technologies to enhance the delivery, as well as the overall educational experience of students studying several different courses.

The benefit of having created an integrated approach to this problem is important, in that faculty members of different departments (i.e. IME and ME in this case) can work together as a cross-functional team, following a coherent educational, as well as an interactive multimedia (i.e. information technology) approach, validate the results individually, as well as together, and then refine and implement the Digital Educational Knowledge Assets (DEKA) in a truly modular, object oriented fashion to develop learning opportunities. Another major benefit of this project will be the fact that we'll have not just the proposed individual working modules, but also the process at which we have reached our results, which itself creates a valuable and repeatable experience and educational material, as well as a tested framework, hence it is extendable, customizable and sizeable, as well as satisfies total quality deve lopment principles.

Keywords: Integrated Engineering Education Modules, Interactive Multimedia, Example-Driven Learning, Product Design and Evaluation, Manufacturing Process Design

1. Introduction

In response to the NJIT Provost’ s Challenge to utilize the Information Technology in Teaching and Learning, the author together with faculty members from Department of Industrial and Manufacturing Engineering met in the spring of 1999 to develop course materials named as Digital Educational Knowledge Assets (DEKA). It is very logical for faculty members from the Mechanical Engineering Department, and the Industrial and Manufacturing Engineering Department within NJIT to work together on this project. Thus, DEKA is multi-disciplinary and integrated approach to teaching materials.

At NJIT, the freshman engineering students are required to take Fundamentals of Engineering Design 101 or FED 101 course. FED 101 is a project-based course, where the students work in a team to do their design projects. For the multi-disciplined project that involves product development, DEKA will be an excellent vehicle for the students in understanding how the product is developed, and manufactured. In addition to that, through DEKA students will learn how ergonomics concepts are used to improve the interaction between human and machine in design.

Eventually, modules of this project will be incorporated and electronically stored in CD-ROM, and accessible over the Internet. The tentative design of DEKA main interface is shown in Fig. 1 below. Note that DEKA is a work in progress project, and modification for improvements in accessing DEKA components is likely to occur.

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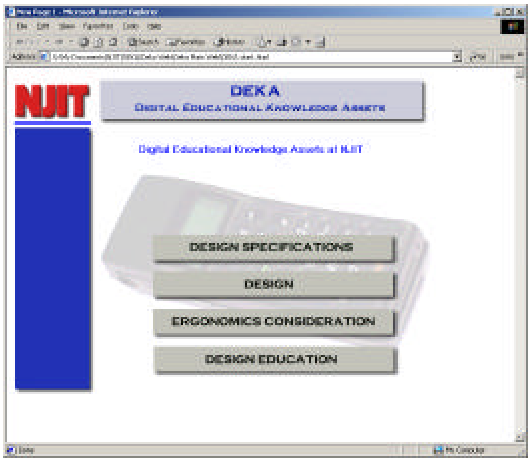

Fig. 1. Main interface of DEKA

2. Example Driven Engineering Education Modules

The cellular phone is chosen in this project due to its popularity at the present time. The students are able to relate, and compare with the currently available phones. Of course, the phone used in this study is the old phone that is no longer on the market, so the students will be able to observe the changes in its design. With the advances of computer chip technology coupled with Internet, the cellular phone will continue to evolve. It will be interesting for the students to watch.

2.1 Design Specifications and Design

This section describes the contribution of the author to the Mechanical Engineering component of DEKA – product design process case study of cellular phones. With the availability of advanced CAD/CAM/CAE systems at NJIT, the instructors will describe in brief not only how the students are introduced with the design process, but also how CAD/CAM/CAE is incorporated in design.

The chosen cellular phone is reverse engineered so that the product can be regenerated in CAD software Pro/ENGINEER® [1, 2]. The traditional hand sketching in isometric as the starting phase of the design process is also explained. The exploded view of assembly is shown in Fig. 2, and each component part in the figure is hyper-linked to explanatory HTML page of that particular part. The student will be able to understand how it is designed in CAD/CAM/CAE [3].

Fig. 3 shows the plastic analysis of the front case of the phone. It is generated using Pro/PLASTIC Advisor of Pro/ENGINEER®. The results of analysis such as injection pressure, weld lines, air traps, etc. are easily accessible on the menu located on the left. Also VRML, and animation of fill time allow the students to have a better understanding of analysis in 3-D perspective. The students can also click the Help button to get information on active topics or results.

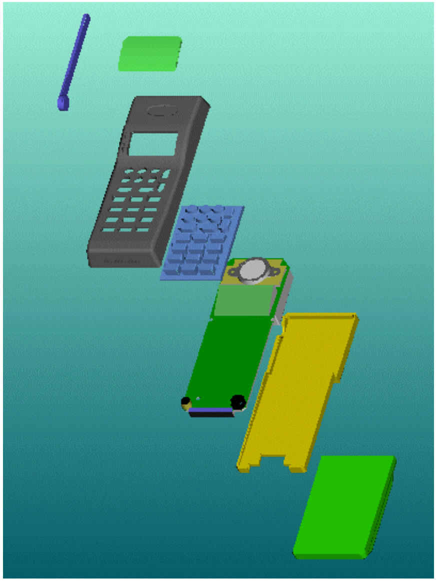

Fig. 2. Exploded view of cellular phone.

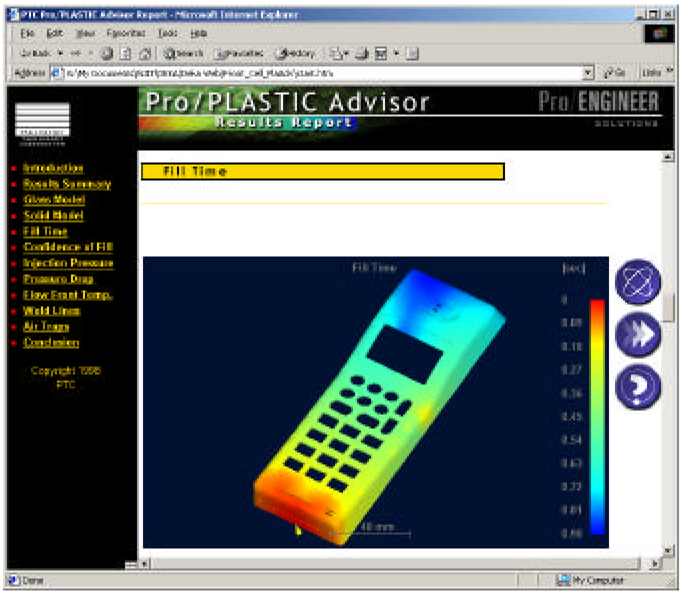

Fig. 3. Fill time of front case of the phone using Pro/PLASTIC Advisor.

2.2 Human Factors/Ergonomics Considerations

Human Factors/Ergonomics deals with the role of humans in complex systems, the design of equipment and facilities for human use, and the development of environments for comfort and safety. The purpose of the design activities is to match systems, jobs, products and environments to the physical and mental abilities and limitations of people [4]. It is the authors' opinion that ergonomics be included in the general engineering curriculum.

The objectives of the Human Factors/Ergonomics module are *converting course materials into digital formats*, *making some laboratory exercise available online*, and *promoting the integration of human factors and ergonomics into other engineering disciplines*. It is essentially the primary motivation for the entire DEKA project to convert course materials into digital formats. The Human Factors/Ergonomics module utilizes the cellular phone example and a top-down approach to introduce the fundamentals of human factors and ergonomics. Use of cellular phones is a good example for human factors and ergonomics since it involves both display input and control output of human users. An existing cellular phone was used to demonstrate the design issues that should be considered for human factors/ergonomics considerations. Therefore students can comprehend concerns of human factors and ergonomics in such a device. For example, the size of visual displays, the layout of control buttons and accessories, the sequences of control buttons for performing certain dialing functions, and the physical size of the cellular phone are discussed. Hyperlinks are provided for students to access fundamental background of the above issues. The fundamental background are in fact derived from traditional human factors/ergonomics lecture materials with hyperlinks. Therefore not only the cellular phone example has hyperlinks to the background materials, but also the background materials are organized into a full coverage of human factors and ergonomics essential topics (see Fig. 4). The current course module also provides online homework assignments and solutions, as well as web links to professional organizations such as the Human Factors and Ergonomics Society. It has been a concern of using hyperlinks in delivering learning materials [5]. Users may be easily lost in the hyperlinked cyberspace. Another concern of using hyperlinks is that users do not know how much information is needed in learning any particular subject. To take the advantage the flexibility of hyperlinks and avoid potential problems associated with hyperlinks, a navigation map is provided and objectives of learning subjects are clearly described in the beginning of each subject (see Fig. 5).

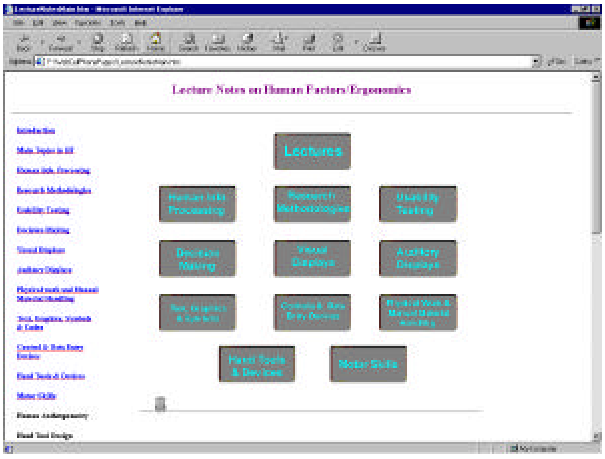

Fig. 4. Layout of the hyperlinked course materials for huma n factors/ergonomics.

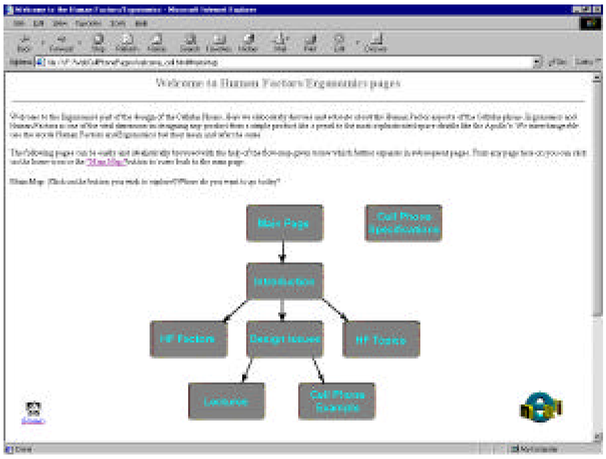

Fig. 5. A navigation map for students to access the Human Factors/Ergonomics Module.

Online and other types of digital education is becoming more and more popular throughout the world. There are, however, some subjects and class activities which are difficult to be delivered online. For example, the laboratory exercise is essential for studying human factors and ergonomics since the knowledge derived from the field is mainly experimental. The Human Factors/Ergonomics Module in this project developed several laboratory exercises using both online and off-line (digital video) techniques. LabVIEW software package (National Instruments) is used for both in-lab and online laboratory exercises. The human sensory inputs are generated and motor control outputs are measured through PC's equipped with data acquisition interface and LabVIEW. For example, a video clip is used to exercise the technique of time and motion study. Students are asked to perform elemental breakdown of operator movements as well as time study of the elements using the video clip. Another laboratory exercise was developed to allow students observing the effect of body postures to the generation of muscle strength. The experiment is setup in the ergonomics lab where a subject performs a series of isometric strength testing of the forearm using different postures. Students can observe the results of the strength testing through the network (see Fig. 6). The results are displayed in line graphs immediately after the trial is completed. Digital time-domain force data are stored and can be accessed for subsequent laboratory exercise.

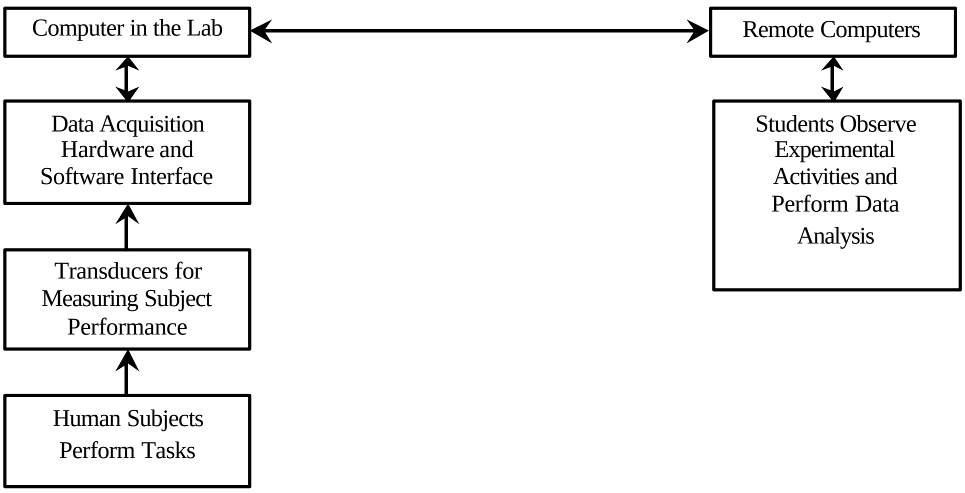

Fig. 6. Flow chart of the online experiment exercise components.

There are several major advantages of making laboratory exercises available online. First, more students can gain hands-on experience without requiring increase of laboratory spaces. Secondly, students spend more time on pertinent issues related to the laboratory exercises because some of the data collection procedures are automated. They can now concentrate on analyzing the data in order to fully understand the laboratory exercises. The online laboratory exercise also provides students with more flexible schedules to do their assignments. There are, however, some limitations to online laboratory exercise. For example, the online strength testing exercise takes students away from the opportunity of being subjects who perform the lifting tasks. Due to bandwidth limitation of current network systems, students cannot observe video of the lifting tasks with synchronized line graph results in real time. It is hoped that there will be more online laboratory exercises available upon utilizing more advanced technologies in the near future.

Since human factors and ergonomics deals with design for human-system interface, it is hoped that the development of the Human Factor/Ergonomics Course Module can eventually help to promote the subject to be included in the general engineering curriculum. Studies have found that human factors and ergonomics can contribute the most when it is integrated in the system design and actively involves in the entire design process. It will be more difficult trying to justify the need of human factors and ergonomics when evaluating and redesigning existing products and systems. Therefore the Human Factors/Ergonomics Course Module will be available for NJIT faculty who would like to incorporate the subjects into their engineering courses.

Although many new technologies and online approaches are implemented in the current projects, caution must be taken not to assume that those courses which use the DEKA modules are automated. It is not an attempt for the current project to develop courses to be delivered without faculty supervising, coordinating and advising students. Feenberg stated clearly that, "To maintain the benefits of online education we have to make sure that it is delivered not just by CD-ROMs, but also by living teachers, fully qualified to teach online and interested in doing so. Interaction with the professor must continue to be the centerpiece of education, no matter what the medium." [6].

4. Conclusions

DEKA is truly an integrated and team oriented approach to educational materials that will help the students to understand the various aspects of product development such as design process, specification, manufacturing, and assembly process in concurrent engineering environments. Ergonomics component of DEKA will make the students realize the importance of user-friendly aspects of the design. Course materials within modules and the modules themselves are flexible so that it will be easy for instructors to adopt them into their course curriculum. The current project has successfully demonstrated an approach for generating up-to-date teaching materials using advanced technologies with interdisciplinary engineering majors. Further investigations should be conducted to evaluate the performance of the course materials being developed.

5. References

[1] G. R. Bertoline, E. N. Wiebe, C. L. Miller and J. L. Mohler, "Technical Graphics Communication," McGraw-Hill Co., Second Edition, 1997.

[2] R. Toogood, "Pro/ENGINEER® Tutorial Release 20/2000i," SDC Publication, April 1999.

[3] K. Lee, "Principles of CAD/CAM/CAE Systems," Second Edition, Addison-Wesley Longman, Inc., 1999.

[4] G Salvendy. (Ed.), "Handbook of Human Factors and Ergonomics,". Second Edition,. John Wiley & Sons, 1997.

[5] A. Dix, J. Finlay, G.D. Abowd and R. Beale, "Hypertext, multimedia, and the world wide web," Chapter 16 in Human-Computer Interaction, Prentice Hall, 1998.

[6] A. Feenberg, "No frills in the virtual classroom," ACADEME, pp.26-31, September-October 1999.

6. Miscellaneous

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