Study Guide 03: Exam 03 26 April 2023

Design Concepts for Engineers, Horenstein, 5th edition

Chapter 05: The Human-Machine Interface 01–13 Mar 2023

Chapter Objectives

- Learn how people interact with machines.
- Understand the importance of the human–machine interface.
- Examine case studies of good and bad human–machine interfaces.

Vocabulary and Concepts

Ergonomics	The science of how the body interacts with machines. Ergonomics focuses on the size, weight, and placement of objects and control devices that interact with the human body
Cognition	The way in which a user learns about the device and masters its features. A well-engineered device affords a short learning curve and a consistent set of operating rules
Right-Hand Bias	The tendency of most ordinary, frequently used items, devices, or systems to favor ease-of-use with the right hand. Objects might be inconvenient, difficult, or even prohibitive to use with the left hand
Universal Design	Process of creating products that are accessible to people with a wide range of abilities, disabilities, and other characteristics; application of UD principles minimizes the need for assistive technology, results in products compatible with assistive technology, and makes products more usable by everyone

Principles of Universal Design

- Equitable Use
  The design is useful and marketable to people with diverse abilities.
- Flexibility in Use
  The design accommodates a wide range of individual preferences and abilities.
- Simple and Intuitive Use
  Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
- Perceptible Information
  The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
- Tolerance for Error
  The design minimizes hazards and the adverse consequences of accidental or unintended actions.
- Low Physical Effort
  The design can be used efficiently and comfortably and with a minimum of fatigue.
- Size and Space for Approach and Use
  Appropriate size and space is provided for approach, reach, manipulation, and use regardless of the user's body size, posture, or mobility.

Questions

Can you answer these questions? If so, you should have a good grasp of the Chapter 03 concepts.

- Are you right- or left-handed? List two tasks which you perform exclusively with that dominant hand. Now try to perform one of those tasks with your other hand and put into words exactly what that feels like. Do you think you could eventually get used to using your non-dominant hand to perform this task routinely? Why or why not?
- Find an example of a common item or product which is simple, intuitive, and effective for a right-handed person to use—but is complicated, frustrating, or impossible to use if you're left-handed. Explain why, using the concepts of ergonomics, the product is suitable for a right-handed, but unsuitable for a left-handed, user.
- Find an example of a different product or tool that is specifically designed for the left-handed user (use your critical thinking skills, and don't fall for the jokes). Examine the product from an ergonomic standpoint and explain how the design differs from a right-handed version of the same product. Would the product significantly improve the experience of a left-handed user, or is it a gimmick designed to separate the left-handed person from their cash?
- Locate an example of a truly ambidextrous tool, item, or product. Note the features that make it suitable for use with either hand.
- Think of a seemingly neutral tool which has a hidden right-handed bias. Explain how it's biased and what makes it hard for a left-handed person to use.
- The textbook uses the example of a typical light switch (position and operation) as an example of the concept of cognition (Example 5.5, page 211). Light switches are placed in locations that 'make sense' and you don't need

instructions when you go to someone else's house because all switches operate the same way. Describe an example of cognition which you encounter routinely in your daily life.

- Think about toys. Specifically, toys for very young children. These tend to rely heavily on the concept of cognition. Why? Recall your own childhood, and think about some of your favorite toys. Choose one and explain how, when you play(ed) with it, you were using cognition.
- Did you ever play with a toy in a way that wasn't intended (or turn something into a toy that was never meant to be played with)? Of course you did. Think about how, as a child, you were using cognition. Specifically, make the connection between your 'rogue' use of the toy and what your understanding of the world was at that age.
- If I tossed you my car keys, could you drive my car? Do I need to tell you exactly what I drive (make, model, year)? How are you able to drive cars made by manufacturers in different countries on different continents? If you stepped off a plane in London, walked up to the rental car counter, and they handed you the keys to a Vauxhall Corsa, could you drive it? What might hinder your ability to easily adjust to driving it? Is it the car (would you be fine if they had just given you that BMW you thought you had reserved?), or is it a bigger issue? Frame your response explicitly in the context of cognition.

Chapter 06: Engineers And The Real World 15 Mar – 26 Apr 2023

Chapter Objectives

- Examine society's view of the engineer.
- Learn about the role of failure in engineering design.
- Discuss classic design failures as case studies.
- Learn how to accept and utilize failure along the path to engineering success.

Vocabulary and Concepts

Misconception An erroneous belief in how a device or system operates, or an incorrect interpretation of a physical law

Ethics Based on well-founded standards of right and wrong that prescribe what humans ought to do, usually in terms of rights, obligations, benefits to society, fairness, or specific virtues

Engineering Ethics The application of general ethical principles to the specific domain of engineering and technical situations and problems

NSPE Code of Ethics National Society of Professional Engineers document outlining the acceptable standards of honesty and integrity to which engineers must be held for the benefit of the public health, safety, and welfare

Fundamental Canons of the NSPE Code of Ethics

- Hold paramount the safety, health, and welfare of the public.
- Perform services only in areas of their competence.
- Issue public statements only in an objective and truthful manner.
- Act for each employer or client as faithful agents or trustees.
- Avoid deceptive acts.
- Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

Failure Analysis The process of determining the most fundamental reason which caused the failure (i.e., root cause), ideally with the intention of eliminating it and identifying means to prevent its recurrences.

Process of Analyzing Failure

- Definition of the problem and data collection
- Identification of damage modes and mechanisms
- Testing for the actual mechanisms taking place, leading to the failure
- Identification of the possible root causes
- Confirmation of cause-effect relationships
- Tests of the actual root cause
- Implementation of corrective actions

Catastrophic Failure A major failure event wherein the device or system is suddenly and unexpectedly rendered inoperable and typically irreparable. No coming back from a catastrophic failure

NTSB The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating every civil aviation accident in the United States and significant accidents in other modes of transportation—railroad, highway, marine, and pipeline

Factor of Safety The required margin of safety for a structure or component according to code, law, or design requirements. A safety factor = 2 means that a structure can safely withstand a load twice as large as the expected maximum

QUESTIONS

Can you answer these questions? If so, you should have a good grasp of the Chapter 04 concepts.

Think of an example of an engineering or scientific misconception or misrepresentation which you encounter, if not frequently, then at least more than once. Choose one that drives you bananas. You might draw inspiration from the examples cited at the beginning of Chapter 06, but do not duplicate them.

- Explain the "wrongness" of this misconception or misrepresentation clearly.
- Briefly analyze whether this is typically an unintentional error, or a deliberate misrepresentation. If deliberate, do you think it's also malicious?
- What difference does it make? Is the propagation of this misconception generally harmless, or are the consequences of perpetuating the myth real, and potentially harmful?

Every now and then, the conspiracy theory that the Apollo moon landings were a hoax seems to gain popularity. For the record: the landings were not a hoax, and the arguments made to "prove" that they were have been debunked, thoroughly, credibly, and repeatedly (google Bad Astronomy and/or Phil Plait; also, *never* tell Buzz Aldrin to his face that he did not walk on the moon, and if you do, don't say I didn't warn you...do you need some ice for that black eye?).

- Research one of the arguments that the conspiracy theorists believe proves that the landings never happened. How does the argument fail under close scrutiny?
- Discuss what you think are possible reasons why some people might *want* to believe this idea. What does a person gain by investing in this particular conspiracy theory?
- Without resorting to fisticuffs, how could you convince someone that the landings were genuine? Do you think this would be an easy thing to do?
- As an engineer, how do anti-science conspiracies affect you personally? Even if you are not a NASA engineer, how does the landing hoax conspiracy impact your ability to pursue the science-and-technology career you have chosen? How is your own credibility put at risk by the persistence of anti-science conspiracies?