Cognitive and human-error task modelling

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Stress in human-computer interaction (Szalma et al., 2012)

- Computer-based tasks are a common **source of stress for users**.
  - ❖ Think of how many times in your own work that the computer has appeared to be a barrier to task completion rather than a helpful tool.
- Tasks that impose either **too much or too little demand** will likely be appraised as stressful.
- The structure and organization of computer interfaces will be a major factor in determining both **performance under stress** and the **relation of performance to perceived workload**.
- Individual *vs* Environment.

Strategies for stress mitigation (Szalma et al., 2012)

- **Skill** development
  - ❖ So it's relatively **automatic** as opposed to the alternative controlled processing.
- Specific **display design changes**
  - ❖ **Simple, easily perceivable graphics** can permit quick, direct extraction of information when cognitive resources are reduced by stress and workload.
- Technologies employing **adaptive automation and decision aids**
  - ❖ Adjusting the **level of automation according to stress state**.
  - ❖ Adapting it to the operator based on their **own personal style of interaction** for aiding performance and reducing stress and workload.

User cognitive capabilities (Ning, 2021)

- They are measured for two primary aims:
  - ❖ To explore the **impact of cognitive** capabilities on the performance and experience of specific tasks.
  - ❖ To **differentiate users** based on their cognitive capabilities:
    - ✓ Based on the profile, designers can evaluate the quality of design, predict user performance, and provide adapted information or products.
- The **higher** the user’s capabilities, the **better** performance can be achieved.

Cognitive challenges in design (Ning, 2021)

- Cognitive design principles and guidelines (early stages)
- Cognitive task analysis (early stages)
- Cognitive walkthrough (evaluation)
- Cognitive modelling (evaluation): CogTool and GOMS

- The pre-existing ways of measuring users' cognitive capabilities **ignore** users' organizational, social, and cultural attributes.
- Designers' perspective is **missing** in current studies.

User emotions (Szalma et al., 2012)

- There is growing recognition of the need to consider a **user's emotional response to a task or an interface** as it is an important aspect of design.
- Computer systems that both **recognize** user emotions and **generate** emotional expressions on behalf of the computer system.
- Emotions have the potential in HCI to become either:
  - ❖ **Stressors** themselves or
  - ❖ Tools by which operators can cope with stress and **enhance the effectiveness and efficiency of performance**.

❖ **Affective Computing** (Picard, 2000), **Hedonomics** (Hancock et al. 2005).

User errors (Fahssi et al., 2015)

- **Skill-based** errors:
  - ❖ **Slip**, or routine error: a mismatch between an intention and an action.
  - ❖ **Lapse**: a memory failure that prevents from executing an intended action.
- **Rule-based** mistakes: application of an inappropriate rule or procedure.
- **Knowledge-based** errors: inappropriate usage of knowledge, or a lack of knowledge or corrupted knowledge preventing from correctly executing a task.

User errors: phenotype and genotype (Fahssi et al., 2015)

- The **phenotype** of an error is defined as the **erroneous action that can be observed** (an observable consequence of an error).
- The **genotype** of the error is defined as the **characteristics of the operator** that may contribute to the occurrence of an erroneous action (the potential associated **causes** of the error).
- HAMSTERS has been extended to allow explicit representation of both **genotypes** and **phenotypes** of errors.

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Genotypes in HAMSTERS (Fahssi et al., 2015)

Element of notation in HAMSTERS		Related genotype from GEMS [32]
Perceptive task 		Perceptual confusion (Skill Based Error) Interference error (Skill Based Error)
Input task  / Motor task 		Interference error (Skill Based Error) Double capture slip (Skill Based Error) Omissions following interruptions (Skill Based Error)
Cognitive task 	Skill based errors	– Double capture slip – Omissions following interruptions – Reduced intentionality – Interference error – Over-attention errors
	Rule based mistakes	Misapplication of good rules – First exceptions – Countersigns and non-signs – Informational overload – Rule strength – General rules – Redundancy – Rigidity Application of bad rules – Encoding deficiencies – Action deficiencies
	Knowledge based mistakes	– Selectivity – Workspace limitations – Out of sight out of mind – Confirmation bias – Overconfidence – Biased reviewing – Illusory correlation – Halo effects – Problems with causality – Problems with complexity
Information Inf : Information		Double capture slip, Omissions following interruptions, Interference error, all of the Rule Based Mistakes and Knowledge Based Mistakes
Declarative knowledge DK : Declarative		All of the Knowledge Based Mistakes

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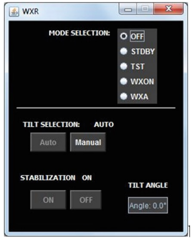
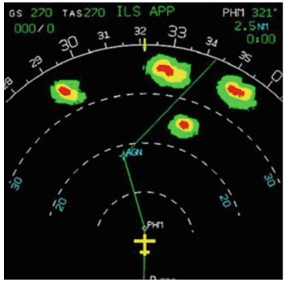
Representation in HAMSTERS (Fahssi et al., 2015)

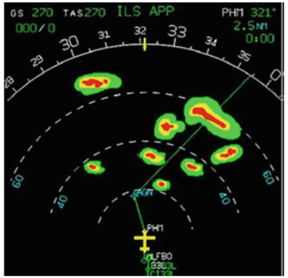
Type of error (GEMS [32])	Level of Performance from [31]	Representation of genotype in HAMSTERS	Representation of phenotype in HAMSTERS
Slip	Skill-based	Slip	
Lapse		Lapse	
Mistake	Rule-based	RBM	
	Knowledge-based	KBM	

Example:





40 NM



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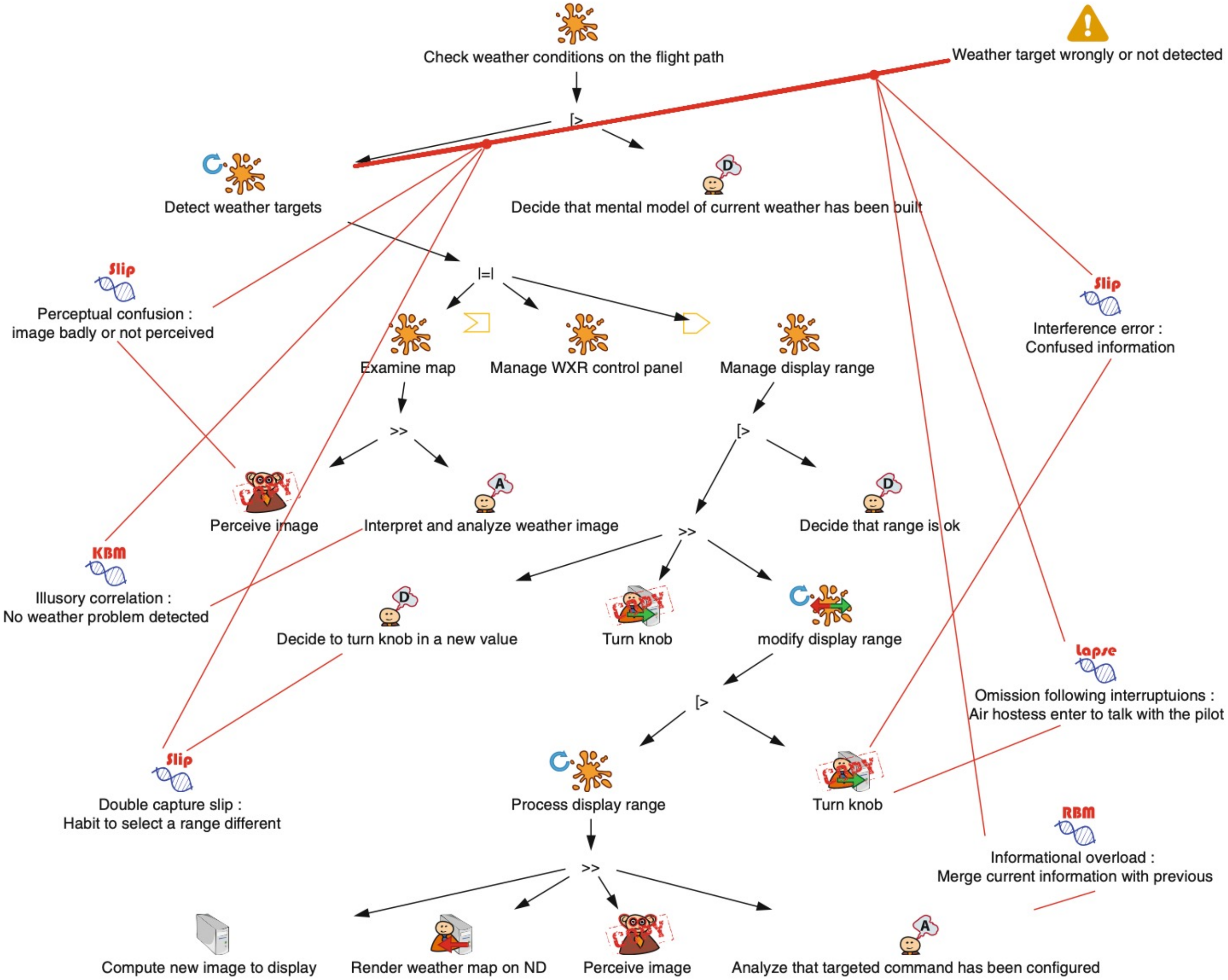

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