Engineering Psychology Course Pack
Fall 2019

A History of Engineering Psychology

Goals of the chapter

- Learn what engineering psychologists research and how they are trained
- Learn about the different names for engineering psychologists and what they do in an industry or government setting
- Learn how engineering psychology began and why it began

Assessment

- What is the difference between engineering psychologists and human factors engineers?
- How did engineering psychology begin according to psychologists?
- Does an engineering psychologist conduct research or provide therapy?
- Why are engineering psychologists often named engineers in industry when they are not required to pass the ABET or take engineering courses?

What is Engineering Psychology?

Engineering psychology is the study of how humans work in systems from the neck up. Systems can be any series of cooperative actions between a machine or series of machines/computers and a human. Work can be any activity that has a goal and measurable progress. The goal can be related to the person's profession, recreation, or personal lives.

For example, a person may need a document printed for an upcoming meeting. In this case, a person may use a copy machine/printer that is connected to a network with a series of computers in different offices or labs. The person accesses the copy machine/printer through the computer to print a document to distribute during a meeting. The person must understand how to access the copy machine/printer, the state of the copy machine/printer's capability to print, and the state of the computer's ability to access the copy machine/printer. For the person to be part of this system, a complex mental model of the system must be available including the physical location of the different system parts as well as their system states. In this example, the person is a part of the printing system as the operator of the machines. The machines cannot print the document without the person issuing the commands for it to print.

Another example would be a recreational goal. A person may want to find the closest public swimming pool for their children's birthday party event. In this case, the person may use their cell phone's mapping application and search for swimming pool near me. This search triggers several systems that support the cell phone's application. The search engine determines what type of information the person typed into the search bar. The cell phone is geolocated through the satellites and IP address. The location of different public swimming pools is also geolocated and the distance is calculated. These systems communicate with the cell phone application. The application displays the selected services for

the person to choose from. The application may also have a function from which the person can dial the business' phone number directly.

A final example would be a personal goal. A person may need to go to their physician for a checkup. In this case, the person does not initiate the action, but it is initiated on that person's behalf by other humans or the system. The person calls the doctor's office and makes the appointment. The administrator at the appointment desk sees the person's phone number trigger an application on the computer that accesses that person's medical records and other files. The administrator verifies that this is the correct information with the person on the phone. Once that verification has been made, the appointment is made, and the system makes the files ready for the doctor at the appointment day and time. In this case, the automation has been designed to lessen the workload on both the person and the administrative assistant.

In each of these cases, knowledge of human cognitive capabilities and limitations play a role in the design process. Research has been conducted to determine the optimal settings for the systems to maximize human understanding, communication, and lessen error reduction. This field of psychology concerning this research is called Engineering Psychology. People who conduct this type of research are called Engineering Psychologists. People who put this research into practice may be called either Engineering Psychologists or Human Factors Engineers.

In the United States, knowledge of human physical capabilities and limitations are a different category of research. These persons who conduct research and make recommendations on how the human physically interacts with a system are called ergonomists. They study anthropometrics or the measurements of humans and human movement in space.

The History of Human Factors

The history of this sub discipline of the profession depends on whom is describing it. Psychologists trace the history back to the work of Wundt's experiments on sensation and perception in the 1800s and then Gestalt psychology in the 1940s and then George Miller's article (Miller, 1956) on the limits of short-term memory in the 1950's1. However, most Engineering psychologists recognize that World War II played a pivotal role in developing the profession. In World War II, technology began to be used extensively in warfare. Walkie Talkies helped soldiers communicate on the battlefield. Airplanes delivered personnel, goods and ammunition as well as bombs to both sides. During the war, psychologists were employed to enhance the performance of the Soldiers and to discover why some Soldiers were more proficient at flying some planes and the reverse. Psychologists investigated why some planes were more difficult for Soldiers to fly and crashed more often. This was the inception of the field of Aviation Psychology which is still a strong sub discipline within Engineering Psychology. Other psychologists investigated how to make Walkie Talkies more effective. They implemented a system of codes that were easier to hear across the noisy battlefield. Many military organizations and paramilitary organizations still use these codes today to convey important standard messages.

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1 http://cognet.mit.edu.ezaccess.libraries.psu.edu/pdfviewer/book/9780262279017/chap13

Those with a background in computer science may trace the origins back to management information systems and human computer interaction. Human computer interaction has a rich research background as described in the journal article by Myers (1996). The origins of most of the devices that we use today can be traced back to a few labs at Stanford, Bell, and Xerox Parc. These early studies in the 1960s laid the groundwork for the mouse, Windows, graphical objects, and direct manipulation in contrast to command line manipulation. Human computer interaction is a part of human factors discipline that works only with how people work with computers.

Ergonomists may trace the origins of Human Factors to Alain Wisner's call (1989) to combine the efforts of psychology, sociology, anthropology, economics, finance, engineering, and politicsi As he was one of the first to ask the members of the IEA to address sociological disparities with technological solutions.

Other disciplines have contributed to Engineering Psychology such that it is one of the branches of psychology that has theory that crosses many disciplines. In addition to theory, many professionals who are not trained as psychologists are also considered Human Factors Engineers. Versions of this class are taught from different disciplines' perspectives in departments of engineering, computer science, and communication. As such, the professional organizations for Engineering Psychologists reflect the broad perspective of the profession and the diversity of viewpoints.

The profession and professional organizations

One of the professional organizations is the Human Factors and Ergonomics society. This organization began in 1955 with the first meeting held in 1958 in Tulsa, Oklahoma. Prior to this meeting, San Diego Human Engineering Society and the Aeromedical Engineering Association of Los Angeles were the professional organizations that supported the discipline (please see <https://www.hfes.org/about-hfes/hfes-history>). The Human Factors and Ergonomics Society states that Human Factors emerged during WWII to improve safety, improve signal detection and recognition, communication and vehicle operation (airplanes). At the same time work in industry began with time and motion studies, task analysis studies, and efficiency studies. Some of the first research questions asked, "Why do people keep crashing this particular plane?" "How do we make Walkie Talkies easier to hear on the battlefield?" and "What is the most efficient arrangement of components on this assembly line?"

As Human factors grew, researchers continued interest in aviation safety and operation, information processing problems, safety and risk, control and display arrangement, and problems in human perception of alarms. As automation began to be incorporated additional issues of trust, dependence, attention, boredom, and awareness were also incorporated. Today, Human Factors professionals conduct research on nearly every product in nearly every sector of industry and government.

Human Factors? Engineering Psychologists- what is the difference?

Engineering psychologists are typically trained as experimental psychologists with an emphasis in research on cognition, or sensation/perception, or interpersonal relations. Then, in addition to this applied research focus, they take additional courses in statistics, engineering psychology, methodology classes, and specific topic courses for their area of interest within engineering psychology. Many people assume that engineering psychologists either take courses in engineering or study engineers. Neither is the case. Engineering psychologists "engineer" psychology to provide technological solutions through psychological methods. Often, they are paid the same as engineers as they have the same salary rank and similar education requirements.

While engineering psychologists are a specific type of experimental psychologist, their work in the field as Human Factors psychologists mean that they also must learn a great deal about industry, computer science, communication, media, information systems, anthropometry, and the other sub disciplines of psychology. It is not unusual for someone with a PhD in Industrial Engineering to also have a specialty in Human Factors and work as a Human Factors engineer. Professionals with backgrounds in management information systems, computer science, communication, anthropology, kinesiology, media, mechanical engineering and electrical engineering will take additional coursework that qualifies them to work as a Human Factors Engineer.

Human Factors engineers work closely with engineers and product managers to develop requirements documents for the system and the human side of the product. They consider the ethical and safety ramifications of design decisions. They elicit feedback from potential operators and consumers of the product. They help the organization balance the ambitious goals of the product management and design team with the marketing and business goals of the organization. Finally, they ensure that the system or product complies with accessibility and safety regulations. Human Factors professionals are often called to testify as to what types of research was conducted to ensure compliance and safety. Along with product managers, engineers, designers, administrators, human factors engineers sign non-disclosure agreements which do not allow them to discuss the product or the research outside of the organization or courtroom without explicit approval. This is one reason that very little is known about their work and few studies are published on their findings.

One of the reasons for this is that each subfield within Engineering Psychology has a rich history and requires a significant amount of domain experience before the engineering psychologist may be knowledgeable enough to make informed decisions. A domain is an area where specific knowledge is needed. Domains include medicine, policing, firefighting, teaching, postal work, aeronautics. These areas typically require people to complete a significant amount of training before they may begin work. An engineering psychologist working in these fields must also complete the training and demonstrate competency before they proceed. Because of this, engineering psychologists who work in these areas do not switch between domains. Much of their work is domain specific.

What does a Human Factors Engineer do?

Let's take the example of medicine and someone named Jenny. Jenny, an engineering psychologist, works at an electronic medical records software company. She is called a Human Factors Engineer by her colleagues as this is her job title. Jenny's duties include attending the development meetings for her assigned product along with the software developers, the visual designers, the interaction designers and the product manager. At the development meetings Jenny observes the direction that the product is taking, new features that are being added or subtracted, and design questions that come up during the discussions. She asks questions that help her to understand the history of the product and its users.

After the meeting, Jenny may contact expert users of the product to determine if these changes would help or hurt their ability to use the product. She may review similar products by other software manufacturers for their features and how these features work in their products. Finally, she may review the scientific literature in psychology, human factors, ergonomics, anthropology, medicine, or other fields to be sure that the changes considered by the team will indeed enhance the product's ease of use, its safety, its compliance with regulations, and its market share.

If she finds conflicts between what the developers propose and what the users need/want and what the literature states, she may recommend that the team consider gathering some data on how this feature will affect the product from all perspectives. For these data gathering activities she will need to know specifics about the product. She will need to know how the electronic medical records are supposed to enhance the ability of the medical provider to do her/his job. She will need to understand a bit about medicine beyond what the average person knows.

This is so that she can design the experiment properly and be able to talk to the physicians and nurses who use the product on a professional level. She will need to know about the health privacy regulations, the other software systems that her software interacts with such as drug formularies, and the environment where the software is used. She will need to know about noise levels, interruption frequency, how quickly the physicians/nurses learn new software, what other tasks they may be doing at the same time as entering the data, and many other things. All of this information will help her ability to collect the right data on which the team will make the right design decision for the product and avoid costly litigation.

During her work with the medical teams, she may discover new ideas that she may bring back to the development team to create innovative services that they had not previously considered. Her understanding of how the medical community uses the product as well as how the software team develops the product puts her in a unique position to translate between the two communities and let each influence the other for the benefit of both. As she continues, she gains a deep understanding of the needs of both communities and a vast knowledge base about what does and doesn't work in the medical domain. Therefore, most Human Factors engineers do not switch domains, they would have to begin learning all over again.

References

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