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Human Factors/Ergonomics: How Can It Influence Your Students?

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An introductory psychology course usually includes information about classical psychological topics. Brief mention is sometimes given to Human Factors or Ergonomics which deals with how people function as part of a system (e.g., an air traffic controller governing our nation's aviation, a physician performing surgery in a modern operating room, a nuclear power plant operator governing the generation of electric power, a computer programmer improving code so that a computer will run more efficiently, or a consumer using a telephone or the Internet to find important information).

Indeed, some students may graduate from high school and not recognize that Human Factors is a part of psychology. Similarly, the students' parents and teachers may not realize this gap in the educational process. Neither the students, their family members, nor their educators may realize how much their lives might be affected by good and bad human factors. Thus, they may be willing to accept that they have an inability to use a computer or a VCR or a new telephone system when, in reality, the system is poorly designed. As a matter of fact, the students and their families are influenced by good or bad human factors design thousands of times every year. The following scenarios illustrate practical applications of human factors.

The Influence of Human Factors

The alarm clock rings at 6:30 in the morning. Our student, Susan, decides that 15 minutes more sleep is desirable, so she presses the snooze button. By mistake Susan turns the alarm off and oversleeps. Why? Is Susan incompetent or is it just too easy for a sleepy student to press the wrong button on the clock? Due to bad product design or bad human factors, Susan is about to miss an important exam. Fortunately, the backup system, Mom and Dad, are there to wake Susan so she won't miss her exam and, this afternoon Mom is going to the store to buy Susan a second alarm clock. This clock will be positioned on the dresser so that Susan cannot turn it off without getting out of bed. Thus, Susan and family are compensating for poor product design. A great alarm clock could have been designed to allow Susan to easily press the snooze button, but would make it more difficult to accidentally turn the clock off. A good human factors professional would have the knowledge to design a teen-proof clock in which it is easy to do the appropriate activity and more difficult to do "typically undesired" activity.

Now that Susan is 15 minutes late, her father has taken her car to work since it was the last car parked in the driveway, so Susan needs to drive his car. She turns on both the lights and the wipers, since it is raining. The rain stops and she attempts to turn off the wipers, but instead finds herself in the dark, since she turns off the lights instead. Susan is distracted by the absence of lights on a dark morning with wet roads. This distraction nearly leads to a collision. Some people might attribute this incident to "operator error" or "driver error." A human factors practitioner might, more accurately, attribute this incident to "poor design compatibility" or "design error," since, the two car makers have their lights and wipers in different positions which was the real cause of this incident. Fortunately, the location of the brake and the gas pedals are standardized!

Upon arrival at school Susan is a bit late. She rushes up the stairs and trips. Feeling a bit rushed and clumsy, she tells her psychology teacher, Ms. Wise, about the day's experience. Ms. Wise asked "Do you think there could be something wrong with the stairs?" At first Susan said no, but then Ms. Wise told her to watch the stairwell for about half an hour and record the number of people that came close to tripping on that step versus all of the other steps. Susan did this exercise and discovered more people tripped on her step. Then Ms. Wise told Susan to figure out why. Susan decided to measure all of the steps in the stairwell. She noticed that "her" step had a rise about half an inch different than all of the other steps. When the building was designed the builders decided to "cheat a bit" rather than redesigning the entire stairwell. They thought no one would be hurt by a small change in height. So, the trip was the fault of the stair designer, not Susan's! The stairs are an example of poor human factors at work.

Susan is now in school. We have seen that bad human factors design nearly caused her to miss an exam, have an automobile accident, and a personal injury. We will now see how less than ideal human factors delayed one of her classes, helped to provide the content for another class, and caused professional drivers, power plant operators, and medical professionals to have accidents and what is now being done to prevent these incidents in the future. We will also see how good Human Factors makes using the Internet easier and more fun. We will conclude by discussing human factors as a profession and ways to include it in the high school curriculum. Let us now rejoin Susan on her way to history class.

The history teacher is attempting to project some artifacts from the museum web site onto a screen for all to see. The projection device being used is a new one, and it is taking the history teacher about 10 minutes to obtain the image. It took 9 minutes too long to get started. Clearly, the Human Factors design of the projector is not a good one.

Next, Susan's physics class is going to a power plant for a field trip. An older style school bus has just pulled up to the curb to take Susan's class on the field trip. Susan notices the bus has the engine up front. The driver apologizes for being late, but he says taking the morning kindergarten children home took a bit longer than expected. Susan is one of the first to get on the school bus and sits up front. When she sits down, Susan notices that she can not see the road right in front of the bus. Susan asks the driver "How do you see the little children in front of the bus when they cross?" He explains that he cannot see them if they get too close. Indeed, he cites several accidents in which the school bus actually bumps into children who got off of the bus, cross the street, and run back for some papers. That, he explains, is the reason why the bus has a gate that comes out from the bumper when the bus stops to release children. The gate discourages children from getting too close to the front of the bus. In addition, children are taught never to come back to the front of the bus after they cross if they drop something. The driver also explains that the addition of the STOP sign to the side of the school bus was made about 20 years ago to discourage motorists from passing a stopped school bus. The driver explains that Human Factors professionals actually were involved in studying school bus safety and the effectiveness of the signs and lights and they designed an advertising campaign to encourage compliance with school bus laws.

Once in the power plant, the operator shows Susan's class a photograph of some of the earlier control rooms as well as today's room. She notices that in the early photograph there are some beer cans on top of the control handles. She asks why. The operator explains that in the early days the handles all looked the same. The operators needed an easy way to differentiate one type of control from another so that they placed a different beer can on each control, and actually referred to the controls by the name of the beer. Today, the human factors team has designed better controls.

Susan asks the operator what had caused accidents at power plants in the past. He explains that it was the result of human error which is sometimes called "operator error." Often, he explains, this human error is caused by poor design of the system, not by the operator on duty. An operator might, for example, be told through a signal that an action had been completed, for example, a valve was closed, whereas in fact all that really happened is that the operator instructed the system to close the valve — but the valve may have malfunctioned and not closed. He explains that in the event of an emergency, sometimes too much information might come in to be handled by a human. Thus, he explains, today a human factors team is involved in determining what messages will be shown under certain circumstances. A Human Factors professional also participated in designing the operator's training program to insure that the operator was not overloaded.

After school Susan goes to the hospital where she does volunteer work. She asks the nurses if errors are ever made in giving patients the wrong medicine. The nurses reluctantly answer yes — this does happen. Susan asks if any Human Factors studies were done to figure out procedures to reduce these errors. The nurse sends her to the hospital pharmacist, who explains that studies of medication errors within a Human Factors framework are just beginning. He refers her to a specialist who is pioneering some of this work. Susan decides, given her interest in psychology and people, medicine, and her knowledge of technology that she wants to study how to prevent medication errors to save patients' lives Thus, she eagerly returns home to search for more information about Human Factors on the web.

Fortunately, the web sites were well designed by Human Factors professionals, so they were easy for her to use. She quickly finds the web site of the Human Factors and Ergonomics Society (WWW.HFES.ORG) which provides her with some great basic information about Human Factors and Ergonomics, which might, one day, become her career. She then calls upon some human factors specialists and she finds that:

- ❑ Human Factors and Ergonomics is the design and testing of systems so that they will be safe, easy (and perhaps fun) for people to use.
- ❑ Psychologists, because they understand people, are able to define what the person can do — and what the system must do to optimize safety as well as the human resources required to perform a task.
- ❑ Human Factors and Ergonomics are essentially the same discipline. The term Human Factors originated in the US, and the term Ergonomics originated in Europe.

❑ Human Factors Psychology is a great career for individuals interested in people as well as technology, because psychologists design and test systems and products based on what people need, want, and can use. It is possible, for example, because of the multidisciplinary nature of the field, to be working on the design of airplanes, possibly even the space shuttle, consumer products, automobiles, medical equipment, and computers all in a single career!

❑ Typically a Human Factors professional will have a BA or BS degree in Psychology or Industrial Engineering and a MA, MS, or PhD in Engineering, Experimental Psychology, or Human Factors. Some Human Factors professionals may have degrees in medicine (MD) or law (JD).

❑ It is best for a human factors professional to study technology as well as psychology in college.

❑ A future engineer, designer, or scientist will benefit from at least studying an introduction to human factors to better design and to know when to call the experts.

❑ A consumer will make better purchasing decisions if they understand human factors.

❑ October is National Ergonomics Month.

❑ The Human Factors and Ergonomics Society consists of a group of professionals with an interest in psychology and one or more of the following technical interests:

- ❖ Aerospace Systems
- ❖ Aging
- ❖ Cognitive Engineering & Decision Making
- ❖ Communications
- ❖ Computer Systems
- ❖ Consumer Products
- ❖ Education
- ❖ Environmental Design
- ❖ Forensics Professional
- ❖ Individual Differences in Performance
- ❖ Industrial Ergonomics
- ❖ Internet
- ❖ Medical Systems and Rehabilitation
- ❖ Macro ergonomics
- ❖ Perception and Performance
- ❖ Safety
- ❖ Surface Transportation
- ❖ System Development
- ❖ Test and Evaluation
- ❖ Training
- ❖ Virtual Environments

The Human Factors and Ergonomics Society (HFES) typically invites a select number of high school teachers and students to its annual meeting. The 2002 annual meeting in Baltimore, MD was attended by psychology teachers Nancy Kreloff, Faye Johnson, and Geri Acquard, and students Rebecca Dreifuss, Amanda Shapin, and Jess Engenbretsen. Teacher Geri Acquard indicated that she was truly impressed with the program. Nancy Kreloff indicated that the conference had been most worthwhile and recommends that teachers and students attend the HFES meeting in the future. Jess Engenbretsen said, "I am mostly interested in psychology and the people, rather than the machines, but today's visit [to the HFES annual meeting] has shown me how important the interaction is." Amanda Shapin indicated that she really enjoyed the presentations, became really excited about human factors, and even edited some of her college essays to indicate this interest. (Teachers interested in being invited to the HFES 2003 meeting in Denver, Colorado or the 2004 meeting in New Orleans, Louisiana should send a note to the author of this article at rshapiro@us.ibm.com.)

Upon completing her web search and interviews, Susan receives an evening telephone call from her brother, Bill, who is in the Army. During the conversation she mentions her new found interest in Human Factors. Bill responds that he had just finished meeting with some Human Factors professionals who were working on making equipment safer and easier to use. He mentions that the Human Factors professionals observed him at work and prepared a detailed workflow analysis showing exactly what he and his colleagues did at every second. They also asked him to test some prototype equipment and observed in great detail how he used this equipment as opposed to the equipment he normally uses.

Recommendations For Teachers

Teaching human factors is consistent with the *National Standards for the Teaching of High School Psychology*, although Nancy Kreloff points out that there is a disparity between the breadth of the human factors field and the tiny reference to human factors in typical high school psychology textbooks. Nonetheless, human factors does integrate well into the standards for teaching high school psychology. Example discussion topics and questions for several of the performance standards (*in italics*) follow:

Standard Area: Sensation and Perception:

♦ *1.2 Describe the operation of sensory systems.* Students can discuss and explain how one would design

equipment, optimizing the strengths of the sensory systems and compensating for the weaknesses.

♦ *1.4 Relate knowledge of sensory processes to applications in areas such as engineering psychology, advertising, music, architecture, and so on.* Students can discuss current products and systems and how they take advantage of the visual system and how they can be improved. For example, are red or yellow-green fire trucks better?

♦ *2.2 Describe binocular and monocular depth cues.* Discuss the appropriate design of computer displays so that a system can be visualized. Perhaps, read some of the medical literature on how physicians can get lost while doing endoscopic procedures. How can the displays be improved?

♦ *3.2 Describe how attention differs for demanding versus simple tasks.* Discuss how people can and cannot multitask. Do a task flow diagram on how a person can actually perform in a complex system, such as driving a car.

Standard Area: Learning:

♦ *3.1 Describe the operant conditioning paradigm.* Discuss how people learn to use computer programs. Where does conditioning take place?

♦ *4.2 Describe cognitive learning approaches.* Explain how to best design learning modules, help panels, and other types of computer learning. When is computer learning better? When is classroom learning better?

Standard Area: Memory:

♦ *2.1 Describe the operation of short-term memory.* Discuss how to optimize a system to complement the limitations of short term memory.

♦ *2.2 Describe the operation of long-term memory.* Discuss how to optimize a system to reduce recall errors.

♦ *3.2 Explain the role that interference plays in retrieval.* Discuss how to minimize interference.

Standard Area: Thinking:

♦ *2.3 Analyze the obstacles that inhibit problem solving and decision making.* How does one design systems to encourage, not inhibit problem solving? How do you prepare people to be able to solve problems optimally under crisis conditions? How well do decision-making models describe your behavior/experience in retail environments? How well do the models describe your shopping/buying behaviors and experiences on the internet? What else might be going on in these experiences?

Standard Area: Social and Cultural Dimensions of Behavior:

♦ *3.2 Describe how social structure can affect intergroup relations.* How does technology (such as a virtual classroom or virtual meeting room) help or hurt the ability of people to build relationships and work together to get things done as teams?

For additional resources, teachers may wish to:

❖ Check the HFES web site over the summer to see what additional HF activities may be available to you in October for National Ergonomics Month.

❖ Read the following articles in *Teaching of Psychology* which promote HF thinking and provide a strong argument for the necessity of this type of education.

- Carkenord, D. M. (1994). Promoting human factors psychology thinking through design assignments. *Teaching of Psychology, 21*, 235-237.
- Stone, N. J. & Moroney, W. F. (1998). Teaching undergraduate human factors: The need, activities, and benefits. *Teaching of Psychology, 25*, 185-189.

❖ Encourage students who are residents of Maryland to apply for admission to Maryland MESA's summer camp for Maryland residents. If interested in applying to this camp contact HFES Diversity Chair, V. Grayson Cuqlock-Knopp by e-mail (vgrayson@arl.army.mil).

❖ Consider attending the following sessions at the Eastern Psychological Association meeting in Baltimore (March 13-16, 2003): *Games To Explain Human Factors* and *Preparing For Your Career With A Psychology Degree.*

❖ Consider inviting a Human Factors Practitioner to address your state or regional psychology conference or your classes. You may try to locate an HF professional by contacting the officers of a local HFES chapter, an HFES student chapter or a university department with a HF program your area. These organizations may be found through the HFES web site (WWW.HFES.ORG). If there are no such organizations in your area, you may contact the HFES central office through the web site or the author of this article for further help.

Summary

As a result of our better understanding our human capabilities and limitations, and demanding that product manufacturers do the same, our society will be safer. We will be more efficient, and will have more fun! Enjoy teaching Human Factors as part of your psychology course. Let me know if I can help.

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