

MIE240: HUMAN-CENTRED SYSTEMS DESIGN

History of
Human-Centred
Systems Design



1

LEARNING OBJECTIVES



Define human
factors and the
goals of human
factors



Develop
awareness of the
motivations of
different industry
sectors



Understand the
historical
development of
HF as a discipline

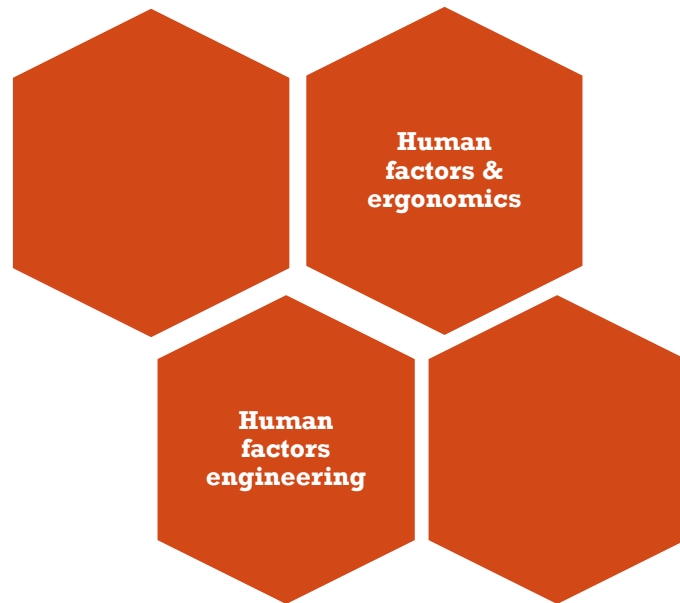


Discuss system
design and areas
of human factors
intervention



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Human factors
examines the
relationship
between humans
and the systems
with which they
interact.



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Goals of Human Factors

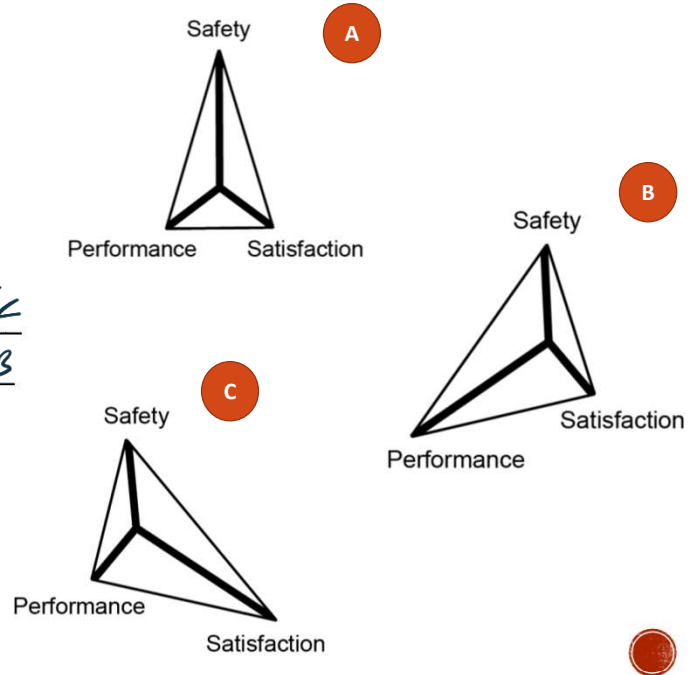
1. safety: Reducing the risk of injury and death
2. performance: Increasing productivity, quality, and efficiency
3. satisfaction: Increasing acceptance, comfort, and well-being



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Examples

- Nuclear power plant A
- VR headset C
- Technical support call center A/C
- Platinum mining operation A/B
- Retail/consumer bank B
- Construction site A

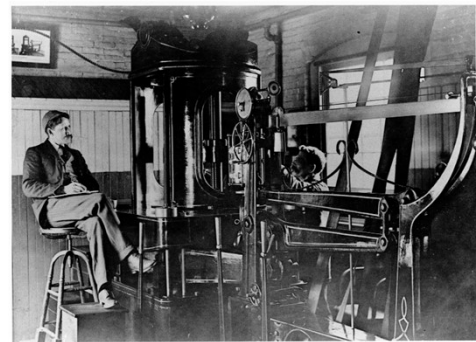


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History of Human Factors



- **Frederick Taylor (1880-90s)**
- Scientific Management
- "One best way"
- Time & motion study



"Testing Engineer at Work." A man, possibly Frederick W. Taylor, sits in a chair observing an engineer at work at Midvale Steel Company, ca, 1885 (<https://www.flickr.com/photos/kheelcenter/5279194177>)

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History of Human Factors

- **Frank & Lillian Gilbreth**
- Contended that Taylor's ideas fell short when it came to **managing the human element**
- Used "Time and Motion studies" to reduce the number of motions in performing a task; train workers
- A new idea: adapt equipment and procedures to people
- <https://www.youtube.com/watch?v=BJWPuigznhI>



Lillian Gilbreth

First female member of the Society of Industrial Engineers (1921)
First woman appointed to National Academy of Engineering (1965)



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History of Human Factors

anthropometric data

Periods of growth and innovation (1900s – 1950s)

I. WWI and WWII

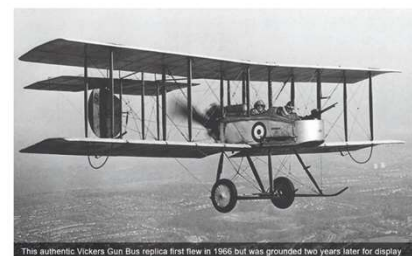
- Recognition of individual capabilities and limitations, work requirements exceed capabilities
- Required psychologists and engineers to work together to develop components



- Height – 5'3"
- Chest size – 34 inches
- Vision – Read 1.25in letters from 20 ft

II. Post WWII

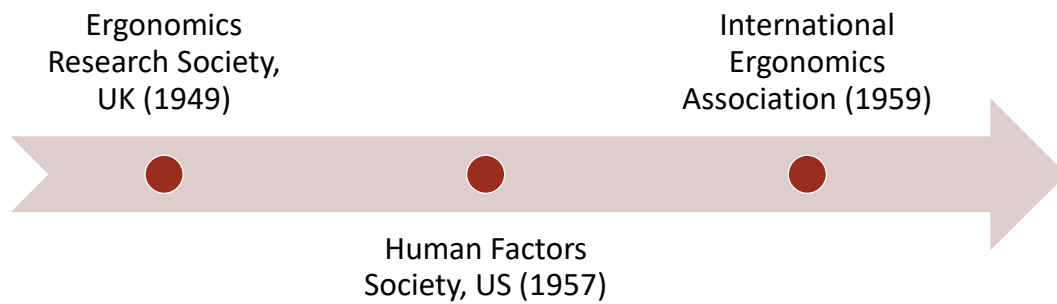
- More emphasis on "Fitting the task to the worker"
- Concerns for productivity AND social conditions
- Expansion in military and government laboratories
- Shift to emphasis on **systems over components**



This authentic Vickers Gun Bus replica first flew in 1966 but was grounded two years later for display

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History of Human Factors



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History of Human Factors

III. 1960s – 1990s

- Research fueled by **space program**
- Expansion into commercial sector : Pharmaceuticals, computers, cars, workplace design, consumer products
 - PC revolution
 - “ergonomic” & “user friendly”
 - Liability and litigation
- Motivated by disaster - *e.g.*, *Three Mile Island (1979)*, ***Bhopal (1984)***, *Chernobyl (1986)*, *Challenger (1986)*, *Exxon Valdez (1989)*



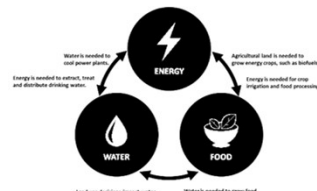
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Current State of HF – 2000s to Present

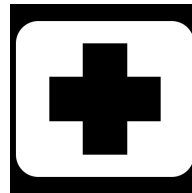
- Regulation and standardization in some industries (*aviation, military, manufacturing*) resistance in others (*medicine*)
- Greater integration of HF in more industries (finance, forensics, etc.)
- Design for aging populations, accessibility, and equity
- Human factors for good & social justice



Insurance and finance



Food – water- energy
nexus



Healthcare

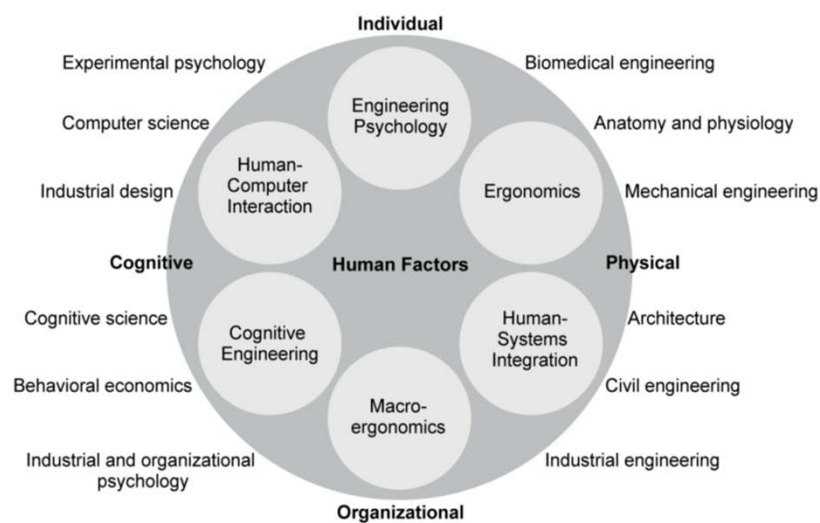


Forensics



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Human Factors Fields



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Human factors opportunities

Sample job titles

- Human factors engineer/psychologist
- Human factors scientist
- Human factors consultant
- UX researcher/designer
- Health system engineer
- Safety engineer/scientist
- Systems engineer
- Ergonomist
- Professor

Industries

- Healthcare
- Banking, finance, and insurance
- Education
- Aerospace and transportation
- Tech
- Manufacturing
- Power generation
- Government (policy, labs, defense)
- Non-profits, NGOs



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What is system design?

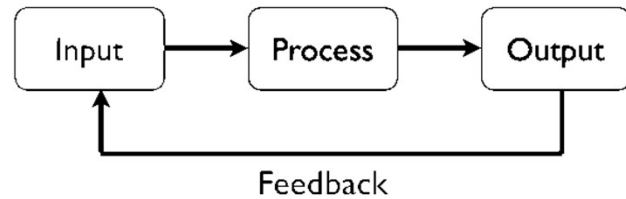


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What is a System?

A system is an organized collection of parts (or subsystems) that are integrated to accomplish an overall goal.

The system has *inputs*, which go through certain *processes*, to produce specific *outputs* - accomplish the **overall desired goal** for the system.

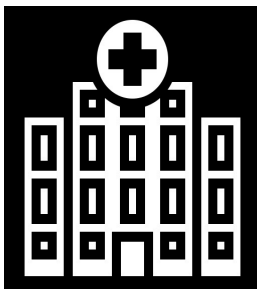


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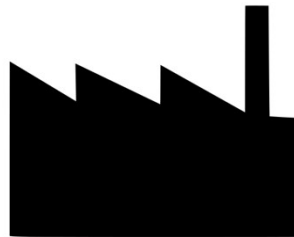
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What is a System?



Hospital

I: *unhealthy patient*
 P: *healthcare*
 O: *healthy patient*



Manufacturing facility

I: *RM*
 P: *machine operation*
 O: *product*



Personal vehicle

I: *fuel*
 P: *engine mechanism*
 O: *movement*

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What is Design?

- 1 Conceptualization and creation of new things
- 2 A plan or specification for the construction of an object or system or for the implementation of an activity or process.



Empathize



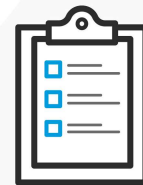
Define



Ideate



Prototype



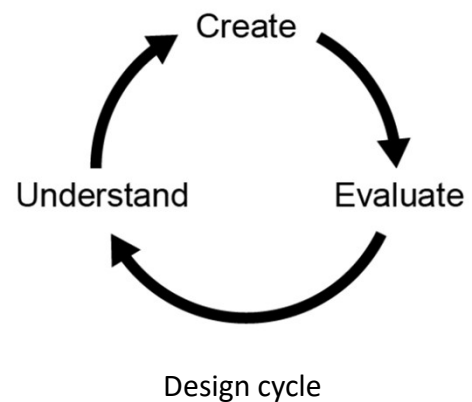
Test

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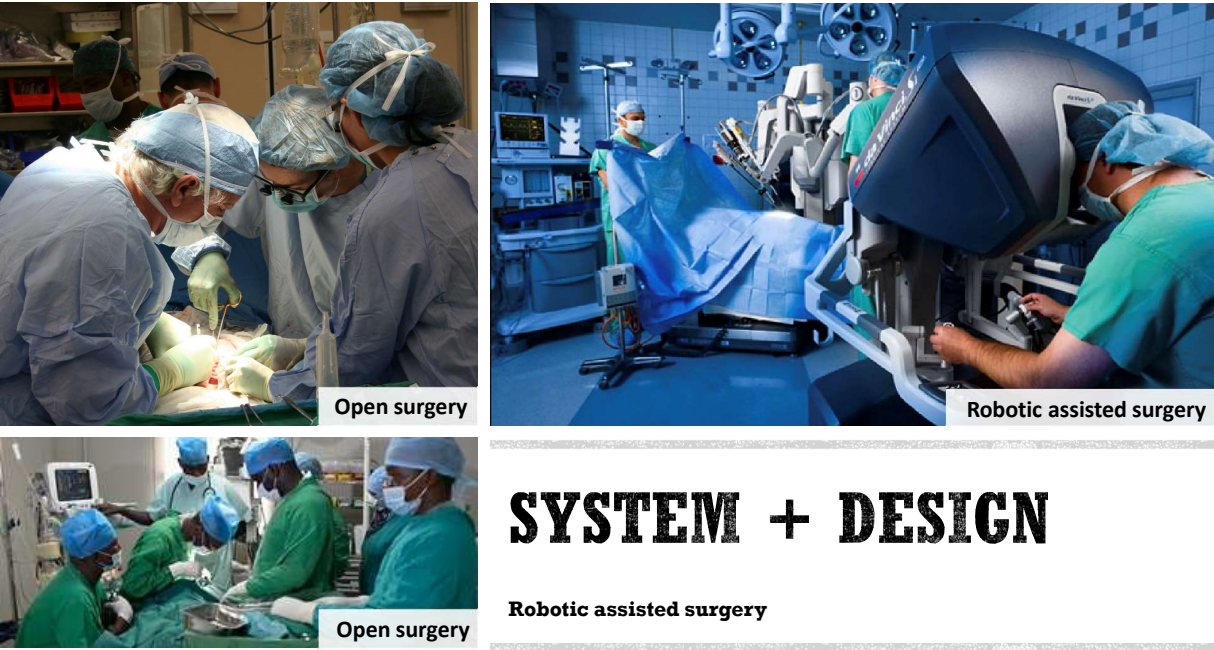
SYSTEM + DESIGN

The process of designing the architecture, components, and interfaces of a **system** to that it meets the **end-user requirements**.

1. interconnection – complex systems have many interconnected elements
2. adaptation – technology often has unanticipated consequences that result from people changing their behavior in response to the technology
3. commitment – our environment guide our behavior



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Open surgery

Robotic assisted surgery

Open surgery

Robotic assisted surgery

SYSTEM + DESIGN

Robotic assisted surgery

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HF Design Interventions

<p>Task design focuses on changing what operators do than on changing the devices they use.</p>	<p>Equipment design changes the physical equipment that people work with.</p>	<p>Environmental design changes the physical environment where the tasks are carried out.</p>
<p>Training enhances the knowledge and skills of people by preparing them for the job environment.</p>	<p>Selection changes the makeup of the team or organization by picking people that are best suited to the job.</p>	<p>Team and organization changes how groups of people communicate and relate to each other, and provides a broad view that includes the organizational climate where the work is performed.</p>

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HF Design Interventions



Adding guards and barriers



Providing PPE



Redesigning the environment

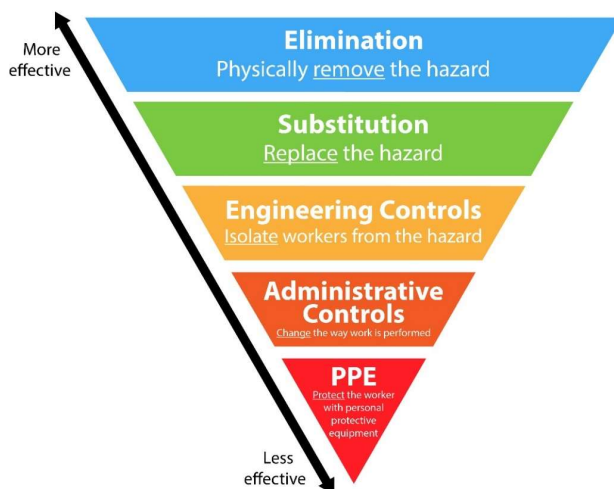


On the job training

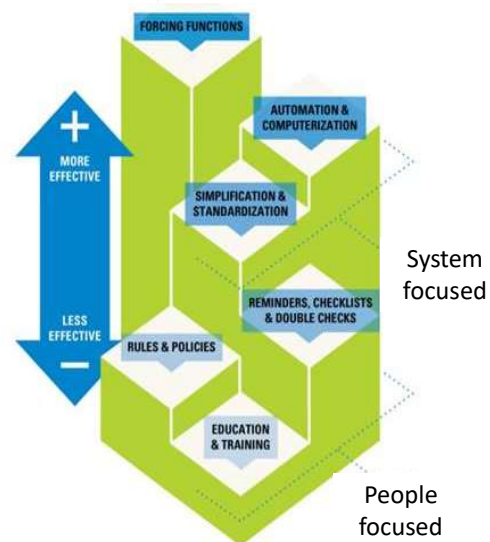


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HF DESIGN INTERVENTIONS



The Hierarchy of Intervention Effectiveness



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Example: Clean Up Task

Example

1. Removing the last page of a document from the copier or scanner
2. Taking your debit card out of the ATM after your withdrawal/deposit
3. Turning off your lights after you park
4. Leaving a sponge or instrument in patient after the surgery

Possible interventions

Ex. 1 *make last page blank*

Ex. 2 *give the card*

Ex. 3 *sound indicate on*

Ex. 4 *cont instrument*



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Summary

- Human factors examines the relationship between humans and the systems with which they interact.
- The goals of HF engineering include improving safety, performance, and satisfaction
- Frederick Taylor is considered the “father” of Industrial Engineering
- Frank and Lilian Gilbreth made important contributions by using “time and Motion studies” to reduce the number of motions in performing a task and train workers
- System Design describes the process of designing the architecture, components, and interfaces of a **system** to that it meets the **end-user requirements**.
- The six areas of intervention are task design, equipment design, environment design, selection, training, teamwork and organization



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NEXT CLASS (FRIDAY, JAN. 10)

Topic: HF in the Systems Design Process

Read: Ch. 2.1-2.4 (less 2.1.1 plus “Integrating HF into design processes”)

