Engineering Psychology

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Week-01

Lecture-02

Introduction - 2

Namaskar, learners! Welcome to the second lecture on the introduction to human factor engineering, also known as engineering psychology. In Lecture 1, we discussed the fundamentals of human engineering, including its components and the variables it involves. I defined human factor engineering and explained that engineering psychology is not about traditional engineering but rather about modifying or applying psychological principles to solve problems related to human systems or human-machine interactions.

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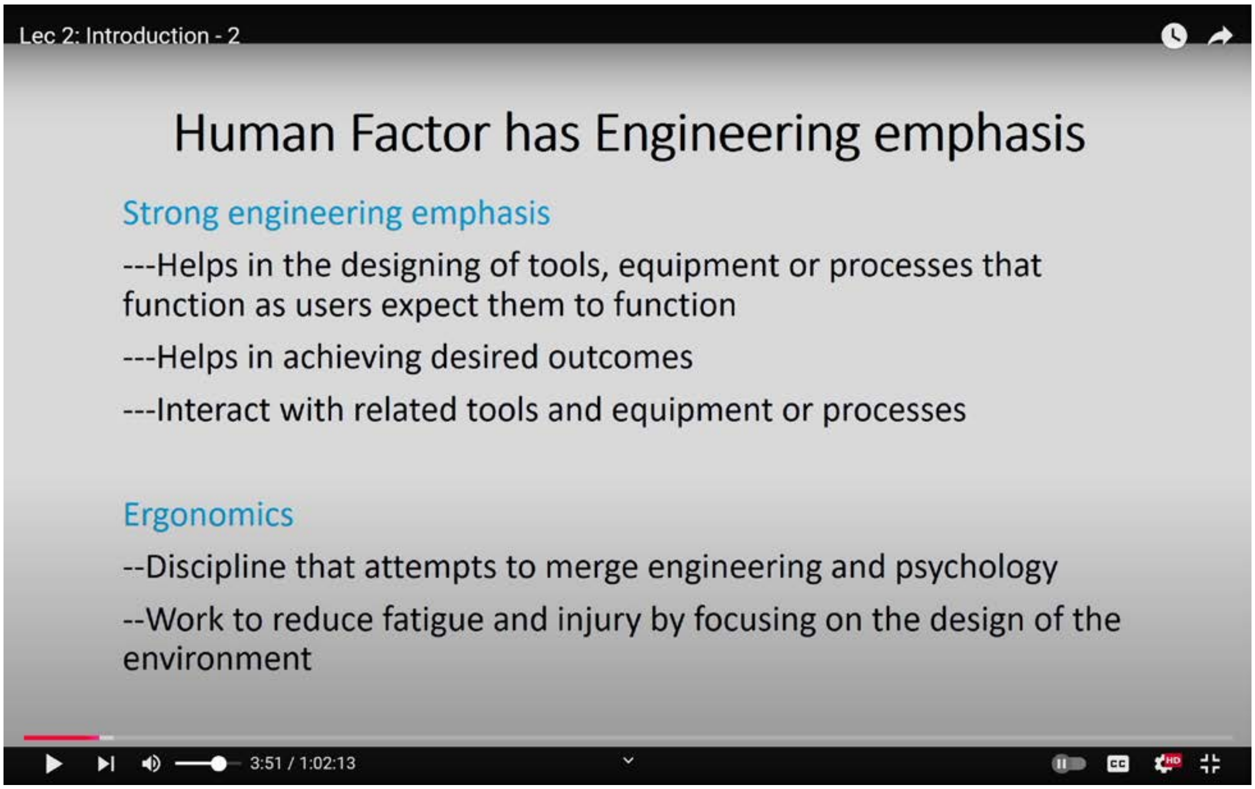

We explored how knowledge from psychology can be used to enhance the understanding of human-machine interactions by focusing on both the limitations and capabilities of humans in terms of psychological inputs, as well as the limitations and capabilities of systems in terms of engineering inputs. Thus, the core of engineering psychology is the study of these interactions.

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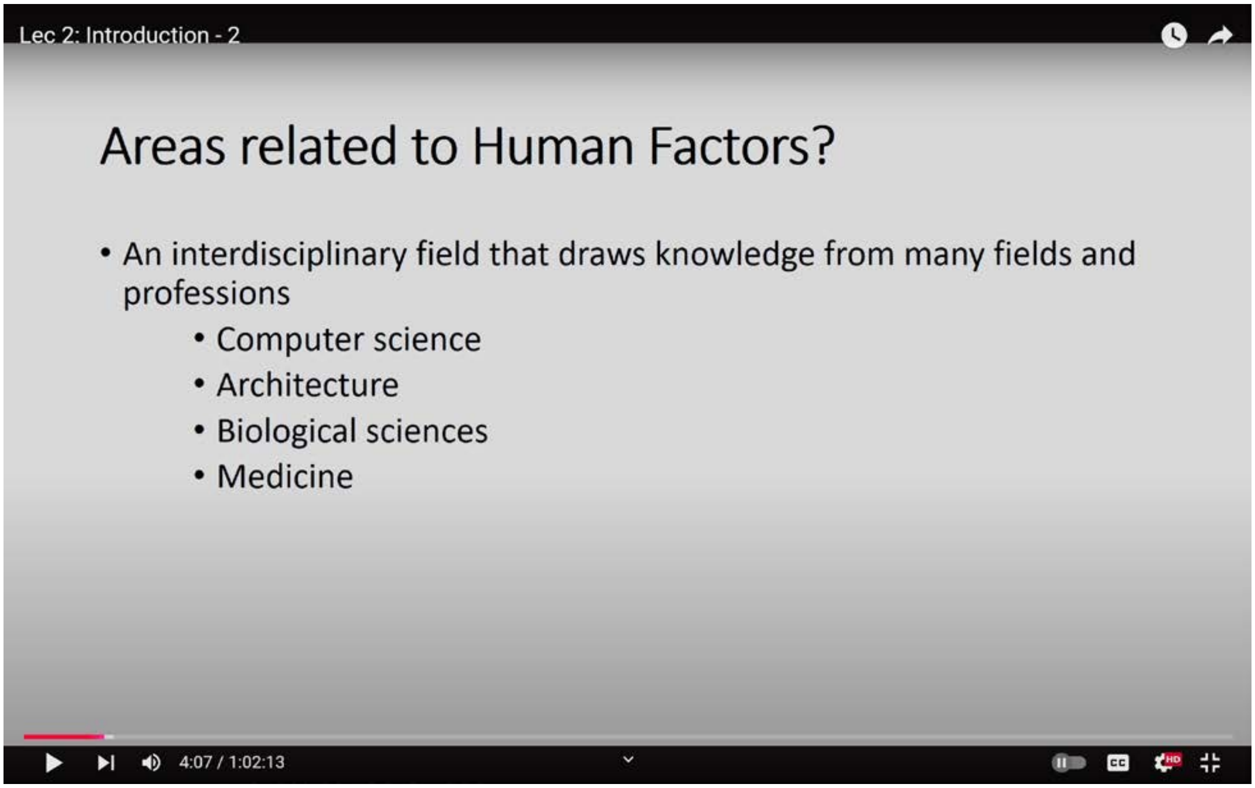

We then examined the subject matter of this field, discussing how human engineering or engineering psychology specifically addresses the cognitive and physical capacities of humans, along with their limitations. Humans possess various cognitive and physical abilities, but they are also restricted by the nature of the tasks they perform and their learning experiences. Engineering psychology seeks to understand how these limitations and capabilities can be leveraged to improve machine usage, thereby enhancing productivity and performance. We also discussed how the environments where human-machine interactions occur can be designed to optimize performance. Additionally, we covered the various aspects of engineering psychology that are critical to study, including both the physical and social dimensions.

In further detail, we reviewed the sensory and cognitive capabilities of humans, exploring how these capabilities are central to the science of engineering psychology. Moreover, we emphasized the strong focus of human engineering on the engineering side and discussed the role of ergonomics in this field. Towards the end of the lecture, we highlighted how engineering psychology is inherently interdisciplinary, drawing on models and methods from fields such as computer science, architecture, biology, and medicine to address challenges in human-machine interactions. One notable example we discussed was the information processing model, which is borrowed from cognitive science and computer science. This model demonstrates how information is processed, and its predictions from computer science can be applied to studying brain function. Similarly, insights from architecture, biology, and medical sciences can be adapted and incorporated into the study of engineering psychology and human-machine interactions.

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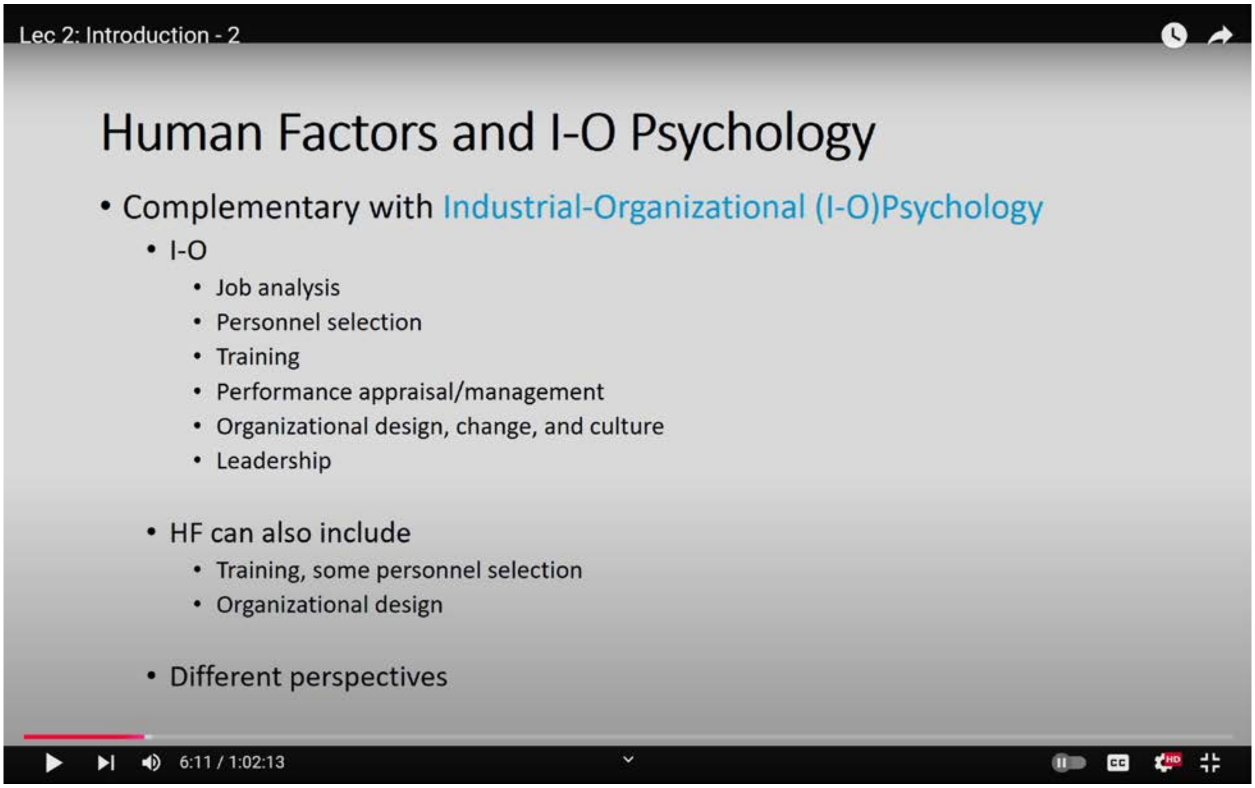

In today's lecture, we will delve into the history of engineering psychology, examining its origins. Additionally, we will explore the various applications of engineering psychology, and towards the end of the lecture, we will discuss the system approach to this field. A key focus of industrial and organizational (IO) psychology is studying how humans are suited to work within organizations, while human engineering focuses on how humans work with machines.

A pertinent question is: how does human engineering differ from industrial and organizational psychology? While there are many similarities between the two fields, both concern understanding how individuals function within systems, engineering psychology specifically focuses on how individuals, organizations, or larger systems should work together to enhance human-machine interaction. So, where exactly do the differences lie? We will explore these distinctions in today's lecture. While both industrial and organizational psychology and engineering psychology are complementary, they serve distinct roles. Many engineering psychologists are employed by industries and large organizations to create more beneficial environments and improve performance. However, several differences exist between the two fields, which we will address further.

One key distinction between the focus of engineering psychologists and industrial and organizational (IO) psychologists lies in the type of analysis they conduct. IO psychologists focus on job analysis. But what exactly is job analysis? In this process, the job itself is evaluated, tasks are examined, and individuals are trained and selected to ensure they are suited for the job. This contrasts with the concept of task analysis, which is central to human engineering and engineering psychology.

In engineering psychology, the emphasis is on analyzing the task. The requirements of the task are examined, and based on these requirements, as well as the cognitive and physical limitations and capabilities of humans, the task is modified to improve human-machine interactions. Therefore, while IO psychology emphasizes training and selecting individuals to fit a job, engineering psychology focuses on designing or modifying systems to fit humans. This fundamental difference defines the approaches of the two fields.

IO psychology centers on personnel selection, ensuring individuals are the right fit for a specific job. As discussed, engineering psychology focuses on analyzing the current system and its operators, then modifying both to enhance interactions and increase performance. While IO psychology prioritizes training, engineering psychology is more concerned with redesigning or remodeling systems. IO psychology also focuses on performance appraisal and management, whereas the foundation of engineering psychology is user-centered design. This approach involves studying the users, understanding their capabilities and limitations, and using that information to redesign systems to better suit them.

IO psychology is largely about organization design, culture, and change. On the other hand, engineering psychology is concerned with systems and processes, how they can be redesigned to align with the cognitive and physical capacities of humans. While IO psychology emphasizes leadership, engineering psychology focuses on understanding and optimizing the relationship between human-machine systems. Despite these distinctions, the two fields do share some common ground, as mentioned earlier.

For instance, human factors in engineering psychology also involve training and personnel selection, particularly concerning how individuals can be trained to operate specific systems. However, this aspect is limited in scope. The primary focus of engineering psychology is enhancing the human-machine relationship to improve performance and create a more effective work environment for both the user and the machine. Human factor engineering, or engineering psychology, applies principles of organizational design by modifying organizational structures and environments to suit operators working with machines.

Additionally, there are differences in perspective between IO psychology and engineering psychology, which we have touched on before. IO psychology is about selecting and training individuals to fit into jobs. In contrast, engineering psychology focuses on understanding the cognitive and physical capabilities and limitations of the operator, as well as the system's capabilities and limitations. The goal is to modify system design in such a way that machines complement human actions, rather than forcing humans to adapt to the machine. This is where the fundamental difference in perspective lies between the two fields.

Let us examine a brief history of human factor engineering, also known as engineering psychology. There are two significant landmarks in this history: one before the start of World War II and the other after its commencement. World War II is considered a turning point for engineering psychology. Why did this transformation occur?

During World War II, numerous machines were utilized in warfare. The Nazis employed airplanes, U-boats, and submarines, encountering various operational difficulties with these machines. The prevailing thought at the time was to train operators to effectively use these machines. However, this approach presented problems. While the machines were designed and operators were trained, numerous issues arose as a result. It was in this context that the science of engineering psychology emerged. The field gained momentum as experts from experimental psychology and other disciplines sought to improve the relationship between operators and machines. Thus, World War II is viewed as a pivotal moment in the history of engineering psychology.

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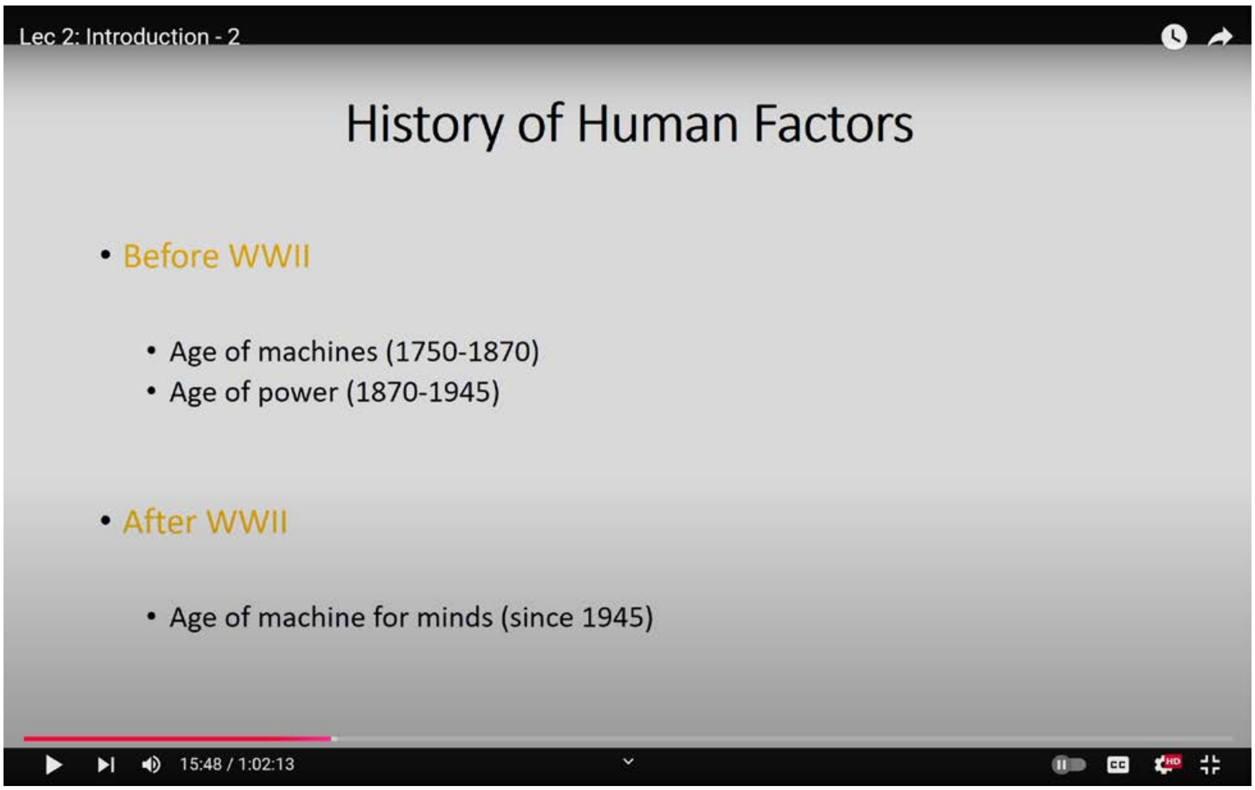

Before World War I, a brief historical context exists between World War I and World War II, marking a transitional phase in this evolution. After World War II, the field of engineering psychology expanded significantly. For clarity, this history can be divided into two parts: the Age of Machines, which spans from 1750 to 1870, and the Age of Power, which extends from 1870 to 1945.

Following the war, a fundamental shift occurred as individuals from backgrounds in experimental and cognitive psychology were recruited to study machines and human interactions. Their goal was to redesign machines to enhance performance. Since 1945, we have entered the Age of Machines, which continues to this day. Now, let us examine these divisions in the historical development of engineering psychology, starting with the initial link, which I referred to earlier as being before World War II, or more specifically, prehistoric linkages.

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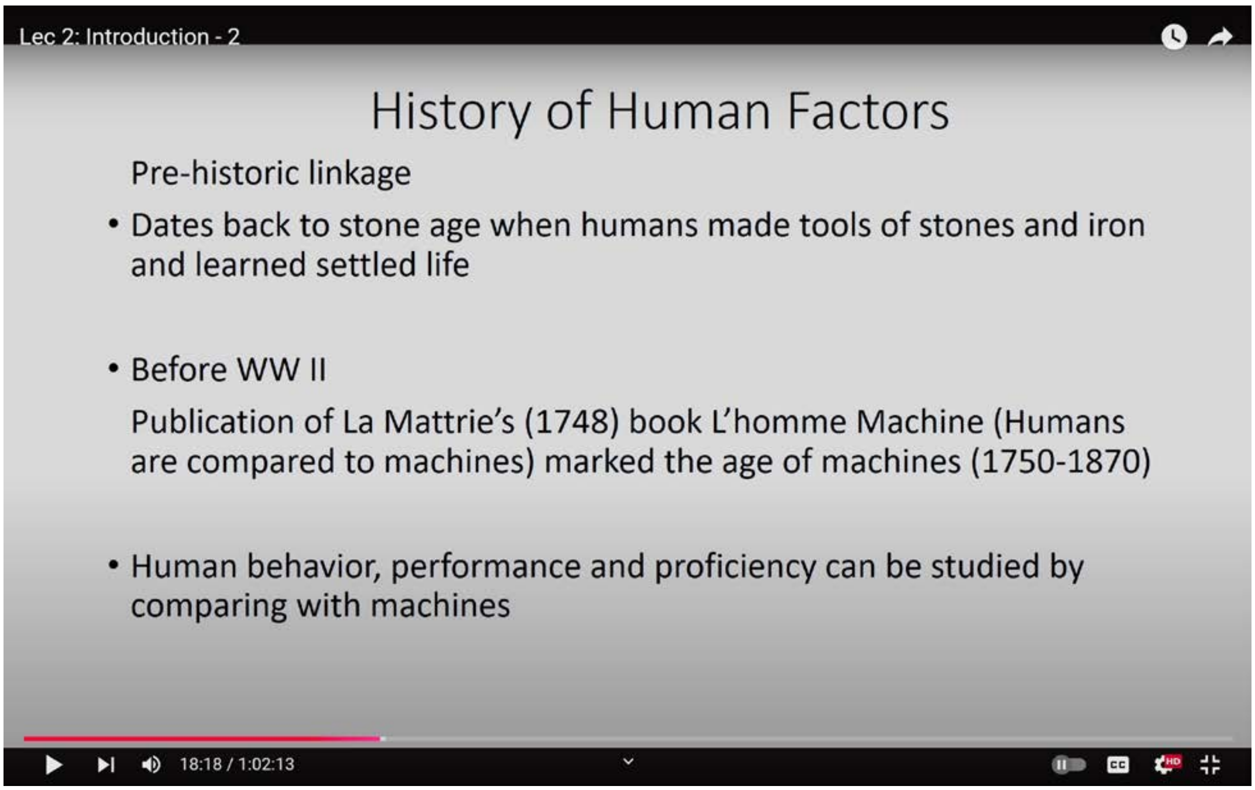

Technically speaking, the science of engineering psychology began with early humans learning to use stone tools and construct shelters. In a very brief overview, it can be stated that the history of this field dates back to the Stone Age, when early humans learned to live in groups and engage in agriculture. At that time, they discovered that stones and metals could be fashioned into tools and equipment, enhancing their ability to survive and defend themselves against threats. However, this ancient history is largely undocumented. Therefore, our study of engineering psychology, in a more formal sense, will begin in 1748.

Why is 1748 considered a landmark year? It was during this year that the book **L'Homme Machina** was published by La Mettrie. The highlight of this book was its assertion that humans could be compared to machines. This comparison allowed for the mapping of machine behavior onto human behavior, enabling systematic study. The publication of **L'Homme Machina** thus marks the beginning of the first phase in the history of engineering psychology, spanning from 1750 to 1870.

One advantage of comparing simple and complex machines to humans is that human behavior can be predicted not only based on observable actions but also in terms of performance and proficiency, akin to the functioning of machines. Most machines operate in predictable ways, while human behavior tends to be less predictable. This unpredictability arises from individual differences; human behavior is not a fixed process but rather a random one.

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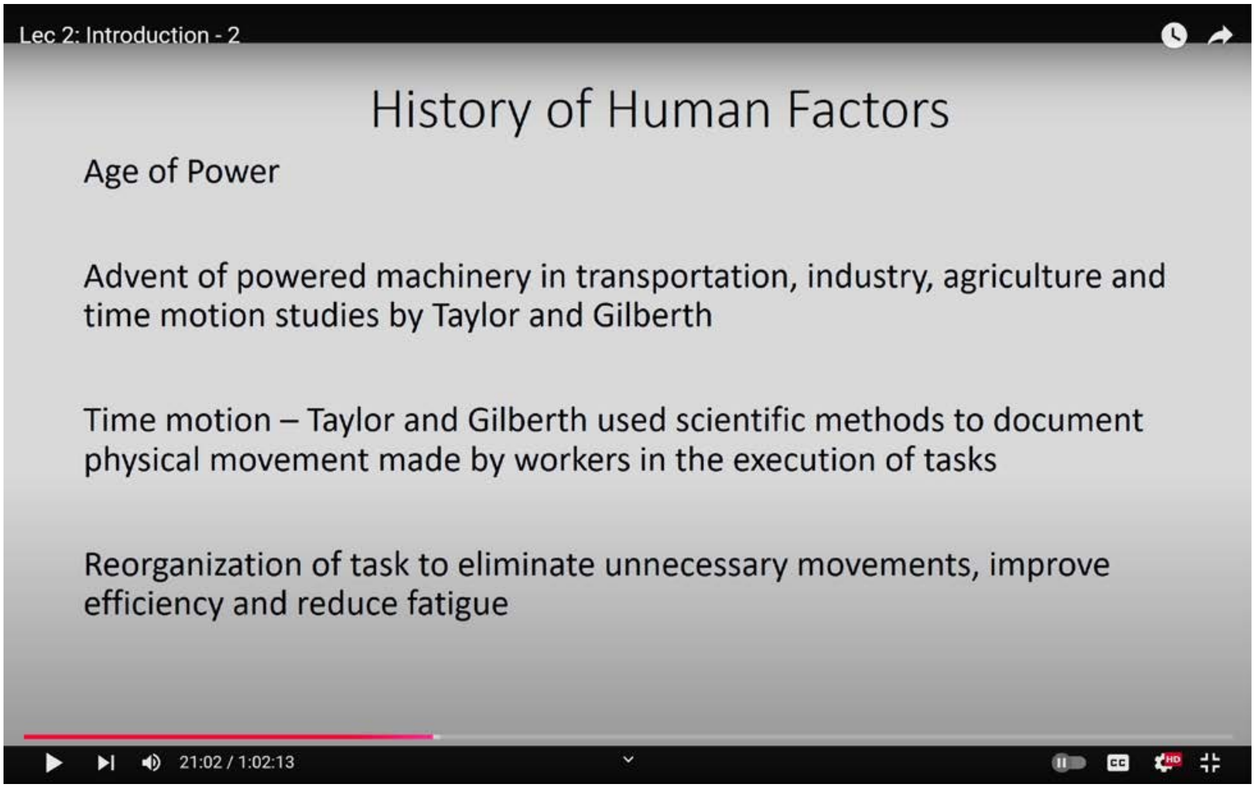

Human behavior is characterized by a probabilistic process, contrasting with the more deterministic, stochastic approach typically employed by machines. To understand human behavior in fixed terms, particularly in stochastic terms, comparisons to machine performance were made, enabling the development of measures for behavior, performance, proficiency, and capabilities. This comparison was a significant advantage arising from the publication of **La Hume Machina** and its insights into human behavior in relation to machines.

The second landmark in the study of human engineering emerged during the Age of Power. Prior to this period, simple machines were hand-driven tools, and human performance was evaluated in relation to these tools. With the advent of power machinery across various fields, such as transportation, industry, and agriculture, new possibilities emerged. The introduction of steam power engines, power looms, and power rotors marked this transformative period. The utilization of energy and power allowed humans to offload their tasks onto machines, which could perform them more efficiently and effectively. For the first time, humans recognized that machines could be engineered as tools to assist them in their work.

It was within the Age of Power that Frederick Taylor and Frank Gilbreth conducted time and motion studies. These studies aimed to analyze how specific actions were performed over time and how these actions could be documented. Time and motion studies involved using scientific methods to record the physical movements made by workers during task execution. For example, consider a simple tilling machine used for sowing crops in a field.

These tillers, made of iron and typically pulled by animals, feature a conical section designed to hold and distribute seeds. The pointed end of the conical structure penetrates the soil to create furrows. If excessive pressure is applied, the pulling animal may struggle, while insufficient pressure could prevent the conical structure from adequately embedding the seeds at the correct depth.

Time and motion studies would analyze the entire sowing process, determining how long each action takes and identifying modifications that could enhance the efficiency of this simple machine. The goal was to optimize the sowing process to maximize seed output in less time while preventing undue strain on the animals. Essentially, time and motion studies examined the relationship between time and the motions performed by humans when using machines. The objective was to minimize time expenditure and improve efficiency by re-evaluating and refining the movements associated with machine operation.

By reorganizing tasks to eliminate unnecessary movements, both Taylor and Gilbreth were able to enhance efficiency and reduce worker fatigue. The motivation for examining motion studies in the context of a simple seed sower was to redesign the machine in ways that would eliminate superfluous movements, thereby conserving physical energy for the operators. This redesign would also enhance efficiency by increasing the number of seeds sown over larger areas, ultimately reducing fatigue for both humans and animals involved in the process. Consequently, this approach would enable greater productivity and performance with less effort through improved machine design, which underpinned the rationale behind time and motion studies.

The primary outcomes of these time and motion studies included the realization by Taylor and Gilbreth that implementing planned breaks could significantly enhance performance. Allowing breaks between tasks provided workers the opportunity to recharge, which in turn reduced both physical and mental workloads, leading to improved efficiency. Additionally, the time-motion studies prompted the redesign of tools, such as the shovel, which is commonly used in various construction activities. Taylor and Gilbreth's redesign aimed to minimize the human effort required while maximizing performance.

As a result, the findings from time and motion studies collectively contributed to the establishment of the field known as scientific management. This field focused on how management practices could be conducted in a scientific manner. A crucial insight from these studies was the acknowledgment that, due to individual differences among workers, there is no single best solution for design problems. Therefore, it is impossible to create one ideal design that would universally accommodate all humans.

Some individuals possess strong physical capabilities, while others excel in cognitive abilities, leading to significant differences among people. From their studies, researchers concluded that a single design cannot accommodate all types of users. In response to this realization, they proposed a solution: designs should not cater solely to the ideal user but should be inclusive of all users.

Instead of creating a single, standardized design, which many production houses or companies typically consider as a one-size-fits-all product, the focus should shift to modifying that product to serve multiple uses across diverse applications. This was one of the valuable insights from the time and motion studies. Another psychologist working during this period was Frank Gilbreth, who studied the work of bricklayers. He observed that many masons engaged in numerous unnecessary activities, which led to poor performance. By applying time and motion techniques to the process of bricklaying, he discovered that eliminating certain unnecessary motions could conserve energy and reduce fatigue.

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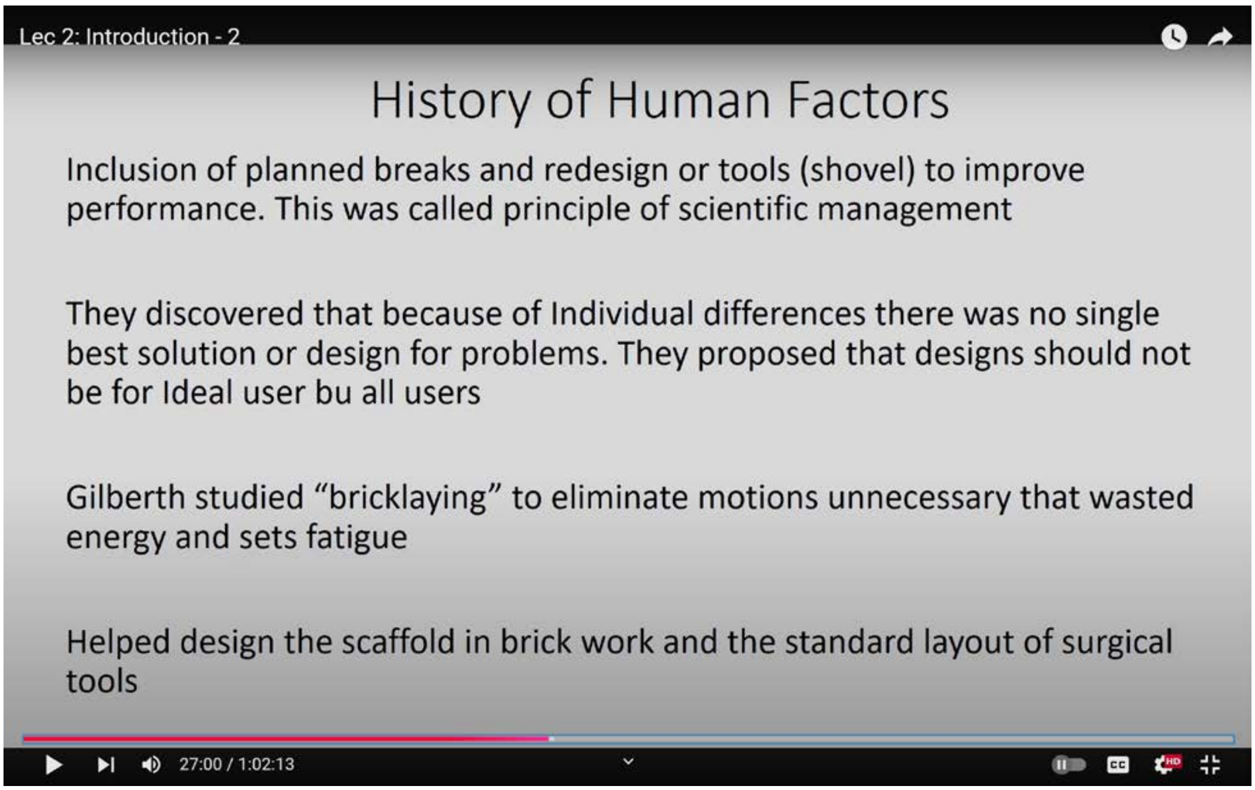

Gilbreth noted that bricklayers performed a variety of actions that contributed little to their efficiency and resulted in increased fatigue. For example, when laying bricks, masons start from the ground and continue to shoulder level. At ground level, they can sit comfortably while picking up bricks that are close at hand. However, when they work while standing, they must repeatedly bend down to pick up the bricks, leading to physical strain and reduced performance.

In response to these challenges, Gilbreth designed a structure known as the scaffold. The scaffold keeps the bricklayer at knee level in a sitting position, allowing for repeated actions without the need to bend excessively. As the brick wall height increases, the scaffold adjusts accordingly, minimizing unnecessary movements and enhancing efficiency.

In addition to his work on bricklaying, Gilbreth and his wife, Lillian Gilbreth, also researched practices in the medical field, particularly during surgical operations. They found that surgeons often performed several unnecessary actions during procedures. To address this issue, they standardized how surgical instruments should be organized on a tray. This standardization reduced the number of movements a surgeon had to make, thereby decreasing the likelihood of operational errors and complications during surgery.

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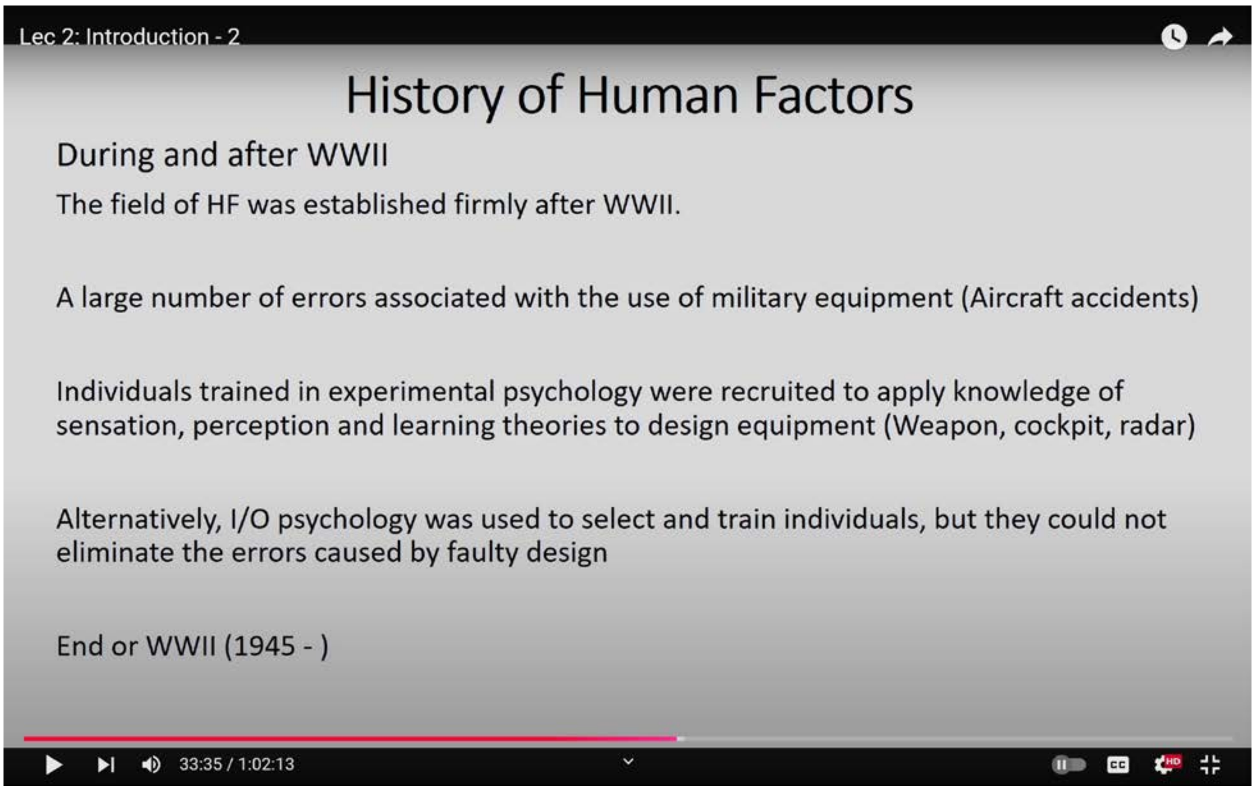

Now, we turn to the second phase in the history of engineering psychology, which occurred during and after World War II. The discipline of engineering psychology was firmly established during this period, primarily due to the significant number of errors associated with military equipment and aircraft accidents. As previously mentioned, various war-related tools and technologies were developed during World War II. While these innovations were impressive, they were often designed with the ideal user in mind. However, human operators are inherently different, possessing unique capabilities and limitations that do not align with the concept of an ideal user.

As a result, operators sometimes faced challenges related to their physical capabilities, leading to actions that resulted in equipment failures and numerous accidents. To address this critical issue, industrial organizational psychologists were brought in to study job functions and subsequently train individuals on how to use these machines effectively. However, as previously noted, this approach alone was not a comprehensive solution.

The fundamental issue is that no matter how much training individuals receive, they tend to make mistakes, which continues to result in numerous accidents. How was this problem addressed? Individuals trained in experimental psychology were recruited to apply their knowledge of sensation, perception, and learning theories to the design of equipment. Those who study human behavior, particularly experimental psychologists, understand the capacities of the cognitive system, including how much the eye can see, how it perceives three-dimensional motion, and where it may fail. They also differentiate between peripheral vision and foveal vision, explore how the top-down process can sometimes dominate the bottom-up processes and create illusions, and examine how motion perception is influenced by learning theories, including principles of reward, positive and negative reinforcement, and the concept of social learning theory.

These aspects of human psychology were applied to real-world problems, enabling the design of systems that fit users' needs. While users were not fundamentally modified, they were provided with training tailored to their capabilities. Any tasks that exceeded human capacities were delegated to machines. For instance, when flying a plane, numerous checks must be performed in the cockpit. Typically, pilots have a checklist of actions to complete, and they check off tasks as they accomplish them. However, this method can lead to problems.

To mitigate this issue, onboard computers are designed to monitor the actions taken and confirm which items have been checked off. If any steps are incomplete at the end of the flight planning procedure, the system can prompt the pilot to complete those missing steps. Although pilots are skilled at performing these checks, short-term memory failures can result in overlooked steps. Machines are more consistent in executing routine tasks and can provide helpful prompts.

Often, you might be performing a task perfectly, yet your computer offers suggestions on how to do it. These suggestions may seem trivial, but they serve a critical purpose: they remind you that a particular step is essential. Even when you're performing well, receiving an additional warning or suggestion can enhance your performance or redirect your attention to the task at hand. Through the application of experimental psychology principles, training individuals can produce better operators capable of working effectively with advanced systems, thus improving performance.

This is another noteworthy point in the history of engineering psychology. During World War II, industrial organizational psychologists were also employed to address some of the challenges faced by engineering psychologists. However, as previously mentioned, one major issue was that while they could select and train individuals to fit specific jobs, this approach was ineffective. It proved unsuccessful because, regardless of how efficiently individuals were trained, they remain bound by their cognitive and physical limitations, leading to potential failures in their actions.

Consequently, engineering psychologists were brought in to examine machine design. By studying the design of machines and leveraging their understanding of human cognitive and physical systems, they were able to create designs that minimized errors caused by faulty equipment. They improved machine designs to handle tasks that humans could not perform due to cognitive and physical constraints. One illustrative example is the learning of a sequence of steps. Performing tasks sequentially tends to yield positive outcomes, following the principle of algorithms. However, the human brain is inherently noisy and does not always adhere to strict algorithms; it often seeks shortcuts or heuristics.

Recognizing that human cognition leans toward heuristics, why not design systems that keep track of algorithmic steps? If a human bypasses an essential algorithmic step by taking a heuristic shortcut, the system can flag this as an error. The previous example of flight plan checks illustrates this concept well. Pilots conduct flight plan checks sequentially, and if they overlook a task, the system can identify the error. This coordinated approach between the system and the operator fosters coherence and leads to improved performance. The period from the end of World War II in 1945 to the present represents the third stage in the history of engineering psychology.

This stage is referred to as the age of machines of the mind. The emphasis of this era was not solely on the design of machines but rather on understanding how minds function. By studying the relationship between the human mind and machines, a more efficient system can be developed, characterized by higher performance and reduced errors and fatigue. During this stage in the history of engineering psychology, there was extensive engagement with experimental psychologists who identified the laws of behavior and applied these laws to address practical problems while also developing theories to explain the origins of those problems.

These experimental psychologists not only utilized their knowledge of human behavior and its mechanisms to solve applied problems but also investigated the underlying causes of these issues. For instance, returning to the cockpit example, humans should follow a sequential process for pre-flight checks. However, human brains often deviate from this order, as they tend to take shortcuts. Errors can arise from this tendency because human cognition is inherently noisy; individuals may assume that certain steps have already been completed. If you have ever experienced writing a paper and received feedback from a supervisor indicating that a particular sentence was missing, you may have found yourself convinced that you had written it. Despite numerous readings, the sentence remains in your mind, leading to a closure problem that obscures the error from your perception, while your supervisor, having a different cognitive process, identifies the oversight.

Language learning tools also illustrate this phenomenon by pointing out similar errors, highlighting the tendency for human minds to overlook mistakes. Understanding why errors occur and identifying potential solutions became the focus of experimental psychologists. They not only redesigned human-machine systems but also examined where errors might occur and how they could be mitigated. One recommendation was for machines to simultaneously check inputs. Rather than relying solely on manual pre-flight checks on paper, pilots could input their actions into a computer system. If an input is missing or incorrectly entered, a warning system would alert the pilot to the error or the incorrect sequence.

In this way, experimental psychologists contributed to the design of systems and risk management. They conducted tests to monitor human performance across various scenarios to identify variables associated with poor performance. The question arises: why do humans perform poorly? Many reasons prompted the hiring of experimental psychologists to investigate human-machine systems in diverse environments. These psychologists aimed to understand the factors contributing to performance deficits.

A classic study in organizational psychology exemplifies this inquiry through the investigation of lighting. It was discovered that increased lighting corresponds with improved human performance. This relationship stems from the idea that brighter light activates the fovea, which in turn sends signals to the brain to enhance alertness and consciousness. Conversely, dim lighting can lead the brain to enter a non-conscious or resting state, resulting in decreased performance.

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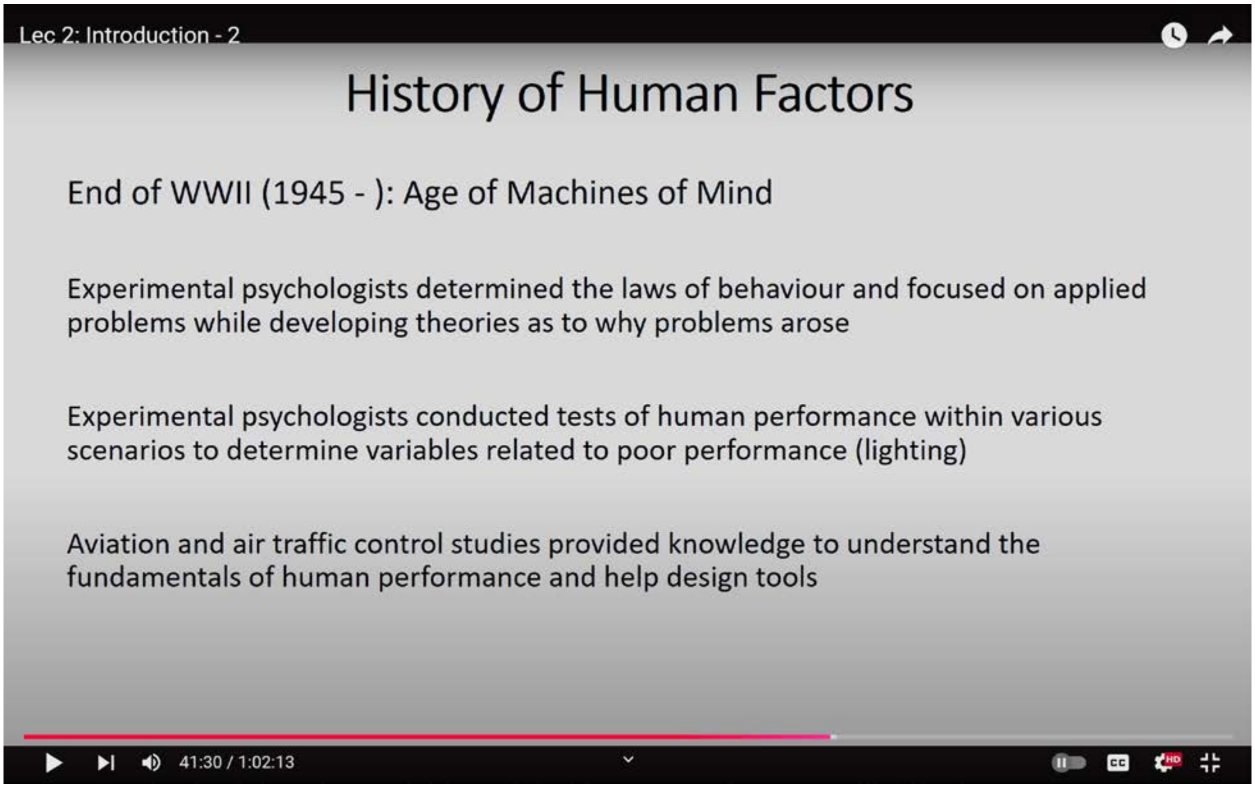

This concept illustrates how lighting affects human systems, which subsequently influences operators' actions and overall system performance, ultimately leading to proficiency. Experimental psychologists assessed performance in various scenarios, identifying potential causes of performance degradation and fatigue, and proposed solutions to alleviate such fatigue. Studies in aviation and air traffic control have provided crucial insights into human performance fundamentals, aiding in tool design.

Research in air traffic control and aviation has helped elucidate the reasons behind numerous accidents, leading to the introduction of concepts such as visual design. One significant finding was that many accidents occurred because pilots mistakenly pulled the wrong lever to lower the landing gear. By employing visual design principles, a lever was created with a visual representation of a wheel, making it clearer to pilots which lever operated the landing gear. This design alleviated confusion and enhanced operational safety.

Thus, the development of visual design concepts emerged from studies conducted by experimental psychologists, marking an important milestone in the history of engineering psychology.

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Let us examine some significant events in the history of human factor engineering, also known as engineering psychology. First, Paul Fitts established the psychology branch of the Aero Medical Laboratory during the late 1960s or 1970s, specifically in the 1950s or 1960s. Paul Fitts was a prominent figure in engineering psychology, and he introduced what is known as Fitts' Law. This law describes the relationship between human actions and the size of devices or controls. It posits that there is a correlation between the distance from a control and the size of that control; specifically, the further one is from a control, the larger that control needs to be. This principle, known as Fitts' Law, highlights how the size of controls should be designed in relation to the operator's distance from them. In addition to founding the Aero Medical Laboratory, which is a significant milestone in the history of human factors, Fitts made substantial contributions to the field.

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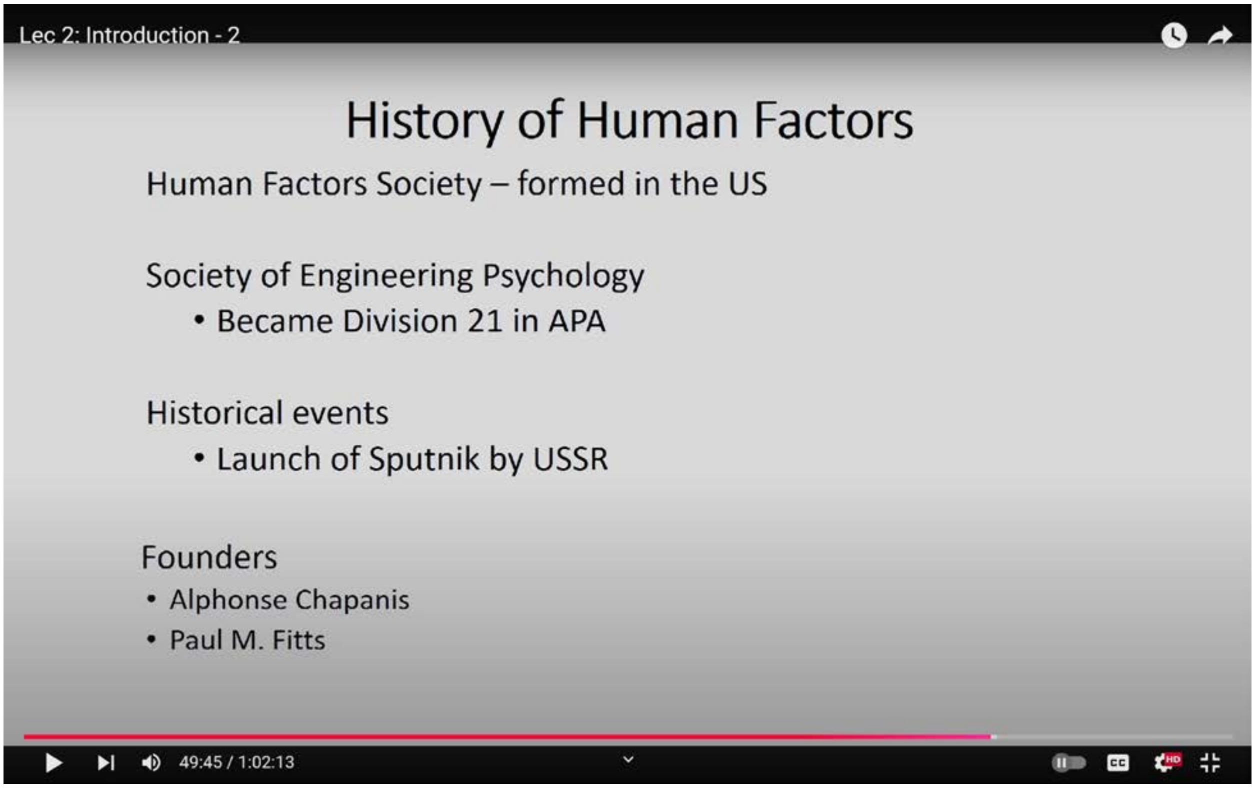

Another landmark event was the establishment of the Ergonomic Research Society of Britain, which also played a crucial role in the domain of engineering psychology. Furthermore, the first book titled **Applied Experimental Psychology: Human Factors in Engineering Design** was published by Chapin, Gard, and Morgan. In 1957, the **Journal of Ergonomics** was launched, marking a pivotal advancement in the field of engineering psychology. Similarly, the formation of the Human Factors Society in the United States and the Society of Engineering Psychology, which became Division 21 of the American Psychological Association, were two additional significant developments in the evolution of engineering psychology.

Historical events, such as the launch of Sputnik by the former USSR, also contributed to the growth of this field. During the Cold War, the United States and Russia competed for technical superiority, and one area where this competition was evident was the space race. The launch of Sputnik, the first series of space vehicles, showcased the technological advancements of the Soviet Union. This prompted Americans and others around the world to consider how to compete with Russia. However, sending space probes and placing humans into space was no simple task; it required extensive input from engineering psychologists, experimental psychologists, and experts from various fields to design systems that could withstand the conditions of space while safely carrying and sustaining human life. The absence of gravity, weather, and atmosphere posed unique challenges in designing spacecraft, making the launch of Sputnik a significant event in the history of experimental human engineering.

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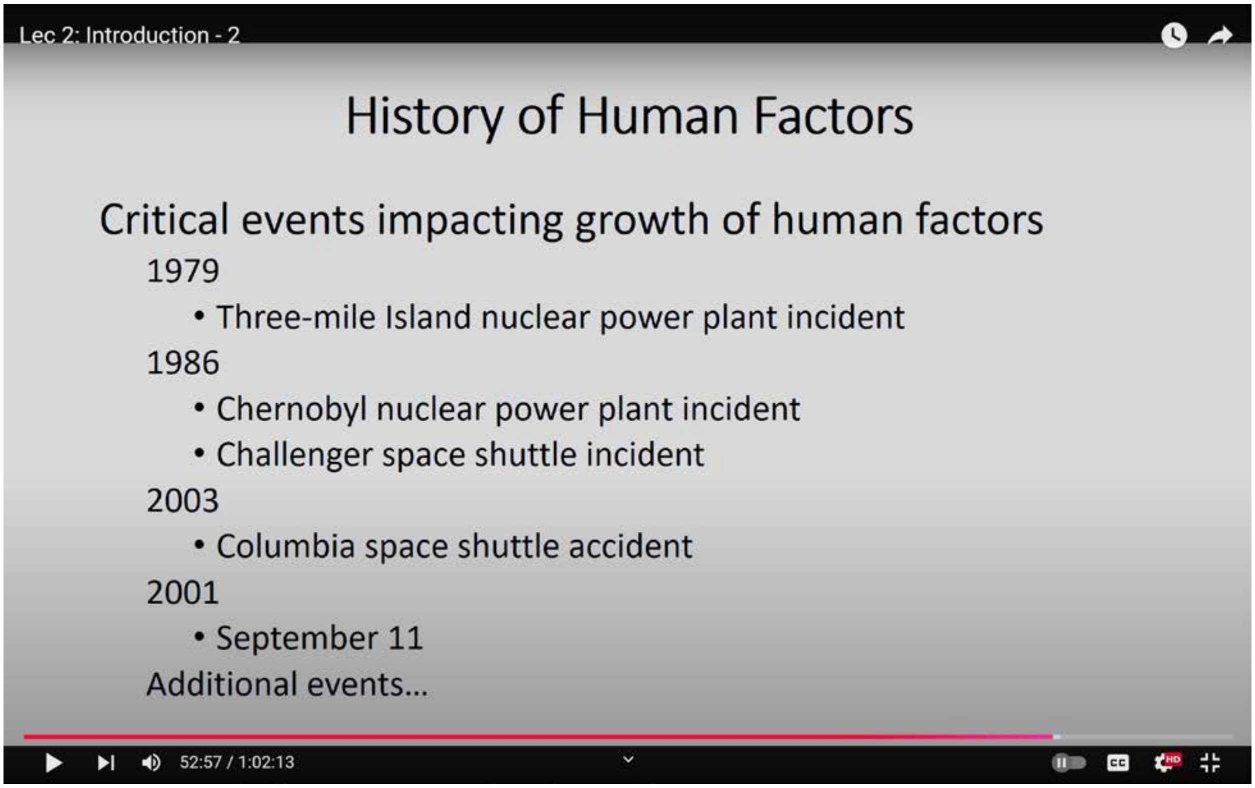

The founders of the field include Alphonse Chapanis, who conducted extensive research, and Paul Fitts, a mechanical engineer who worked with the military and is renowned for Fitts' Law. One critical event that significantly impacted the growth of human factor engineering was the Three Mile Island nuclear power plant incident in 1979. This incident was caused by operator error, leading to the meltdown of the reactor core. As a result, the entire atomic program in the United States was temporarily halted. Another major event occurred in 1986 with the Chornobyl nuclear power plant disaster, where the fourth cooling tower imploded, resulting in numerous fatalities and severe radiation exposure for the surrounding area. This incident rendered the city of Chornobyl, now located in Ukraine, uninhabitable for years due to the radiation fallout, all stemming from a single mistake made by an operator who overrode a faulty machine's input without verifying it against the actual system.

Furthermore, the Challenger Space Shuttle disaster, caused by a faulty O-ring, and the Columbia Space Shuttle crash in 2003, which occurred during re-entry due to a flawed external tile that could have been replaced, are also related to issues of engineering psychology. In both cases, the failure to recognize the importance of seemingly minor elements led to catastrophic outcomes. Additionally, the September 11 attacks had a profound effect on security measures, resulting in the implementation of more rigorous and advanced scanning systems at airports. These events prompted further advancements in the field of engineering psychology.

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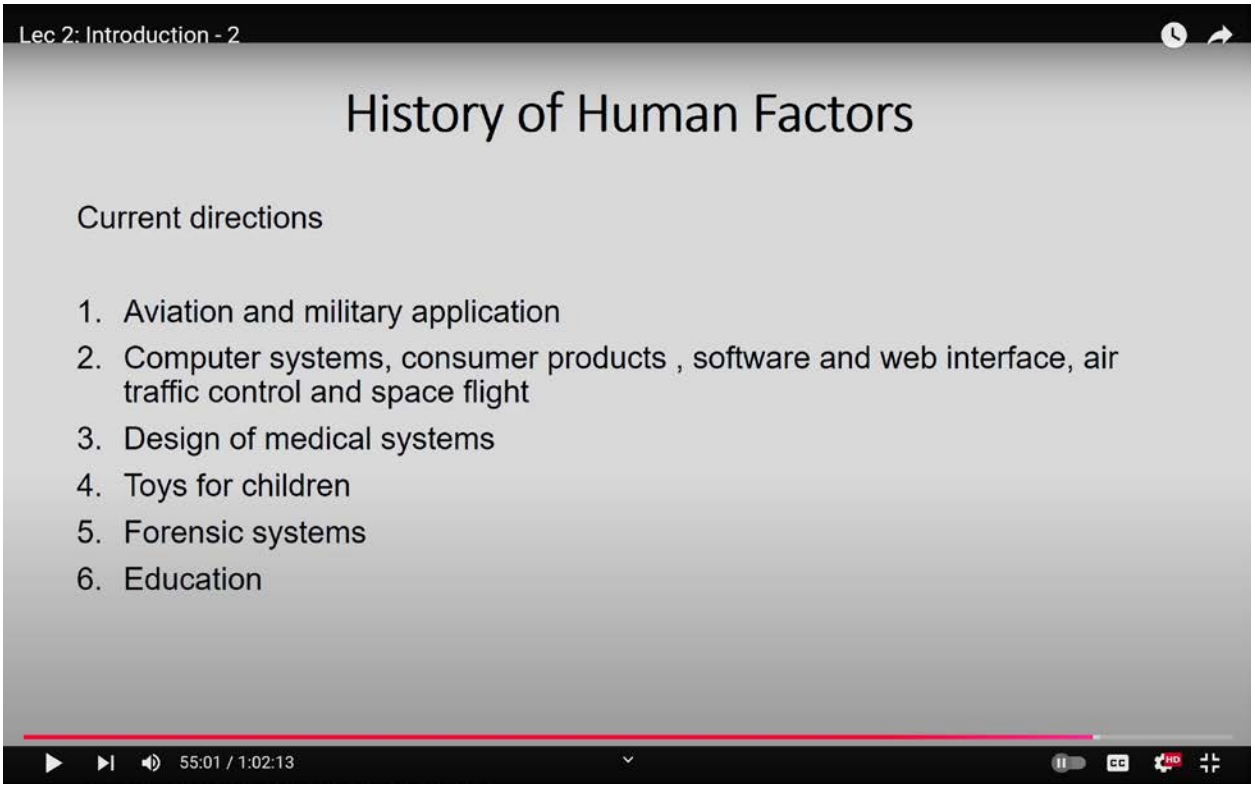

In terms of current directions, engineering psychology today focuses on applications in aviation and the military, including the development of aircraft-related and military systems. Another area of application is in computer systems, specifically the advancement of quantum computing and qubit computing, as well as the development of consumer products, software, web interfaces, air traffic control, and space flight. Engineering psychologists are instrumental in designing medical systems, such as portable life support systems and portable defibrillators.

Moreover, when designing toys for children, engineers ensure that these toys are not only safe but also educational. Efforts are being made to design innovative toys that enhance learning. In the realm of forensic science, engineering psychologists are contributing to improved human-machine interactions to advance the field. This advancement is evident in the emergence of virtual and online classes, including the one we are currently participating in, a concept that originated from the collaboration of educators and engineering psychologists.

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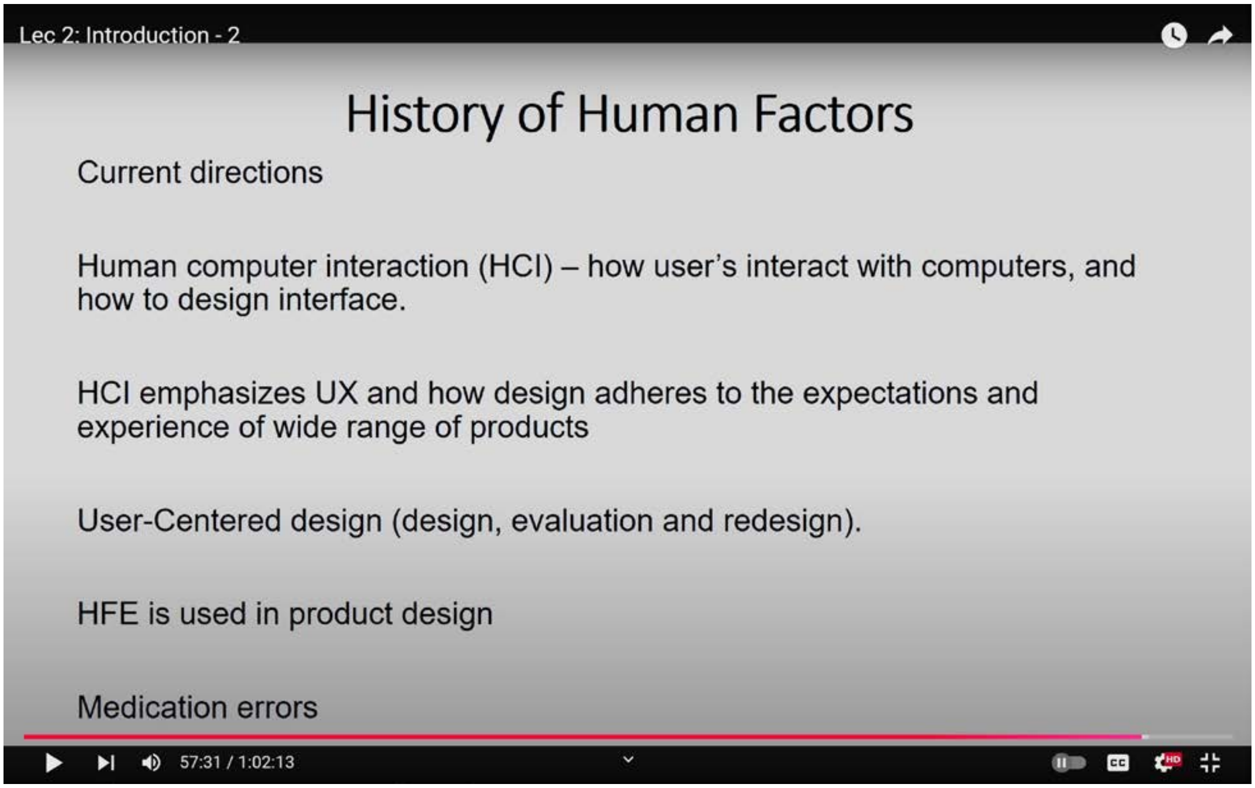

Current directions in the field also encompass human-computer interaction (HCI), which focuses on studying how humans interact with computers, how users engage with these systems, and how to design effective interfaces. HCI emphasizes concepts such as user experience (UX), user design, and user-centered design, all aimed at ensuring that design adheres to the expectations and experiences of a diverse range of products. The objective is to create systems and interfaces that understand users and reduce their cognitive load.

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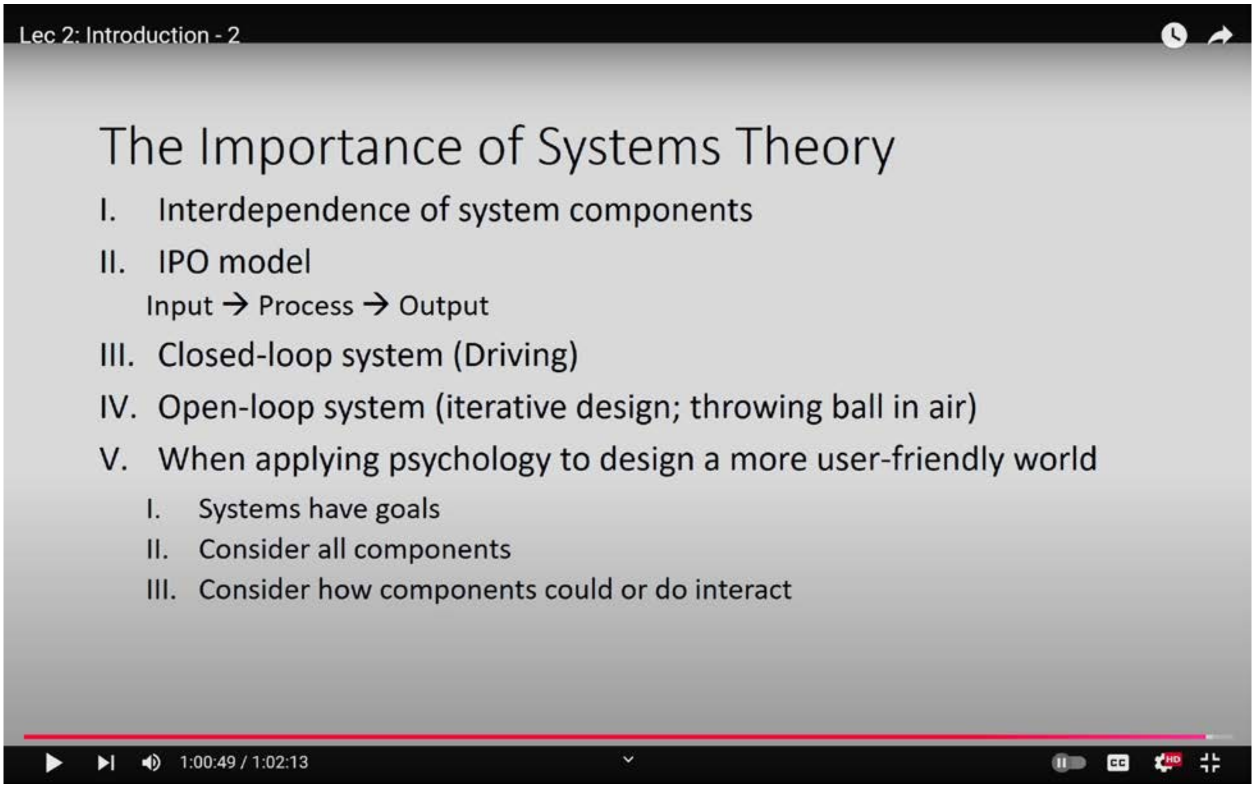

The principle of user-centered design involves evaluating and redesigning products with user input from the very beginning of the conceptualization process. In the initial stages, when the idea of developing a product or system is first considered, users are involved in discussions. As the design evolves, user feedback is continually solicited to inform adjustments. For existing systems requiring modifications, the perspectives of current users are gathered through thorough discussions and brainstorming sessions. Ultimately, once a prototype of the new system is developed, the same users are engaged again to provide feedback, ensuring that the final version of the system is both proficient and efficient. This inclusive approach throughout the design process exemplifies user-centered design.

Human factor engineering also plays a crucial role in product design and in addressing medication errors, where mistakes can lead to serious consequences, such as amputating the wrong limb or administering an overdose of medication. To mitigate these risks, human factors engineering assists healthcare professionals in making critical decisions within the medical field. Engineering psychologists adhere to a systematic approach to design, which is characterized by inputs, processes, and outputs.

In classic system design, inputs are transformed into outputs through a process, with interdependencies among system components. Many engineering psychology challenges adhere to this systematic design framework. The Input-Process-Output (IPO) model is commonly applied, where the output can, in many cases, provide feedback to the input. For example, when using a printer, the input involves entering data into the printer, which processes the data and generates an output. Evaluating this output influences whether to proceed with the same print layout or modify it.

Systems can be categorized as either closed-loop or open-loop. Closed-loop systems are those that can be modified during operation. For instance, while driving, adjustments can be made to the vehicle or driving behavior, allowing for an enhanced or more enjoyable experience. Conversely, open-loop systems operate without the possibility of modification until the process is complete. A classic example of an open-loop system is throwing a ball into the air; once thrown, its path cannot be altered until it lands.

By applying psychology to design, we can create a more user-friendly world. Achieving this requires consideration of three key aspects. First, most systems have a specific goal, and we must think about how human-computer interaction can facilitate this goal. Second, it is essential to consider all components of the system, not only the input but also the process and output components within the machine-human relationship. This analysis includes understanding how these components interact with one another.

For instance, consider the interaction between inputting a page for printing and the subsequent printing process. If an incorrect command is given, the printer may produce the wrong output or fail to print altogether. It is vital to identify which commands users can input and what outputs can result from those commands. Additionally, it is important to develop mechanisms that enable the machine to recognize and rectify incorrect commands autonomously, thereby reducing the burden on the user. Spell check features serve as a prime example of this; when a misspelled word is detected, the system often automatically corrects it.

Thus, the human-machine relationship is critical, and systems theory aids in understanding these interactions, allowing for effective problem-solving and adjustments. This concludes Lecture 2. In summary, we have explored the historical context of the field, differentiated between industrial-organizational psychology and engineering psychology, and examined the current directions of the discipline of engineering psychology.

In the upcoming lectures, we will discuss engineering psychology and explore additional aspects of the field. Until we meet again, thank you, and goodbye from the MOOC studio. Thank you.