SWEN 422 Lecture 7
Interaction

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Agenda

- Review of previous lecture
- Building interactive systems
- Modeling the user
- Modeling tasks
- User-centred design

Topics covered in previous lecture

- Biases, reliability, validity, credibility, dependability
- How many participants?
- Participants’ rights and getting consent
- Covert/undercover usability testing
- Valuing user feedback
- When not to evaluate?

Human-Computer ***Interaction***

- **<u>Interaction</u>**
  - between a biological information processor (i.e., the brain) and a mechanical information processor (i.e., the computer)
  - happens at the interface
- **<u>Cognitive</u>** processes define how the human brain processes input/information -> cognitive psychology
- **<u>Representation</u>** at the interface affects cognition

Cognitive processes

- Attention
- Perception
- Memory
- Learning
- Reading
- Speaking
- Listening
- Problem-solving
- Reasoning
- Planning

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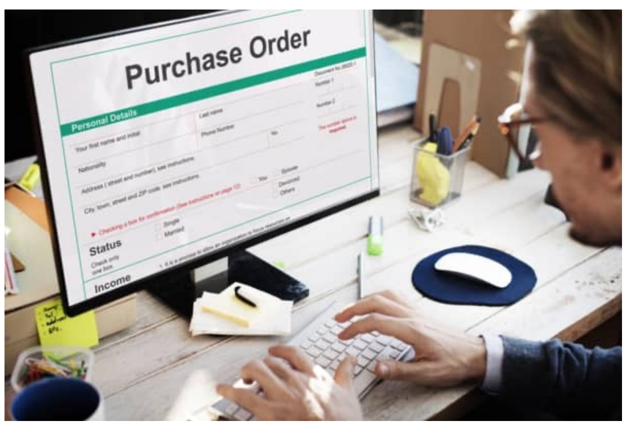

https://www.zurich.ie/blog/motorway-driving-tips-for-nervous-drivers/

https://engoo.com/app/lessons/placing-an-order/PXEXXiQ4EeexNotf1uYFJA

https://support.apple.com/en-nz/108781

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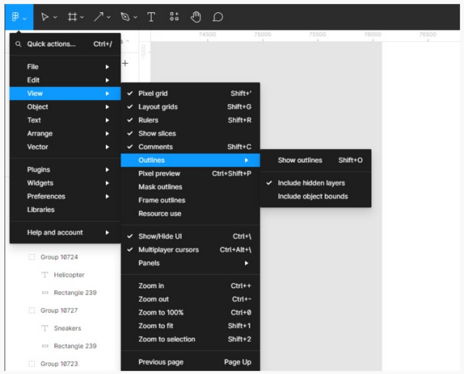

https://think360studio.com/blog/cascading-menus

Cognitive processes

- Attention
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https://www.herald-dispatch.com/special/visitors_guide/understanding-how-to-use-a-compass/article_ecefafa3-e84d-57b8-ae67-856e0097c93e.html

- Speaking
- Listening
- Problem-solving
- Reasoning
- Planning

https://thenewstack.io/7-best-practices-for-data-visualization/

Which representation for problem solving?

Let's play a game: the game of "15."

- The "pieces" for the game are the nine digits – 1, 2, 3, 4, 5, 6, 7, 8, 9.
- Each player takes a digit in turn.
- Once a digit is taken, it cannot be used by the other player.
- The first player to get three digits that sum to 15 wins.

https://pages.ucsd.edu/~johnson/COGS102A/Norman94Chap3

Which representation for problem solving?

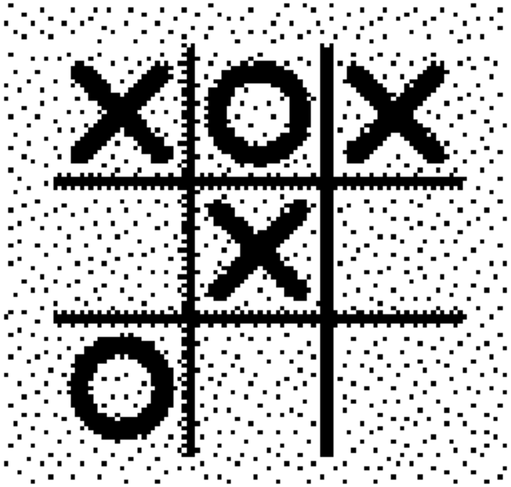
Sample game: Player A takes 8.
Player B takes 2.
Player A takes 4.
Player B takes 3.
Player A takes 5.

Question 1: Suppose you are now to step in and play for B. What move would you make?

https://pages.ucsd.edu/~johnson/COGS102A/Norman94Chap3

Which representation for problem solving?

Sample game:



Question 2: Suppose you are now to step in and play a O for B. What move would you make?

https://pages.ucsd.edu/~johnson/COGS102A/Norman94Chap3

Which representation for problem solving?

Sample game: Player A takes 8.

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Question 1: Suppose you are now to step in and play for B. What move would you make?

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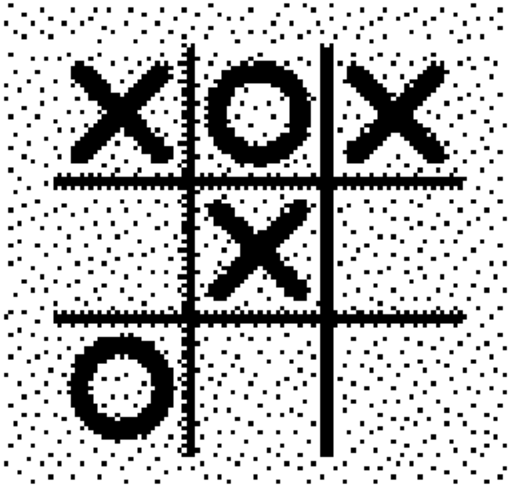
A game of arithmetic, which requires <u>reflective cognition</u>

Which representation for problem solving?

Sample game:



Question 2: Suppose you are now to step in and play an O for B. What move would you make?

A game of space, which requires <u>experiential cognition</u>

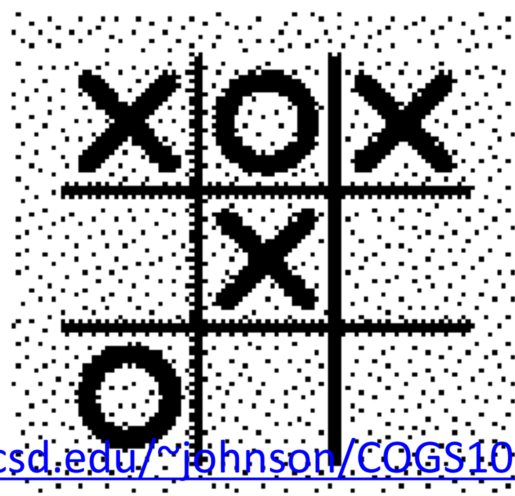
https://pages.ucsd.edu/~johnson/COGS102A/Norman94Chap3

Conclusions about representation

Sample game: Player A takes 8.
Player B takes 2.
Player A takes 4.
Player B takes 3.
Player A takes 5.

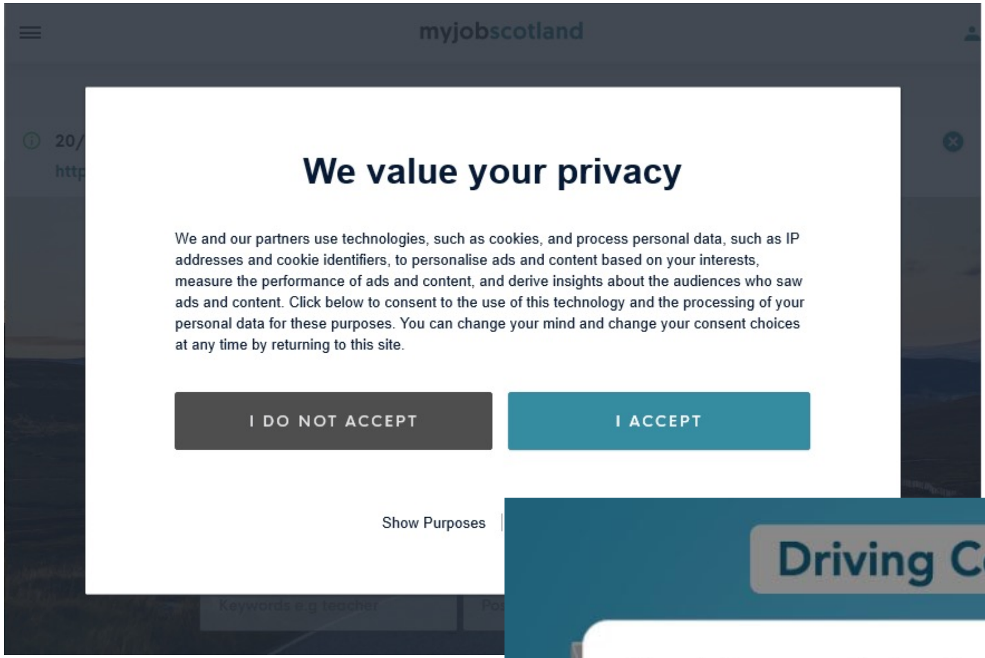
- Representation changes the task
- Reflective cognition is difficult without aid - > [cognitive load]

Sample game:



https://pages.ucsd.edu/~johnson/COGS102A/Norman94Chap3

FIGURE 1.1 Building map or word? What you see depends on what you were told to see.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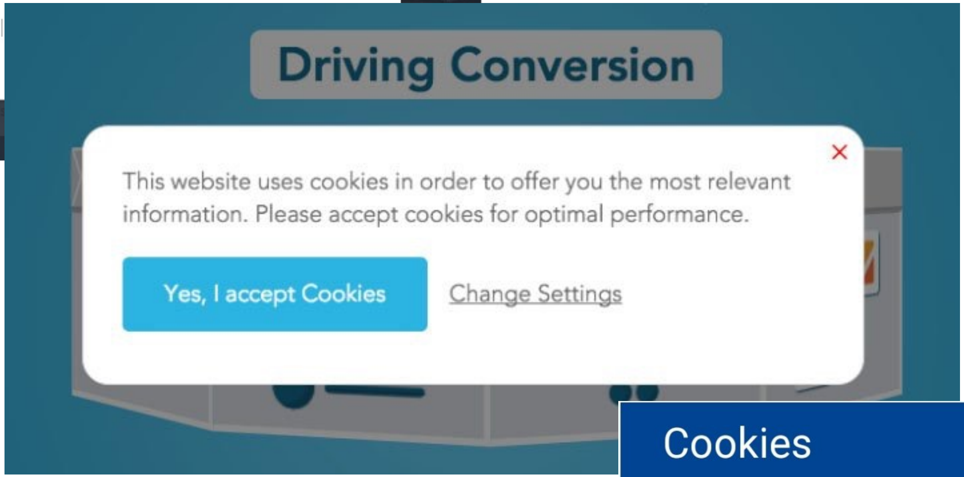
I ACCEPT
Show Purposes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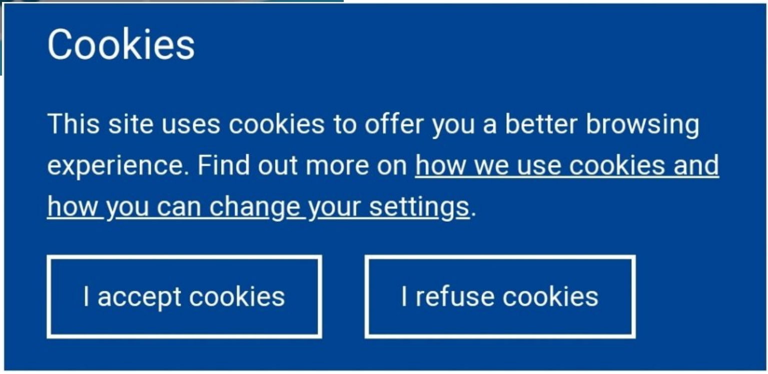
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FIGURE 1.4 The same character is perceived as H or A depending on the surrounding letters.

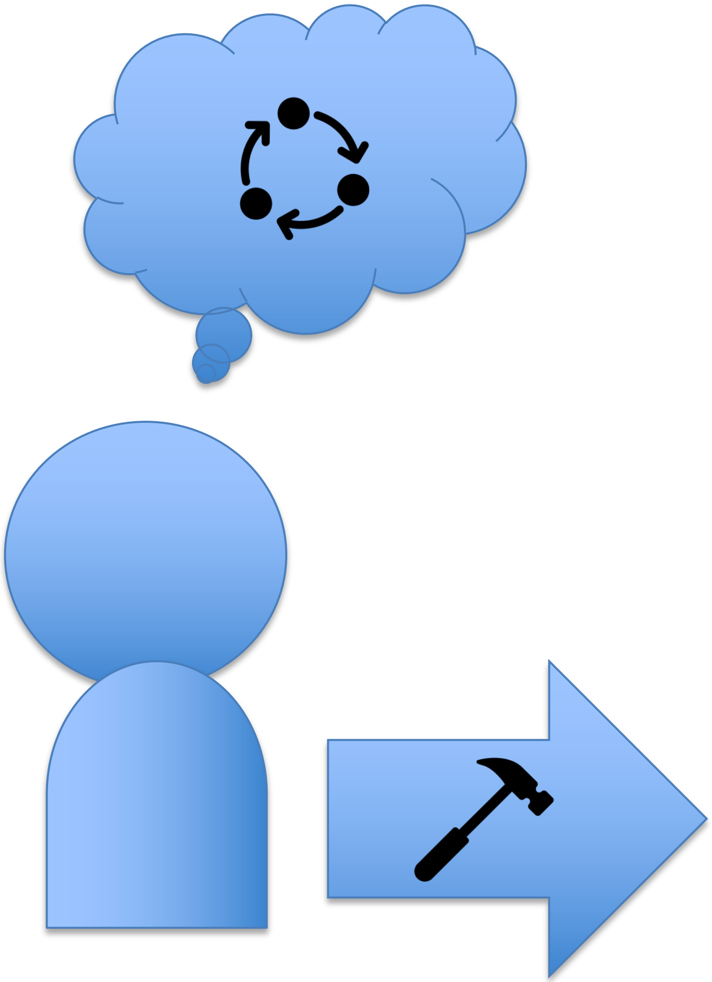
FIGURE 1.8 Toolbox: Are there scissors here?

Was there a screwdriver in the toolbox?

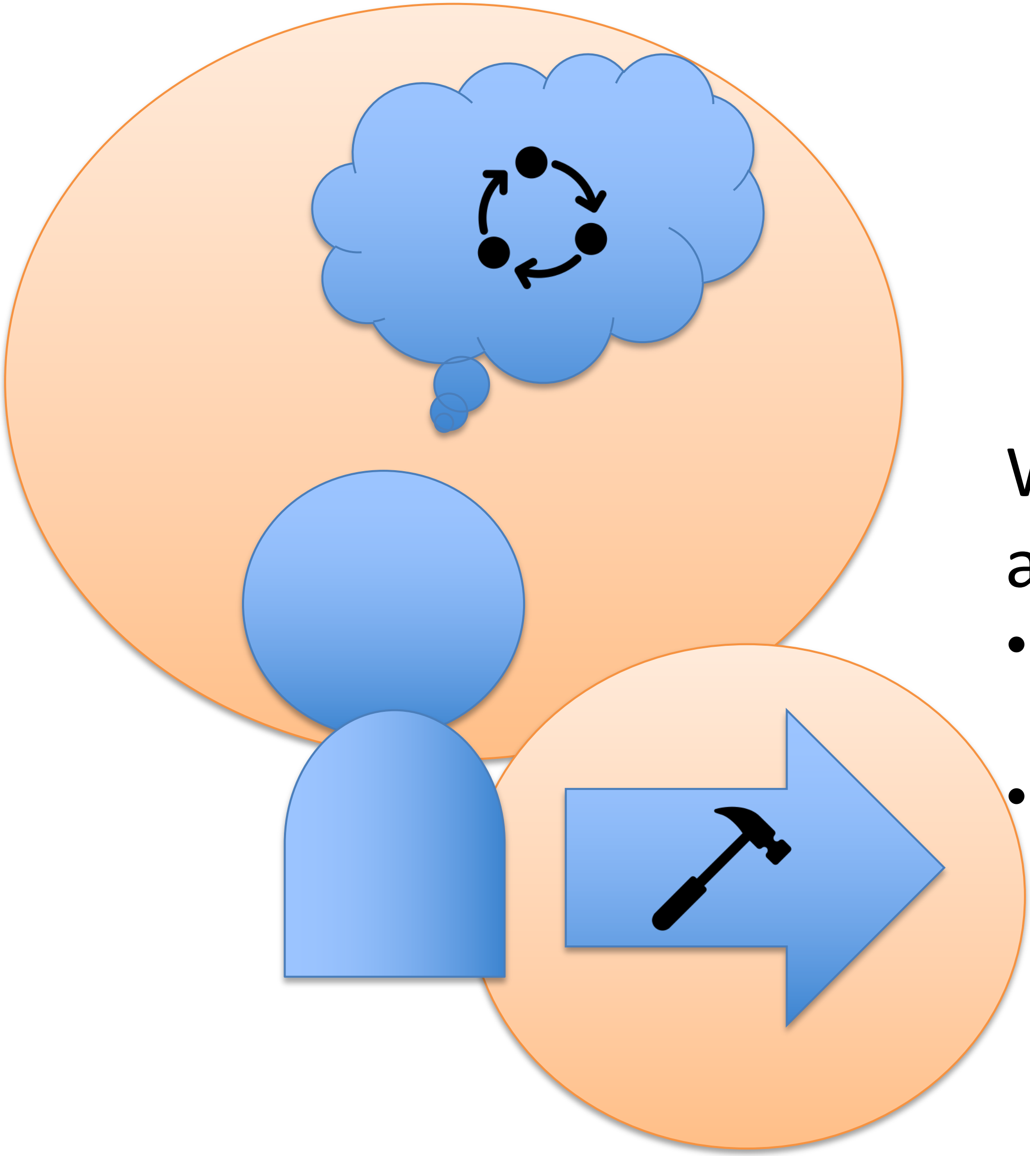
Perception is biased (Johnson 2020)

- ***The past:*** our experience
- ***The present:*** the current context
- ***The future:*** our goals

How



What should be designed and built?



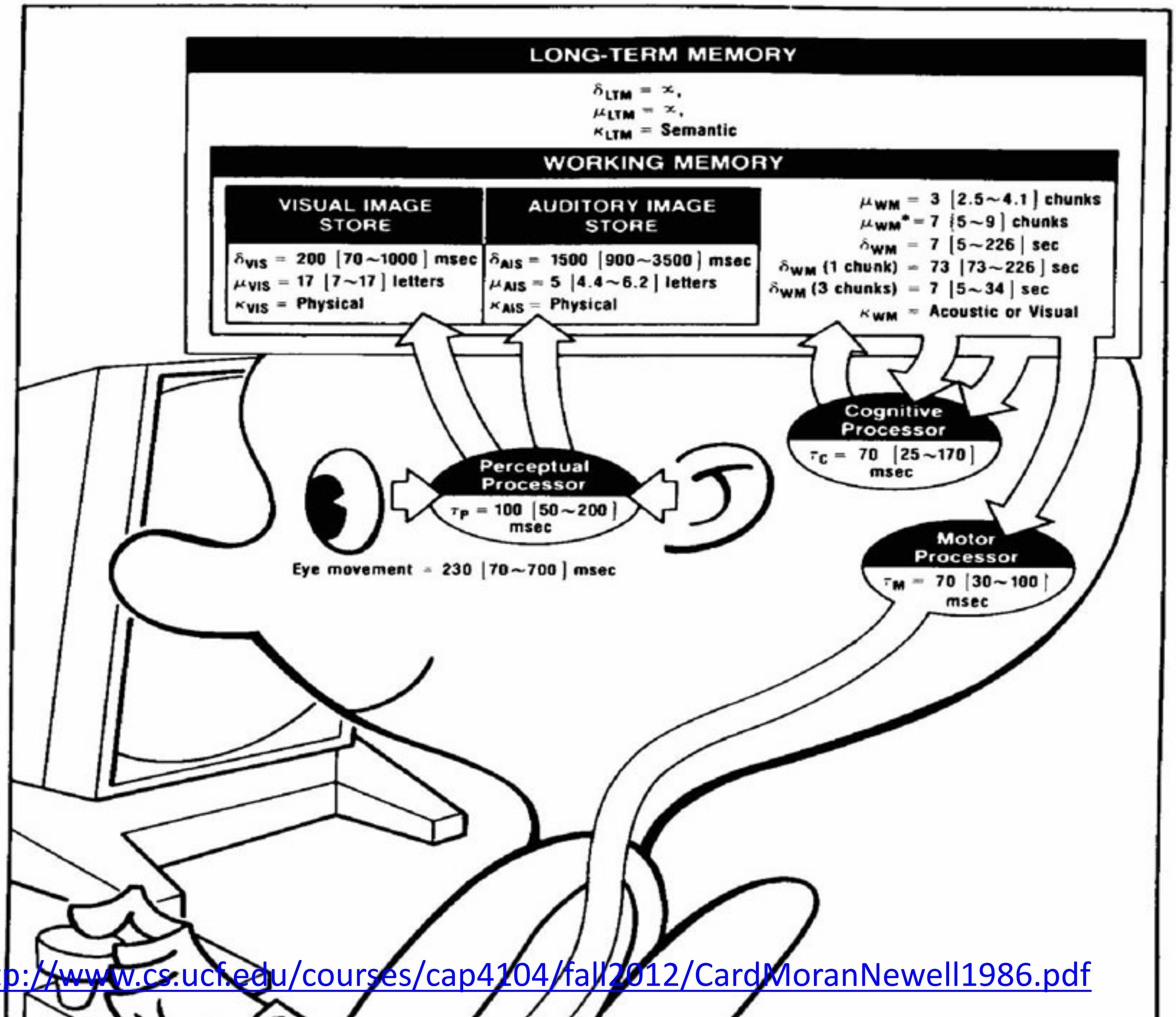
What should be designed and built?

- know about the user's cognition
- know about what the user wants to do

The human brain is a computer

The Model Human Processor: An Engineering Model of Human Performance by Card, Moran and Newell (1986)

- Humans perceive inputs -> process and store -> produce outputs
- The mind as an information processor
- Engineering model of cognition used to predict user response
  - Their aim was to make **psychological knowledge** more accessible to **engineers**



http://www.cs.ucf.edu/courses/cap4104/fall2012/CardMoranNewell1986.pdf https://en.wikipedia.org/wiki/Human_processor_model

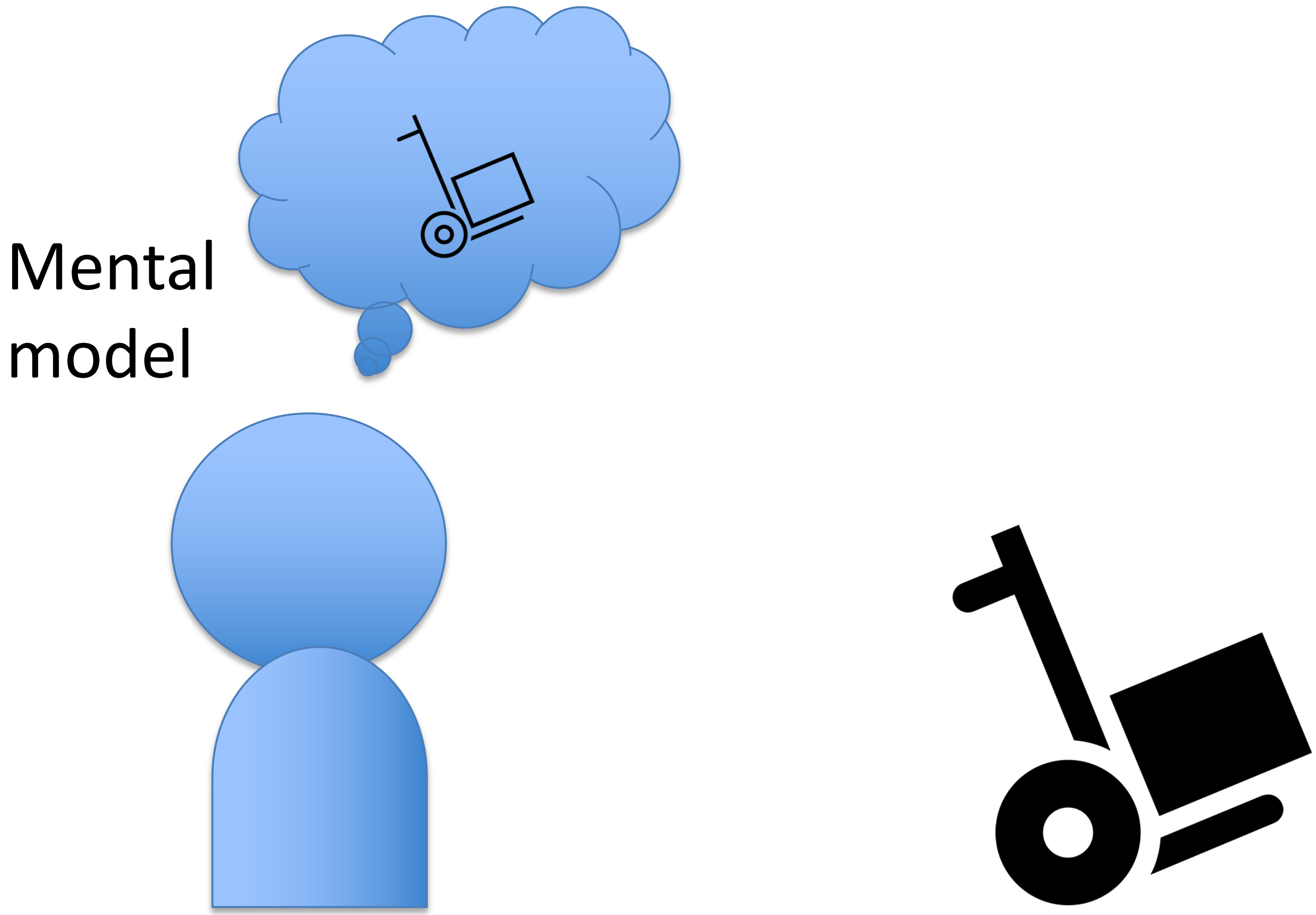
Parameter	Mean	Range
Eye movement time	230 ms	70–700 ms
Decay half-life of visual image storage	200 ms	90–1000 ms
Visual Capacity	17 letters	7–17 letters
Decay half-life of auditory storage	1500 ms	90–3500 ms
Auditory Capacity	5 letters	4.4–6.2 letters
Perceptual processor cycle time	100 ms	50–200 ms
Cognitive processor cycle time	70 ms	25–170 ms
Motor processor cycle time	70 ms	30–100 ms
Effective working memory capacity	7 chunks	5–9 chunks
Pure working memory capacity	3 chunks	2.5–4.2 chunks
Decay half-life of working memory	7 sec	5–226 sec
Decay half-life of 1 chunk working memory	73 sec	73–226 sec
Decay half-life of 3 chunks working memory	7 sec	5–34 sec

9 Principles of Operation

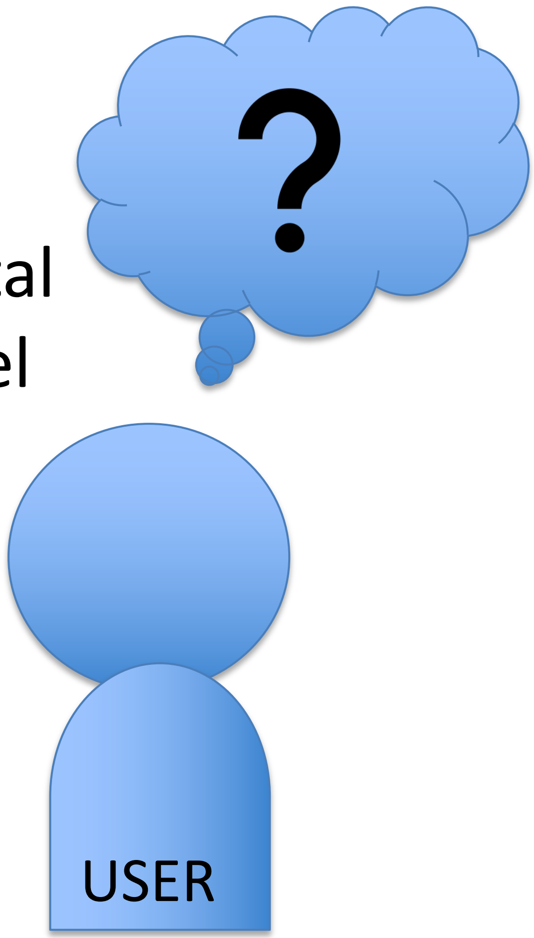
- P5: Fitt's law (proposed in 1954)
  - time required to move to a target depends on the distance to it, yet relates inversely to its size.
- P9: Power Law of Practice (proposed in 1928)
  - The more a task is repeated the faster it can be performed (not accounting for quality or knowledge acquisition).

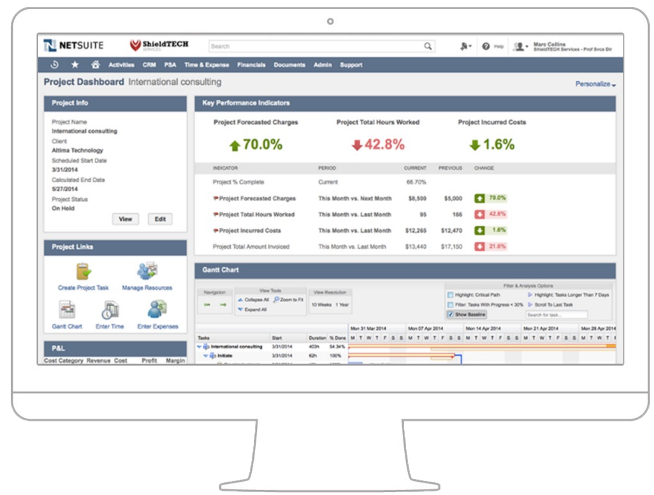
Limitations of the human brain is a computer metaphor

- Aging humans
- Limited to an individual
- Ignores the environment of the user
- No account for learning, distractions, task switching
- Interacting with things outside the specific interface for problem-solving
- Perhaps the brain is NOT an information processor

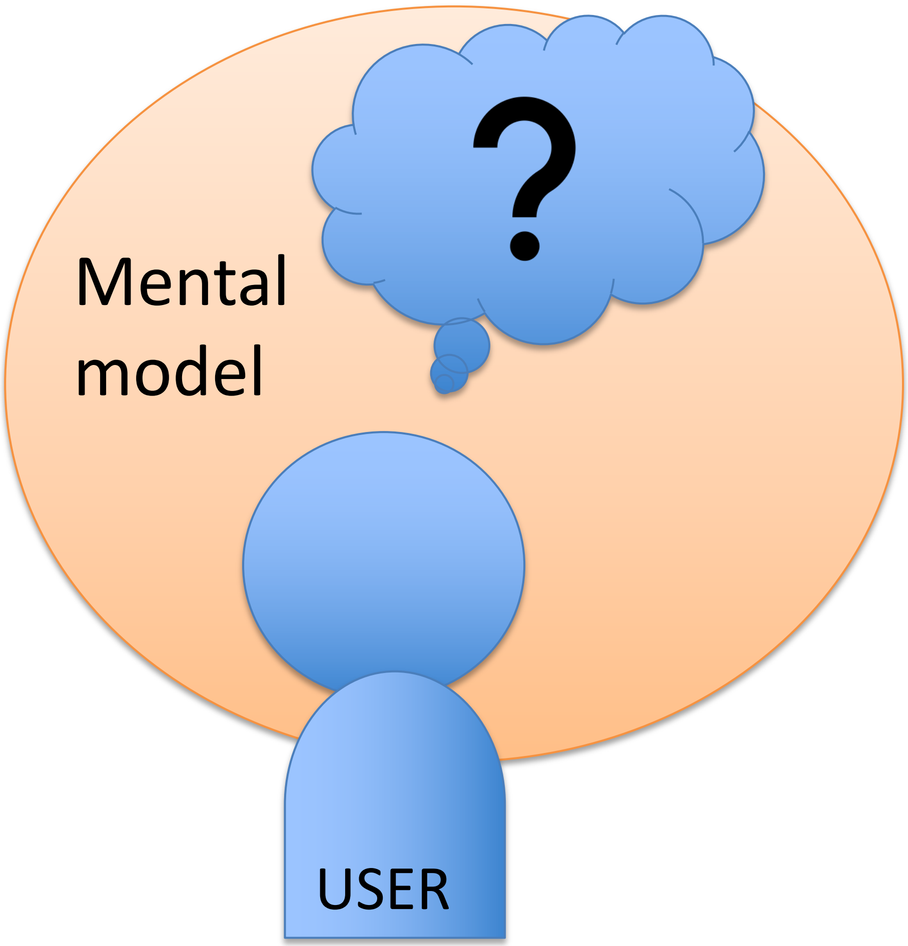

Mental
model

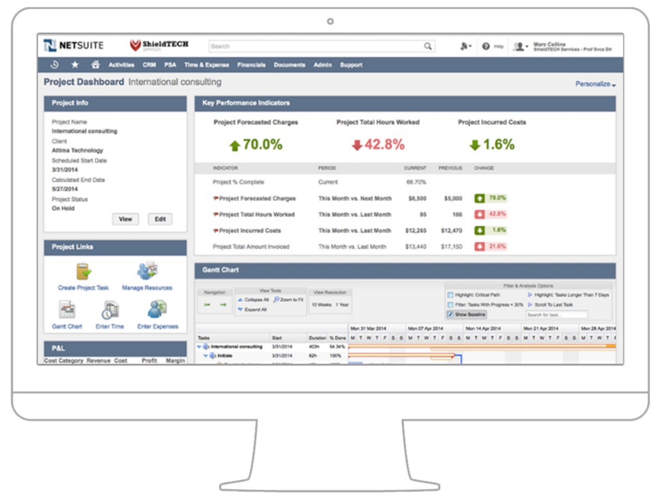
Mental model





https://www.netsuite.eu/products/experience/user-interface.shtml





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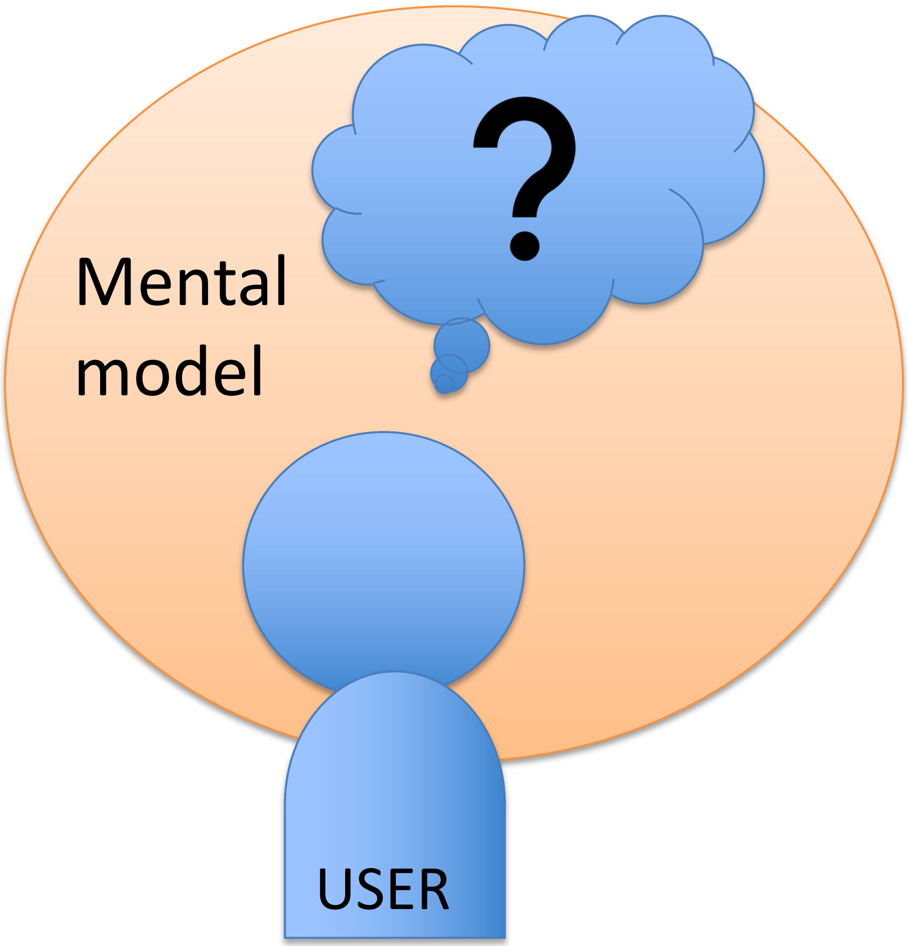
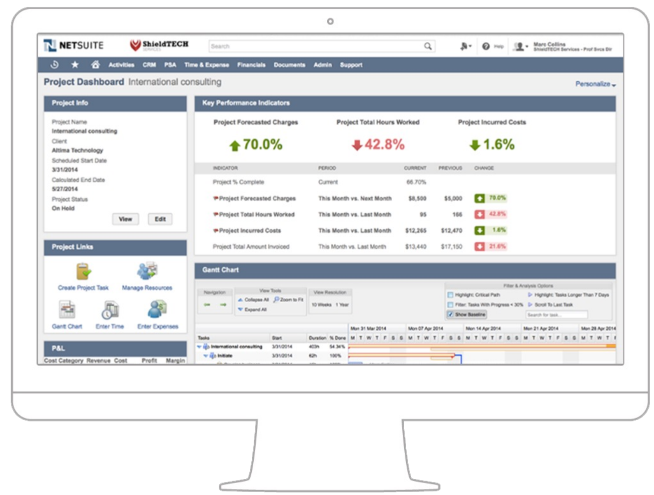
Mental models

- Users develop an understanding of a system through learning about and using it
  - How to use the system (what to do next)
  - What to do with unfamiliar systems or unexpected situations (how the system works)
- People make inferences using mental models about how to carry out tasks
- Shallow (driving a car) vs. deep (also knowing how a car works)

How to access the user's mental model?

- Through what they *say*
  - **Thinking aloud testing** – you ask test participants to use the system while continuously thinking out loud…verbalizing their thoughts as they move through the user interface. (NN/g)
- Through what they *do*
  - **Card sorting** – labels written on notecards according to criteria that make sense to them. This method uncovers how the target audience's domain knowledge is structured. (NN/g)
  - **Contextual Inquiry** – observe users in their natural environment as they conduct their activities, asking them questions. (NN/g)





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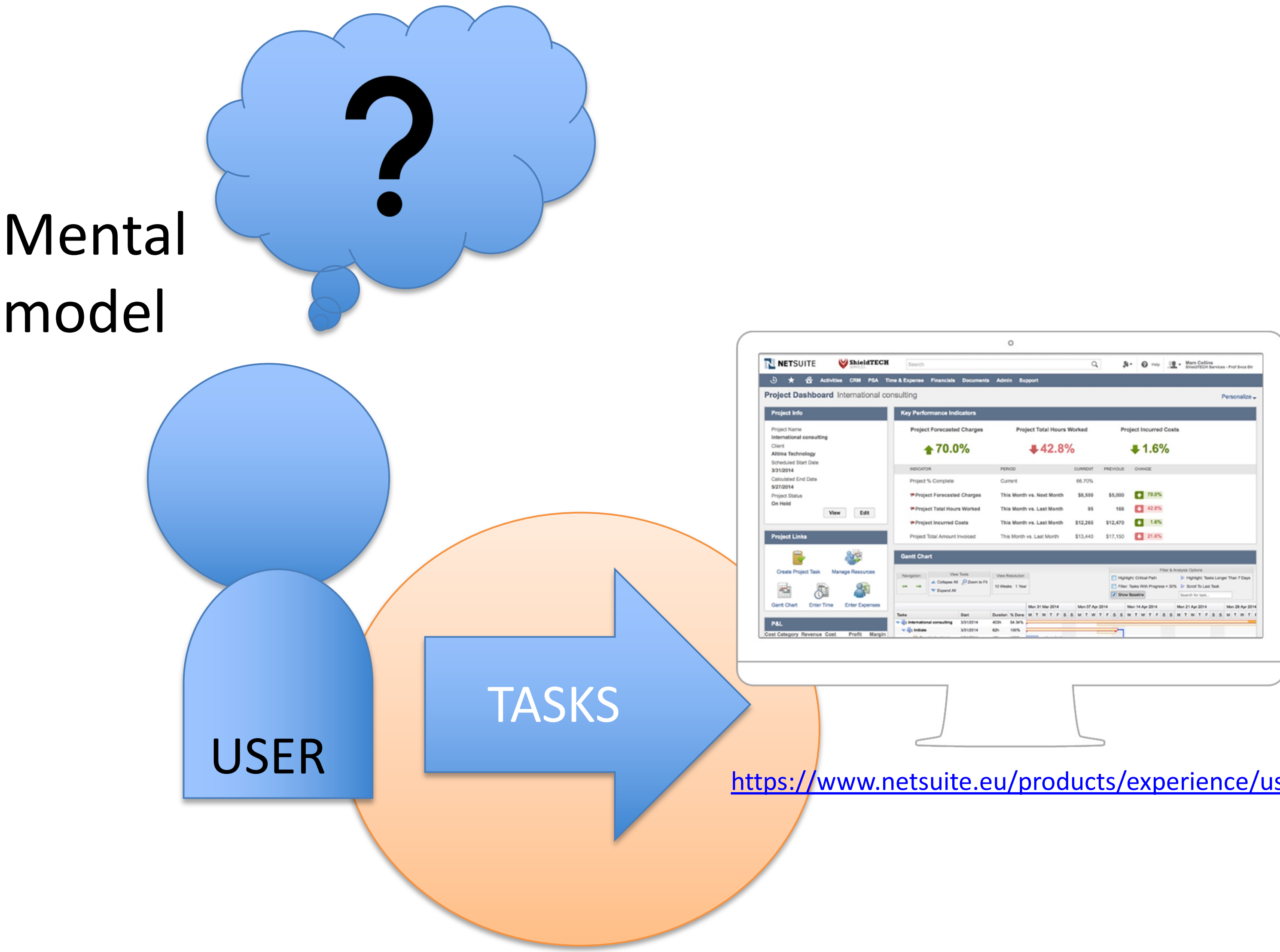

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Analyse tasks

Understanding human action

Action Regulation Theory

Solving a task or problem means that the user has to follow four steps:

(1) goal setting,
(2) planning and selection of means,
(3) perform the selected action,
(4) check the outcome against the intended goal.

Norman (1986, 1988)

Action is an execution-evaluation cycle comprising seven stages:

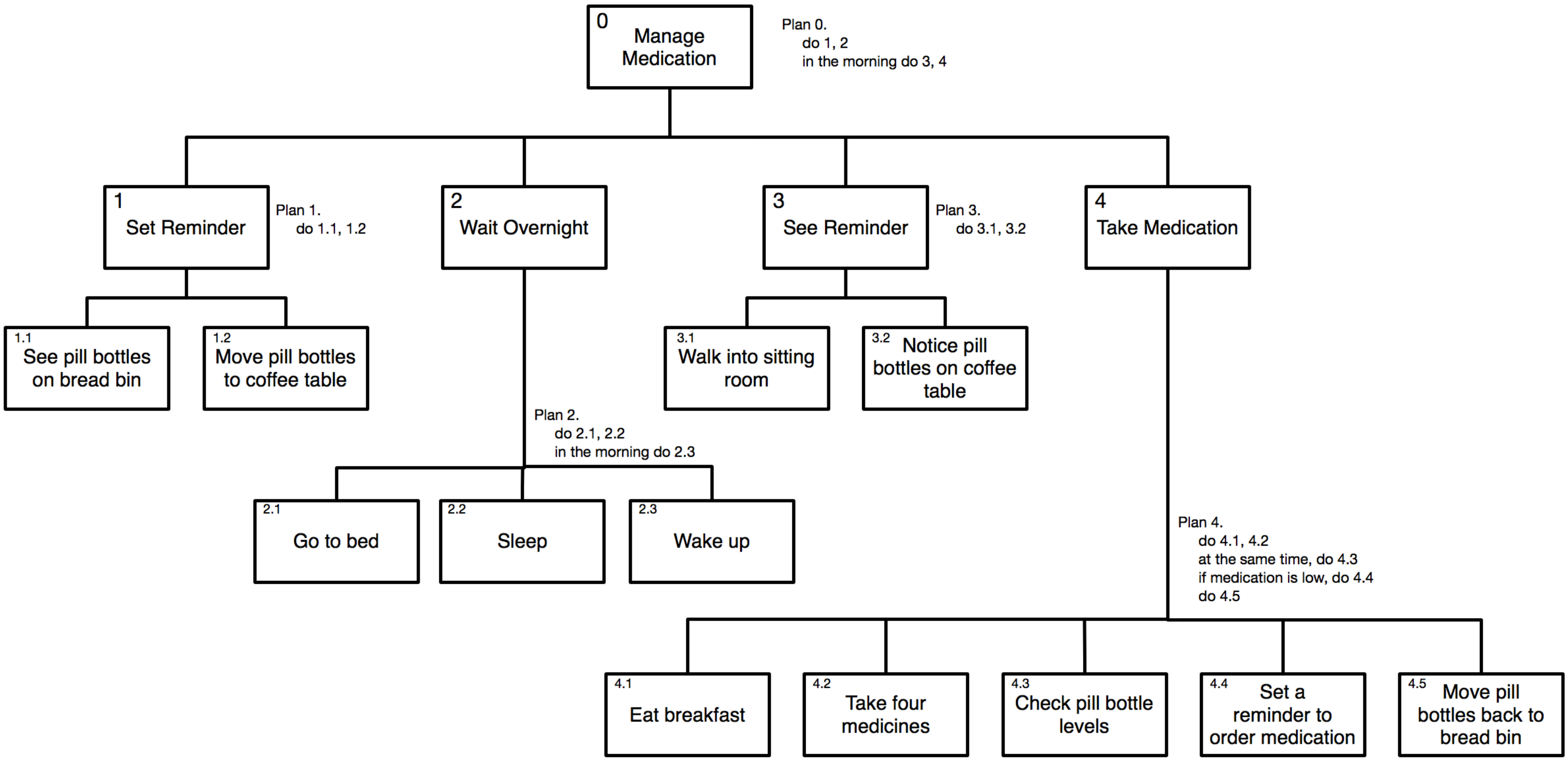
(1) setting a goal,
(2) developing an intention to act,
(3) planning a sequence of actions,
(4) executing the sequence of actions,
(5) perceiving the state of the world caused by the execution of the action sequence,
(6) interpreting the perception, and
(7) evaluating the interpretation.

If the goal is achieved, the action is completed. If not, the cycle is repeated over again or the action is terminated.

Task analysis

- **Tasks** are goal-oriented actions, can be decomposed into sub-tasks
- **Goals** are desired future states
- **Plans** specify task process
- Complexity is based on
  - number of actions/operations required
  - length of the goal-directed sequence
  - number of possible actions/operations
- Useful for sharing with clients to validate designs
- Provides requirements to developers
- Represents data requirements and flow

Hierarchical Task Analysis



https://blogs.city.ac.uk/dimitrakopoulo-inm452-2016/2017/01/07/hierarchical-task-analysis-hta/

Task analysis: Plans

- Types of plan
  - **sequence** 1.1 then 1.2 then 2.1
  - **optional** if the pot is full 2
  - **wait** when kettle boils, do 1.4
  - **cycles** do 5.1 5.2 while there are still empty cups
  - **parallel** do 1; at the same time
  - **discretionary** do any of 1.3.1, 1.3.2 or 1.3.3 in any order
- Most plans use several of these.

Task analysis questions

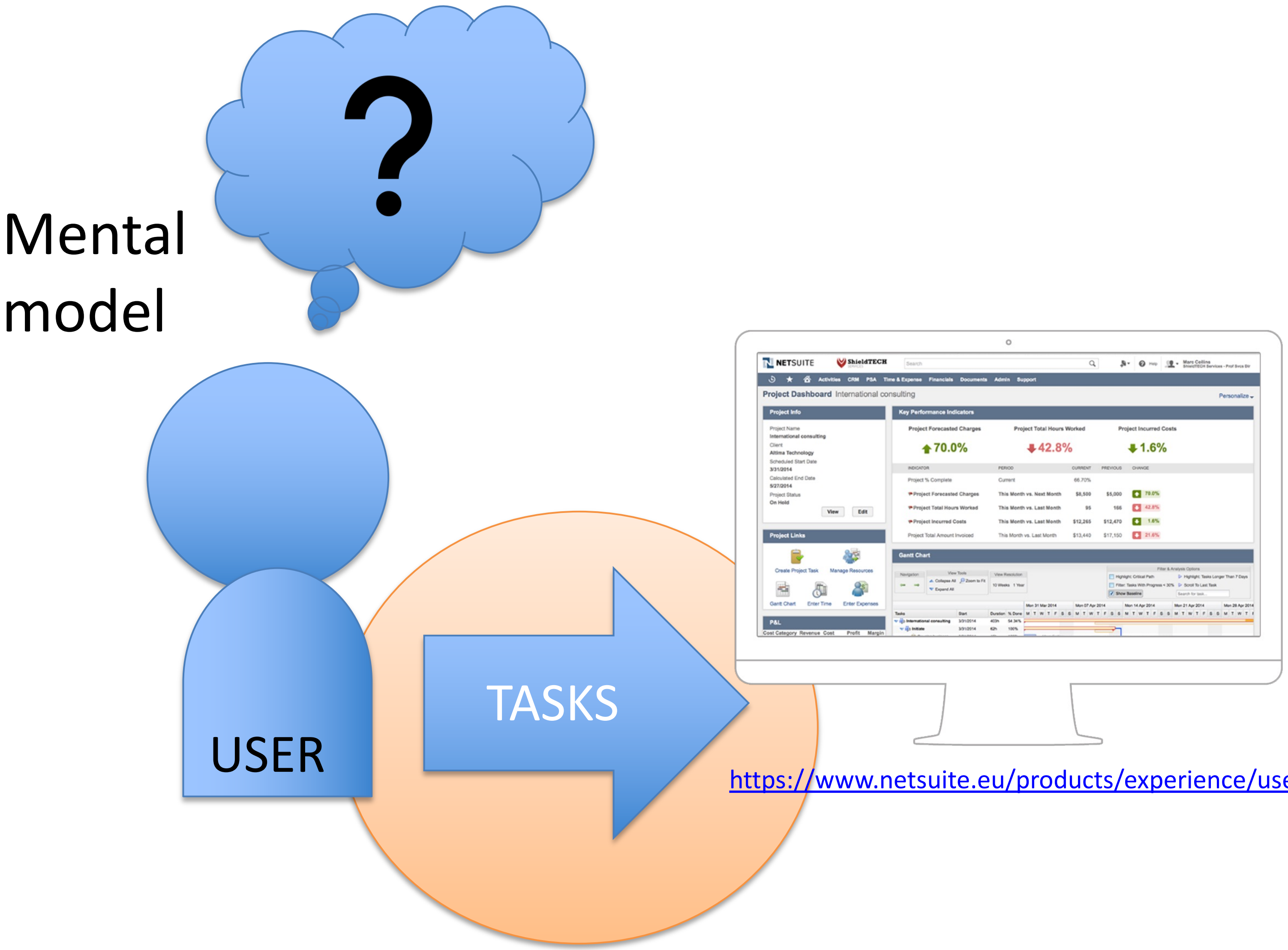
- **Preconditions**: what must be satisfied before it is reasonable or possible to attempt the task?
- **Information needs**: what must the user know in order to do the task?
- Where/when are the tasks performed?
- How often are they performed?
- Are there time/resource constraints?
- How is the task learned?
- What can go wrong (exceptions, errors, emergencies)?
- Who else is involved in the task?

How to do task analysis

- Interview users and observe them
- Ask them questions about what they are doing
  - Why do you do this? (goal)
  - How do you do it? (tasks/subtasks)
- Look for weaknesses in current situation
  - Goal failures, wasted time, user irritation

How to do task analysis

- When is decomposition complete?
  - When the user can execute without problem solving (but note this may differ for different users)
  - Above ‘device specific’ implementation details (but note shape of task is often device dependent)
  - Suggested heuristic is to stop when probability of error (p) multiplied by cost of error (c) is below threshold



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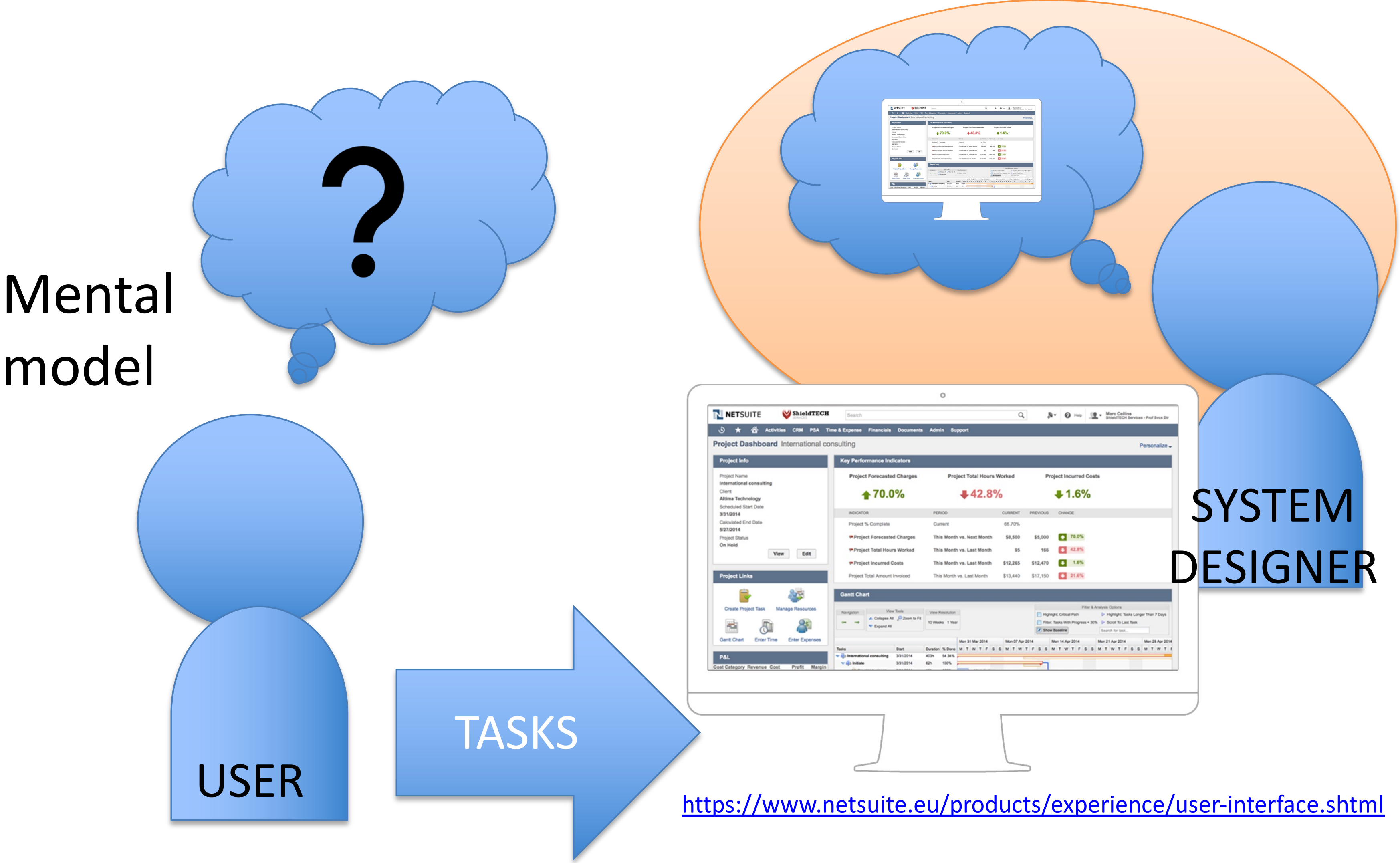
Analyse tasks



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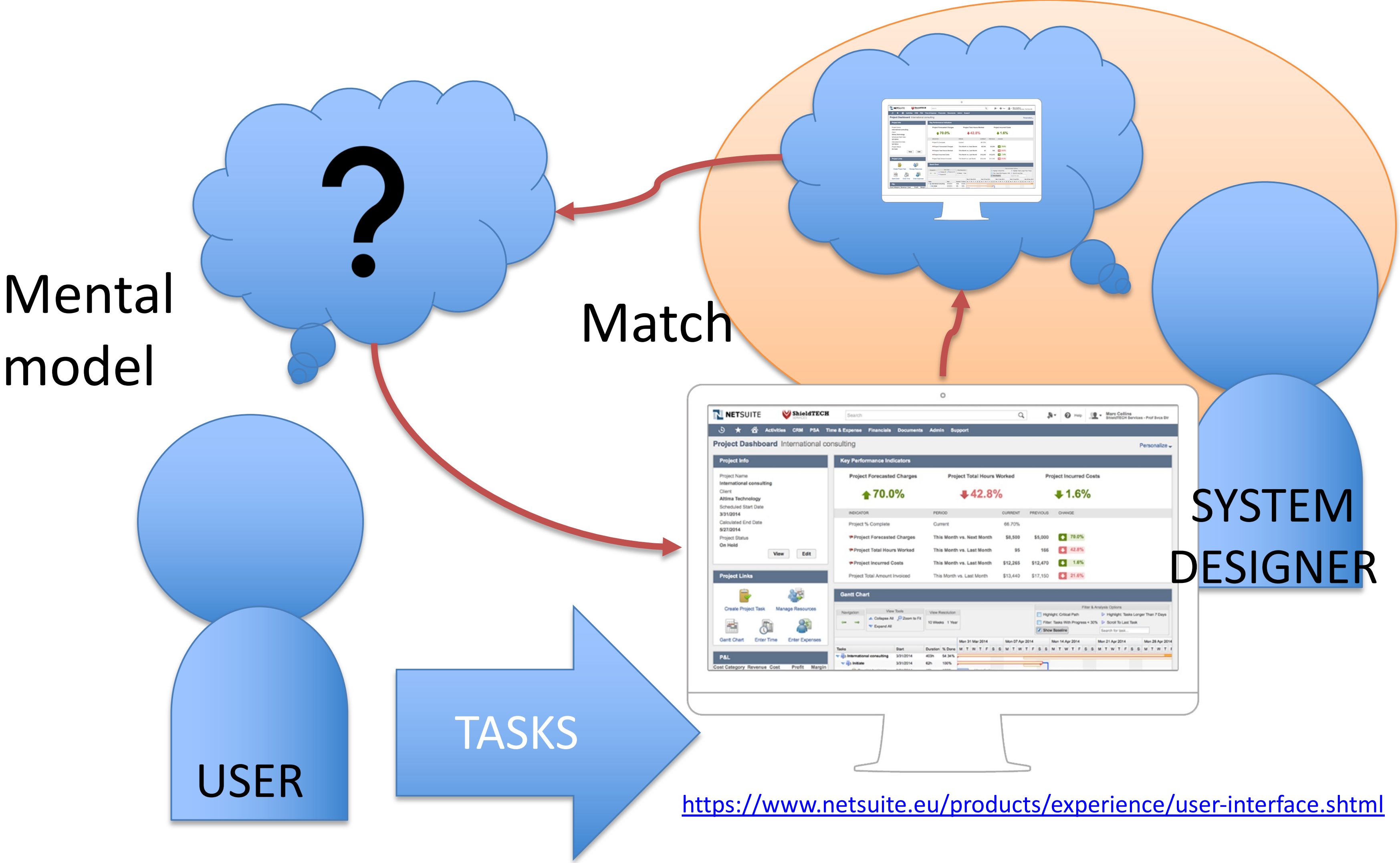


Analyse tasks

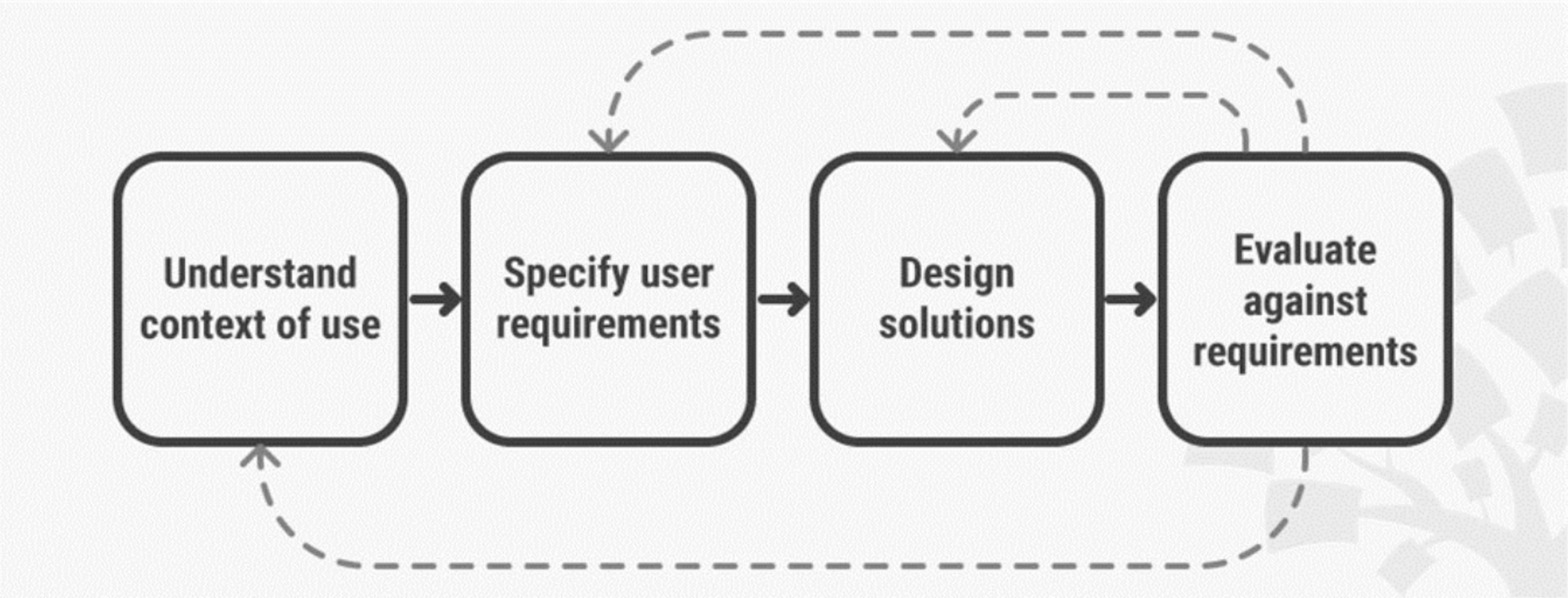
A classic HCI framework

Don Norman’s (1988) framework of the relationship between the design of a conceptual model and a user’s understanding of it

Consists of three interacting components:

- *The Designer’s Model*
  - The model the designer has of how the system should work
- *System Image*
  - How the system actually works, which is portrayed to the user through the interface, manuals, help facilities, and so on
- *The User’s Model*
  - How the user understands how the system works

How?



User-centered design is an iterative process that focuses on an understanding of the users and their context in all stages of design and development.

https://www.interaction-design.org/literature/topics/user-centered-design

User-centred design (UCD)

- Proven that UCD is more likely to meet user needs, expectations, and requirements
- Empirical approach
  - Empiricism is the philosophy that all knowledge originates in experience and observations. It's a cornerstone of the scientific method and underlies much of modern science and medicine. [scrum.org]
- Combine various methods
  - Observations, interviews, usability tests, etc.

Further reading

- Is your brain a computer? MIT Technology Review
- Hacker, W. (1994). Action regulation theory and occupational psychology: Review of German empirical research since 1987. *German Journal of Psychology*.
- French, A., Taylor, L. K., & Lemke, M. R. (2019). Task analysis. In *Applied human factors in medical device design* (pp. 63-81). Academic Press.
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- D. Diaper (2004) Understanding Task Analysis for Human-Computer Interaction. In Diaper & Stanton (eds.) The handbook of task analysis for human-computer interaction. Lawrence Erlbaum, London.
- MIT Resources on User-Centered Design