Human Factors at Work

The first article in this series introduced human factors specialists and how they study the sensory, cognitive, and motor aspects of human performance. Now we will take a closer look at some of the work that human factors engineers are involved in. (Here's a link to Part 1 if you want to refer to it.)

Distracted Driving

We're all familiar with the dangers of driving while texting, talking on the phone, checking Facebook, or looking at a navigation app. According to the U.S. Government, 3,154 people were killed in the U.S. in 2013 because of distracted drivers.[1]

Many companies are looking to address distraction by improving the human-machine (or driver-car) interface. Heads-up displays, which project information in the driver's field of view, are one potential improvement. One manufacturer is developing a device that projects notifications, such as navigation directions, caller ID for in incoming call, or social media notifications, so that they appear to be floating six feet in front of the driver.

The argument is that information is less distracting when presented this way, because it is in the driver's field of view. In a *New York Times* article, one company executive points out that airline pilots use a similar technology when landing an airplane, proving that the technology is safe.[2]

From a human factors standpoint, however, the argument is not so clear. A human factors expert would distinguish between information that is critical to the task being performed and information that is peripheral. Peripheral information is a distraction that competes for your attention, no matter how or where it is presented. The information a pilot sees in a heads-up display is related to the task at hand; the pilot doesn't see any tweets. Caller ID and text messages are not related to the task of driving.

This is one example of how human factors specialists look at the way people process information. What does a pilot need to know when landing an aircraft? What does a military commander need to know in the middle of a battle? Human factors helps filter out unnecessary information in situations such as these and present important information in a way that captures our attention.

Poor Software Development Practices and User Interface in Medicine

Between 1985 and 1987, at least six patients receiving radiation therapy from a machine known as a Therac-25 received massive overdoes of radiation, resulting in death or severe injury. [3]

---

[1] http://www.distraction.gov, 29 May 2015

[2] http://www.nytimes.com/2015/05/31/technology/windshield-devices-bring-distracted-driving-debate-to-eye-level.html, 29 May 2015

The Therac-25 could operate at low or high power; when operating at high power, a mechanism was activated to diffuse the beam. But a software bug existed: an obscure combination of keystrokes caused the Therac-25 to operate at high power without the diffuser activated. When this situation occurred, the machine operator would see a vague error message: the word MALFUNCTION followed by a number. The operators did not understand this error and simply bypassed it and continued. According to one researcher, the Food and Drug Administration reported that:

> The operator's manual supplied with the machine does not explain or even address the malfunction codes. The Maintance [sic] Manual lists the various malfunction numbers but gives no explanation. The materials provided give *no* indication that these malfunctions could place the patient at risk.

The researcher further noted that "an operator involved in one of the accidents testified that she had become insensitive to machine malfunctions."[4]

Software interface issues range from being annoying to, in this case, deadly. There were several human factors issues in this situation. Obviously, the error message was inadequate. But there were also issues with the design of the Therac-25 and the software development and quality assurance processes used when developing the instrument. All of these issues had human factors components.

Fatigue in Aviation

As discussed in Part 1 of this series, over 50% of fatal aviation accidents are caused by human error. Distraction often plays a role in these errors, and distraction is often exacerbated by fatigue. Human factors experts examine the effect of fatigue on human performance.

In 2015, UPS flight 1354 crashed short of the runway on landing, killing the pilot and co-pilot. The flight crew made numerous errors upon landing approach, as detailed in the accident report from the National Transportation Safety Board.[5] In particular, they failed to properly configure the flight management computer, monitor altitude, and communicate critical information during the landing. The NTSB saw fatigue as a key factor in this accident and found that "for the captain, fatigue due to circadian factors may have been present at the time of the accident" and that the first officer "was fatigued due to acute sleep loss and circadian factors, which... likely resulted in the multiple errors she made during the flight."

The effects of fatigue are well known and have been compared to blood alcohol level:[6]

- 17 hours awake is equivalent to a blood alcohol content of 0.05
- 21 hours awake is equivalent to a blood alcohol content of 0.08
- 24-25 hours awake is equivalent to a blood alcohol content of .10

---

[3] http://en.wikipedia.org/wiki/Therac-25, 29 May 2015
[4] The Therac-25 Accidents, by Nancy G. Leveson, http://sunnyday.mit.edu/papers/therac.pdf, 29 May 2015
[5] http://www.ntsb.gov/investigations/AccidentReports/Pages/AAR1402.aspx, 29 May 2015
[6] http://www.ccohs.ca/oshanswers/psychosocial/fatigue.html, 29 May 2015

Human factors specialists look at fatigue in a variety of industries besides aviation, such as trucking, nuclear power, healthcare, and athletics. The Rolling Stones even worked with a sleep specialist because of the demands of their touring schedule.[7]

Poor Work Controls and Training in Nuclear Power

In 1999, workers in Japan's Tokaimura Plant were preparing a batch of nuclear fuel. They dissolved uranium oxide powder in nitric acid in buckets and then poured the solution into a tank. As they did so, the uranium reached a critical mass in the tank, meaning that self-sustaining nuclear reaction occurred, emitting intense gamma and neutron radiation. Three workers were hospitalized for radiation exposure, and two did not survive.[8] Sixty-eight other people received lower doses[9] and local residents were evacuated.

The International Atomic Energy Agency found that the cause of this accident was "human error and serious breaches of safety principles":

- The workers were not trained to perform the task. They were used to working with uranium enriched to 5% and the uranium they were working with was enriched to 18.8%. They did not understand the dangers of working with highly enriched uranium.
- Criticality accidents essentially occur when too much radioactive substance occupies too little space, allowing a nuclear reaction to initiate. The approved procedure for performing this task had controls on how the dissolved uranium was added and required that the mixing occur in a tank designed to prevent criticality. Modifications to the procedure had bypassed these safeguards.

In complex technical environments such as nuclear facilities, personnel selection, training, communication, and procedures are very important. Human factors specialists are very involved in all of these areas, particularly where worker and public safety are at risk.

Learning More

These are just a few examples of the types of work that human factors specialists perform. If you're interested in learning more about any of these incidents, you can investigate further by reviewing the references. If you're interested in learning more about human factors, you could check out the Human Factors and Ergonomics Society or the Human Factors Journal.

Part 3 of this series will take a closer look at human factors in one industry -- software development.

---

[7] http://www.mensfitness.com/life/sports/sleep-doctor-elite-athletes-ceos-even-rock-stars, 29 May 2015
[8] http://www.world-nuclear.org/info/safety-and-security/safety-of-plants/tokaimura-criticality-accident, 29 May 2015
[9] http://www.wise-uranium.org/eftokc.html, 29 May 2015

Dr. Craig Rosenberg is an entrepreneur, human factors engineer, computer scientist, and expert witness. You can learn more about Dr. Rosenberg and his expert witness consulting business at www.ui.expert

Craig Rosenberg, Ph.D.
www.ui.expert
craig@globaltechnica.com
206-552-9898