

# **Ergonomia Cognitiva (Cognitive Ergonomics)**

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## Definition Of Ergonomics

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.

– International Ergonomics Association

<http://www.iea.cc>

# Anatomy

Use:

- knowledge of human characteristics
- relevant methods and tools

Do:

- **understanding** interactions among humans and other elements of a system = **accumulating knowledge of human characteristics** – science
- **designing** - engineering

for:

- **optimizing** human well-being and overall system performance

# Cognitive Ergonomics

Use:

- knowledge of **human cognitive characteristics**
- relevant methods and tools

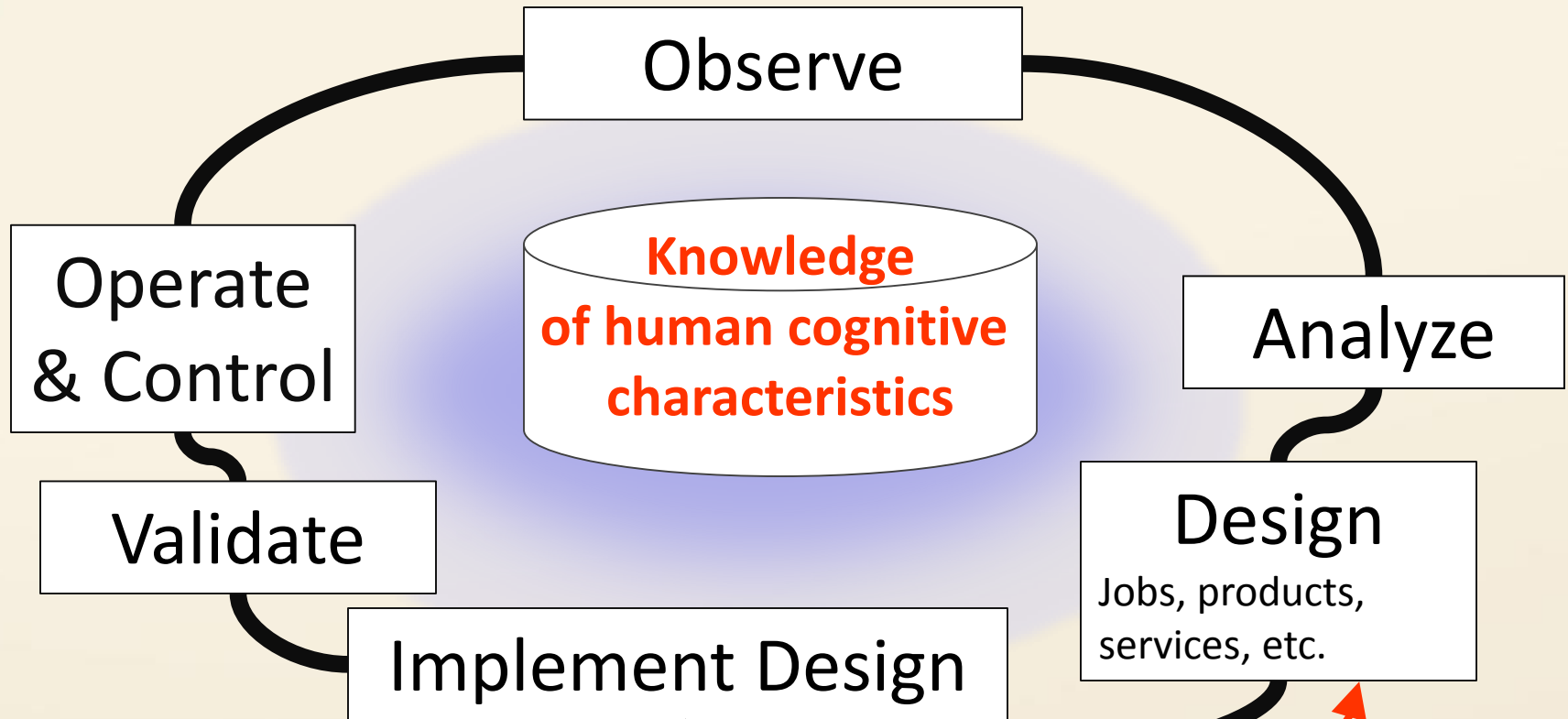
Do:

- understand **cognitive interactions** among humans and other elements of a system – science
- design - engineering

To:

- optimize human well-being and overall system performance

# [Cognitive] Ergonomics Process



**Technologies (e.g. ICT),**  
design of system, regulations, standards, user requirements, market trends, social climate,...

# Robots, Artificial Intelligence,...



# Bhopal – Fertilizer Plant Accident, India



# Challenger – Space Craft Accident, USA





# Minamata – Mercury Contamination, JPN



# The Fukushima - NPP Accident, JPN



## **- Abstraction -**

**You don't know the real things  
behind Human System Interfaces**

# Gas Tank Level Measurement

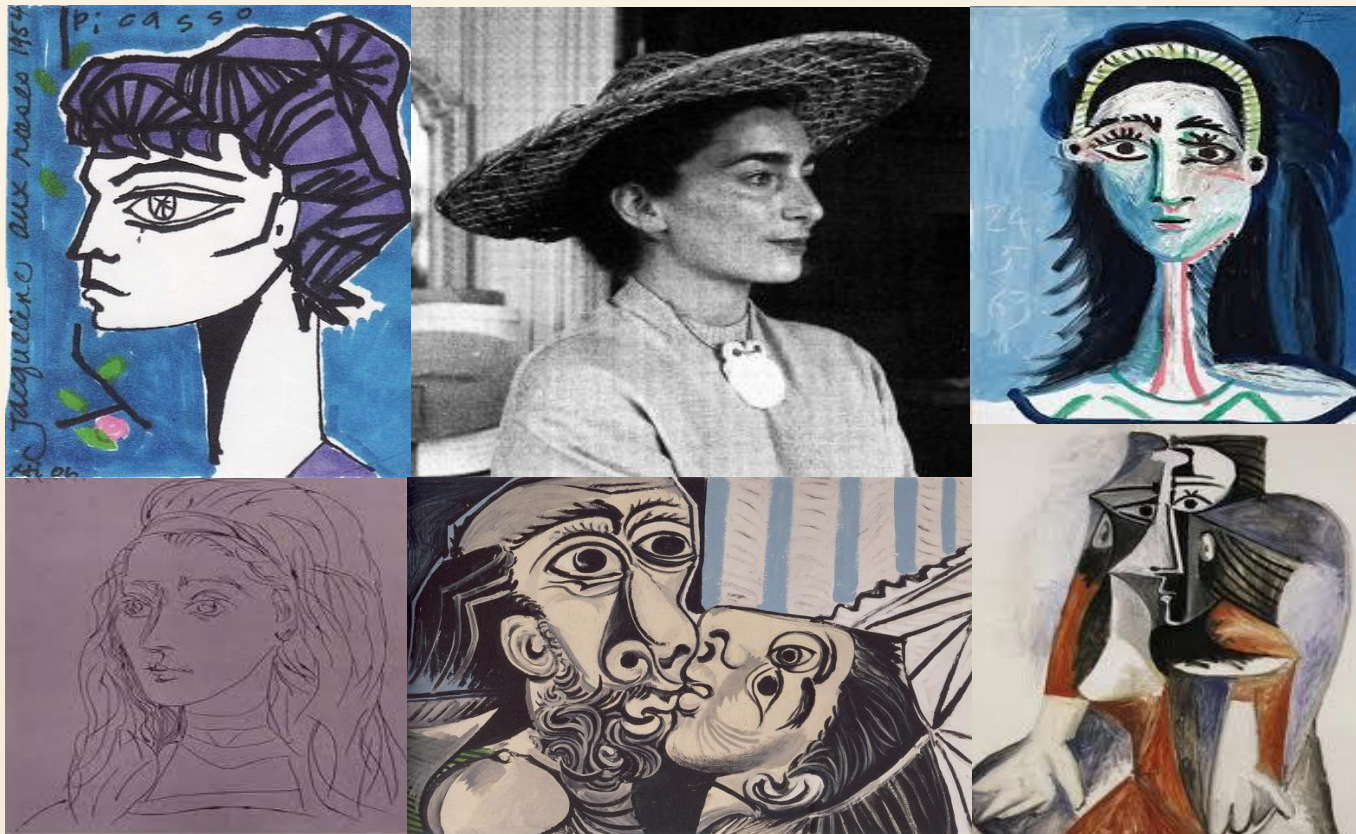


# You Do Not See The Face Behind The Mask



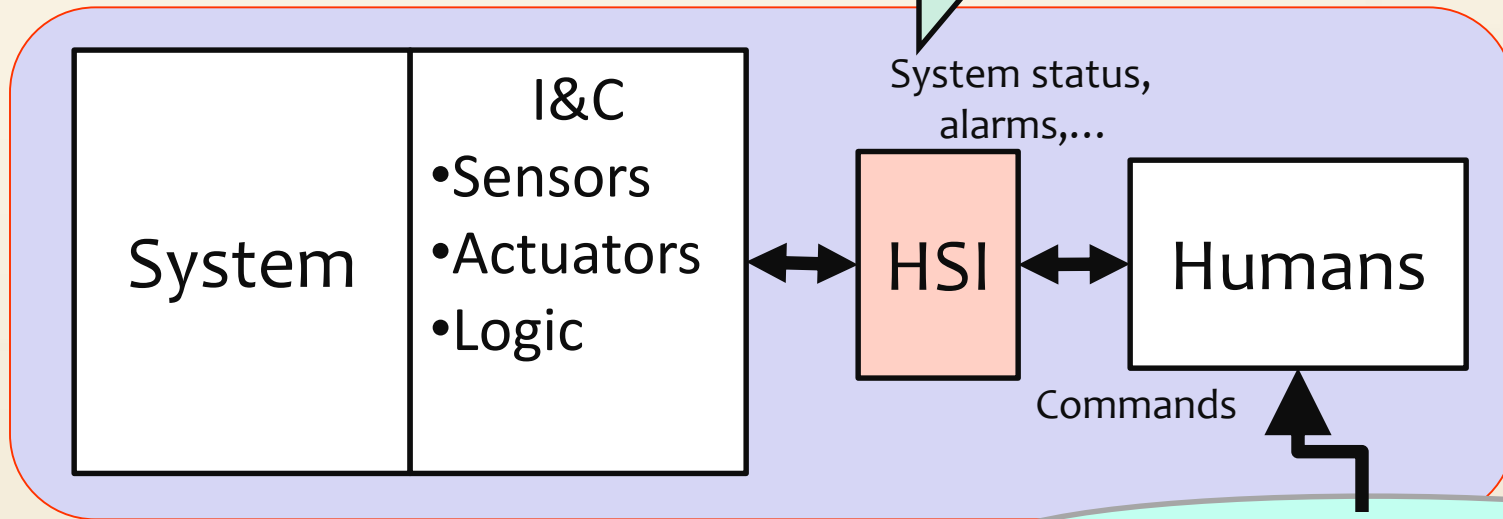
Noh, Japanese traditional theatrical play

# How many Jacquelines you see here? Aren't you watching your mind?

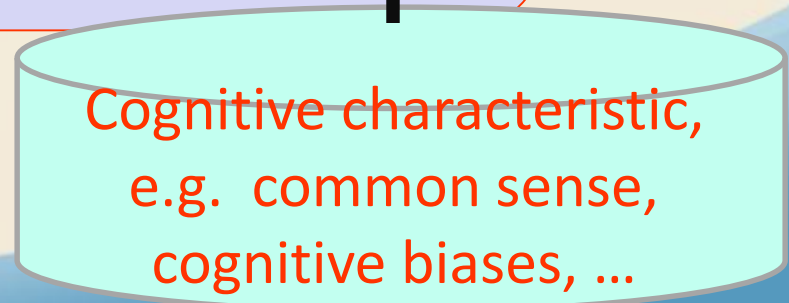


# Where Is The Reality?

Complicated  
sensory systems, info selection,  
info processing, interpretation,  
abstraction, modeling,...



Join Human-Machine System



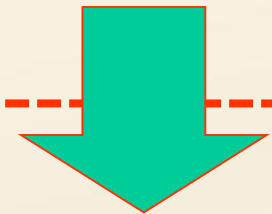
Cognitive characteristic,  
e.g. common sense,  
cognitive biases, ...

# You Never Know What Exactly Are Behind

Grids



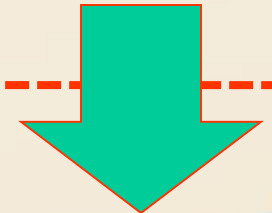
Real world



HSI



Abstracted world



Operators



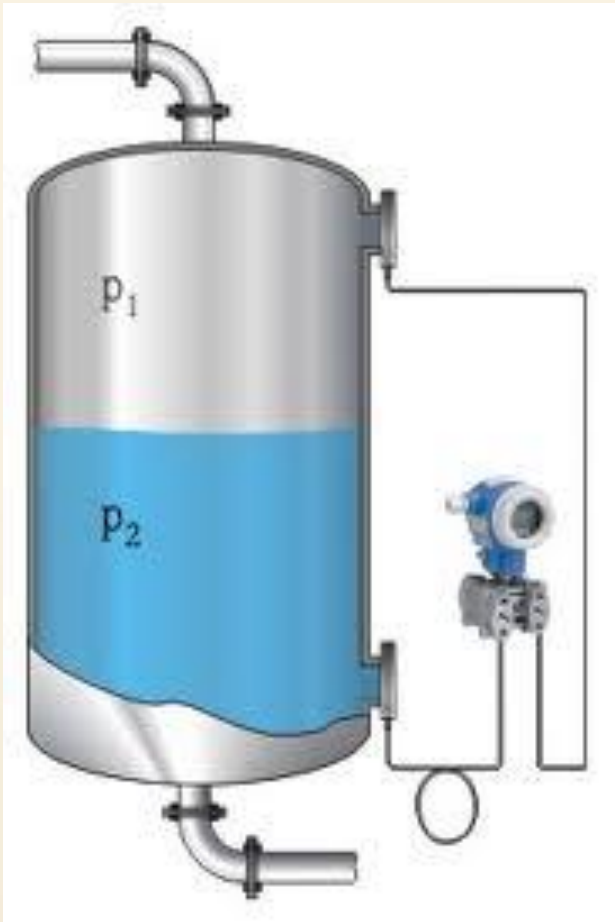
Even more abstracted world



## **- Human Errors -**

**The same cognitive process  
results sometimes in success and  
sometimes in failure**

# Differential Pressure Level Measurement



# NPP Pressurizer (H=10m, P=15.4MPa)



# You could be fooled by information

## Three Mile Island NPP accident

Status	Operating Procedures	What happened	
		Indication	Actual status
Relief valves	Closed	Closed	Stuck open
Level full	Full	Full	Vacant
...	...	...	...
Emergency core cooling system	Stop to avoid "SOLID"	Stopped	⇒ Loss of cooling ⇒ Core melt

**Hindsights : Valve status indications are based on demands**

**: Level gauge was non-functional with full vapor**

**: Temperature trend indicated loss of cooling ⇒ Error!**

# **- Contextual Errors -**

**You are almost forced to err.**

# Natural Accident



## Context

- Poor visibility – blizzard
- Descending road
- Slippery road – frozen road
- No center line
- No vehicles around
- Me driving in Mexico
- The radio is on.
- Your friend has spilt coffee and **screamed!**

AND:

- A car is approaching just behind the blind corner

$$P_{\text{head-on collision}} = \text{HEP}_{\text{under context}} \times P_{\text{context}}$$

almost =  $P_{\text{context}}$

## **- Resilience -**

**Life Is full of uncertainties. How can you remain resilient beyond postulated situations?**

# You Never Know Win or Loss To The Very Last Moment



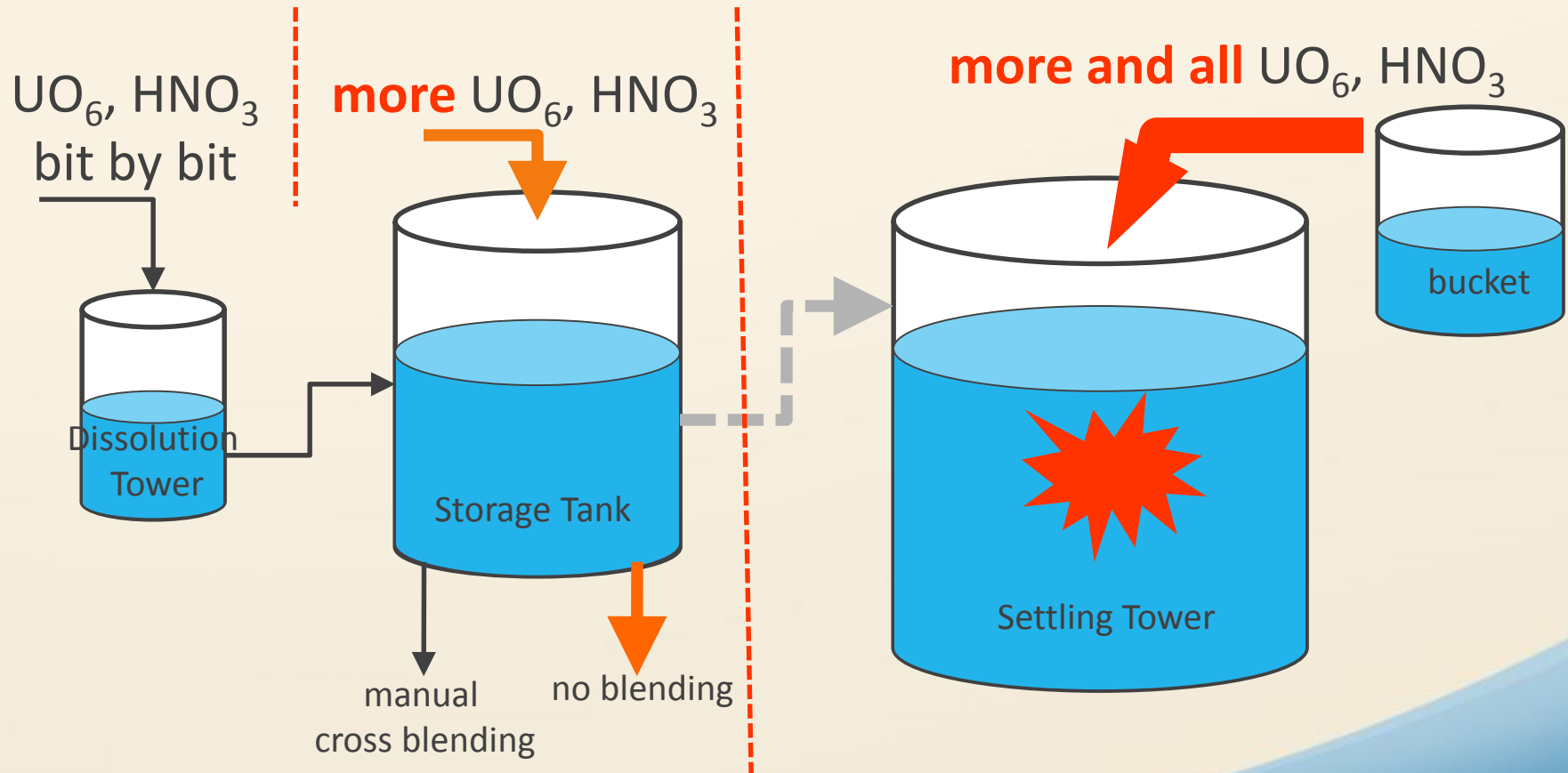


# Grandchampions are not dancing

- We are all resilient by nature for survival. -



# You Can Fool Yourself Under The Name Of “Improvement.” – A Criticality Accident, JPN



# Things Inevitably Change Over Time, Sometimes Causing Loss of Resilience

*Safer, cumbersome*

<<<<< >>>>>

*Riskier, easy*

Formal Procedures	Working Procedures	Killer Procedure
<ul style="list-style-type: none"> <li>Mix UF<sub>6</sub> with HNO<sub>3</sub> in <b>the dissolution tower</b></li> </ul>	<ul style="list-style-type: none"> <li>Mix UF<sub>6</sub> with HNO<sub>3</sub> in <b>a large SUS bucket</b></li> </ul>	<ul style="list-style-type: none"> <li>Mix <b>more</b> UF<sub>6</sub> with NO<sub>3</sub> in a large SUS bucket</li> </ul>
<ul style="list-style-type: none"> <li>Transfer the solution to <u>the storage tank</u> at a <b>regulated rate</b></li> </ul>	<ul style="list-style-type: none"> <li>Put the solution to <u>the storage tank</u> <b>at once</b></li> </ul>	<ul style="list-style-type: none"> <li>Put the solution to <b>the settling tower</b> at once</li> </ul>
<ul style="list-style-type: none"> <li>Manually <b>cross blend</b> the solution with containers (PRODUCT)</li> </ul>	<ul style="list-style-type: none"> <li>Pour into a container one by one <b>without blending</b> (PRODUCT)</li> </ul>	

## Some Important Facts of Life - I

- Real-world problems are always ill-structured with a great deal of uncertainties.
- Joint human-machine systems are subject to change over time:
  - Conditions that the original system design postulated do not remain stable.
  - People are never successful in the attempt of specifying precise procedures.
  - People are never successful in the attempt of fixing procedures.

## Some Important Facts of Life - II

- People are proactive – always try to make a decision even when it is not possible for objective eyes.
- People rely on common senses – effective mostly, but could be fatal.
- People bet on frequency.
- People bet on fresher experiences.
- People try to solve problems in terms of the hypothesis-and-test.
- ...
- Most fatal accidents are preceded by precursors which are observable in normal situations.

# Remote Control, Artificial Intelligence,...

## - How ergonomists can/should contribute to the future job environments?



Rio Tinto - Control many more than forty mines from distance (1,500Km)

**Thank You!**

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