Lesson 4

Interaction Design (CM3055)

GOMS: introduction

- **What is GOMS?**
  - Description of the knowledge that a user must have in order to carry out tasks on a device or system
  - Representation of the "how to do it" knowledge that is required by a system in order to get the intended tasks accomplished.

Why is GOMS important?

GOMS

(CMN-)GOMS

- Plain GOMS
- Pseudo-code
- First introduced by Card, Moran and Newell

KLM

- Keystroke-Level Model
- Simplified version of GOMS

NGOMSL

- Natural GOMS Language
- Stricter version of GOMS
- Provides more well-defined, structured natural language
- Estimates learning time

CPM-GOMS

- Cognitive Perceptual Motor analysis of activity
- Critical Path Method
- Based on the parallel multi-processor stage of human information processing

What does a GOMS task analysis involve?

- Involves defining and then describing the user’s

  - **Goals:**
    - Something that the user tries to accomplish (action-object pair, e.g. delete word)
    - Include context
  - **Methods:**
    - Well learned sequence of steps that accomplish a task
    - How do you do it on this system? (could be long and tedious…)
  - **Selection Rules:**
    - Only when there are clear multiple methods for the same goal.
  - **Operators:**
    - Elementary perceptual, cognitive and motor acts that cause change (external vs. mental)
    - Also uses action-object pair (e.g. press key, select menu, make gesture, speak command...)
    - mostly defined by hardware and lower-level software.

How do I use this tool?

1. DEFINE THE USER’S TOP-LEVEL GOALS

2. GOAL DECOMPOSITION
Break down each top-level goal into its own sub goals.

3. DETERMINE AND DESCRIBE OPERATORS
Find out what actions are done by the user to complete each sub goal from step 2. These are the operators.

4. DETERMINE AND DESCRIBE METHODS
Determine the series of operators that can be used to achieve the goal. Determine if there are multiple methods and record them all.

5. DESCRIBE SELECTION RULES
If more than one method is found in step 4, then the selection rules, or which method the user will typically used, should be defined for the goal.

GOMS: example

- **GOMS analysis – File & directory operations - a better version:**
  - Method for goal: delete an object.
    - Step 1. drag object to trash.
    - Step 2. Return with goal accomplished.
  - Method for goal: move an object.
    - Step 1. drag object to destination.
    - Step 2. Return with goal accomplished.

- **GOMS analysis – the drag operation**
  - Method for goal: drag item to destination.
    - Step 1. Locate icon for item on screen.
    - Step 2. Move cursor to item icon location.
    - Step 3. Hold mouse button down.
    - Step 4. Locate destination icon on screen.
    - Step 5. Move cursor to destination icon.
    - Step 6. Verify the destination icon.
    - Step 7. Release mouse button.
    - Step 8. Return with goal accomplished.


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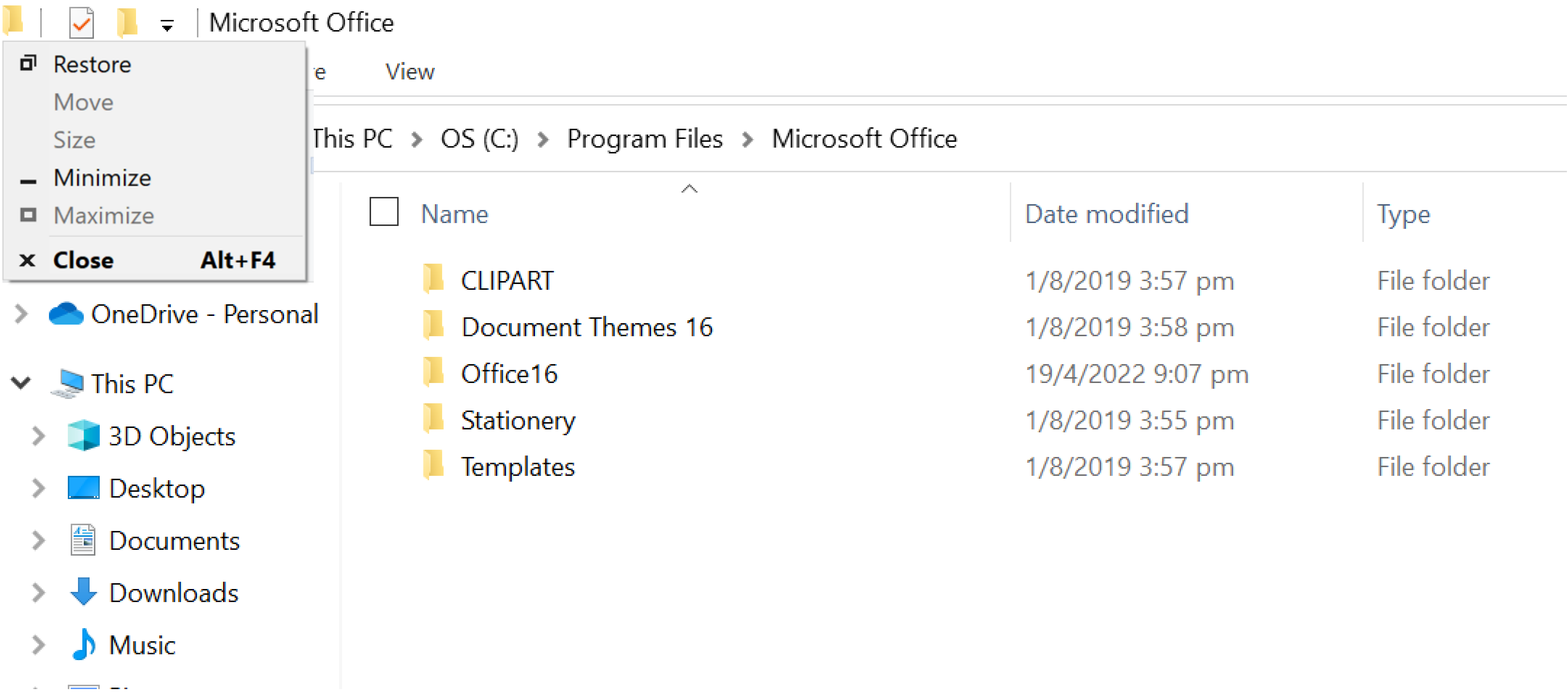
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What are the disadvantages of GOMS?

- Lack of account for errors, even skilled users make errors but **GOMS** does not account for errors.

- Mental workload is not addressed in the **model**, making this an unpredictable variable.

- **GOMS** only addresses the usability of a task on a system, not its functionality.

What is the difference between KLM and GOMS?

The biggest difference between GOMS and KLM is **how time is assigned to cognitive and perceptual operators when it comes to execution time predictions**

KLM has a single M operator that precedes each cognitive unit of action.

GOMS assigns no time to such cognitive overhead.

How long does it take to drag a file to the trash?

- List steps
- Identify operators
- Look up times
- Add up

KLM- GOMS: introduction

Calculates task execution time using pre-established keystroke-level primitive operators.

- **Six types of operators:**
  - **K:** to press a key or a button
  - **P:** to point with a mouse to a target on a display
  - **H:** to home hands on keyboard or other device
  - **D:** to draw a line segment on a grid
  - **M:** to mentally prepare to do an action or closely related series of primitive actions.
  - **R:** to symbolize the system response time during which the user has to wait for the system.

KLM- GOMS: introduction

- **Each of the six operators has an estimate time or simple approximation function.**
  - Time to execute is empirically defined:
- $\mathbf{T_{execute} = T_k + T_P + T_H + T_D + T_M + T_R}$

- **Heuristics for adding M**

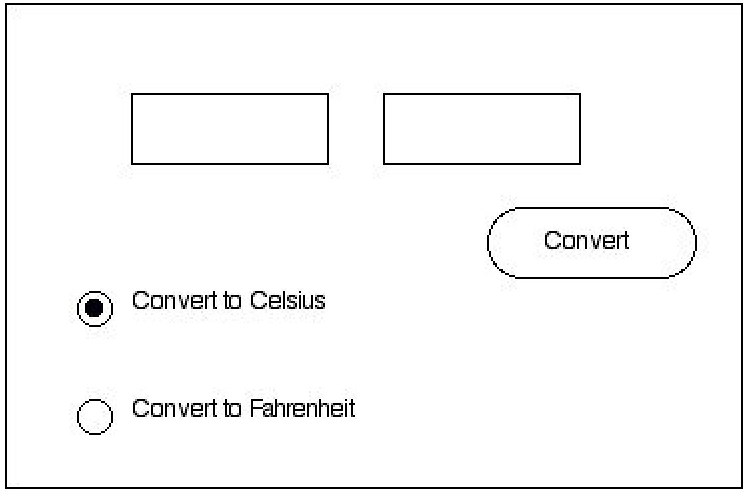
KLM- GOMS: operator times

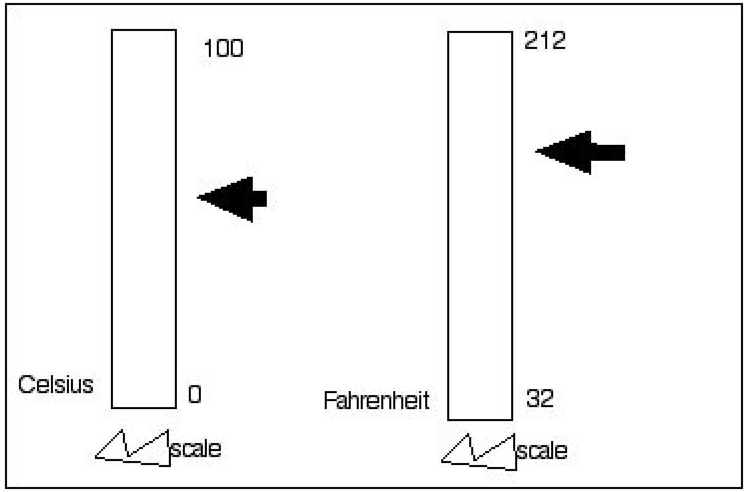
Operator	description	time (sec)
K	press key or button (shift or control key count separately) best	
	typist (135 wpm)	.08
	good typist (90 wpm)	.12
	average typist (55 wpm)	.22
	average typist (40 wpm)	.28
	typing complex codes	.75
P	point with mouse to target on display (Fitts's Law)	1.10
	Clicking the mouse or similar device (B)	.10/.20
H	home hand on keyboard or device	.40
D(n,l)	draw *n* straight-line segments of total length *l* cm	
	(calculated for a square .56 cm grid)	***.9****n* +.16*l*
M	mentally prepare/respond	1.35

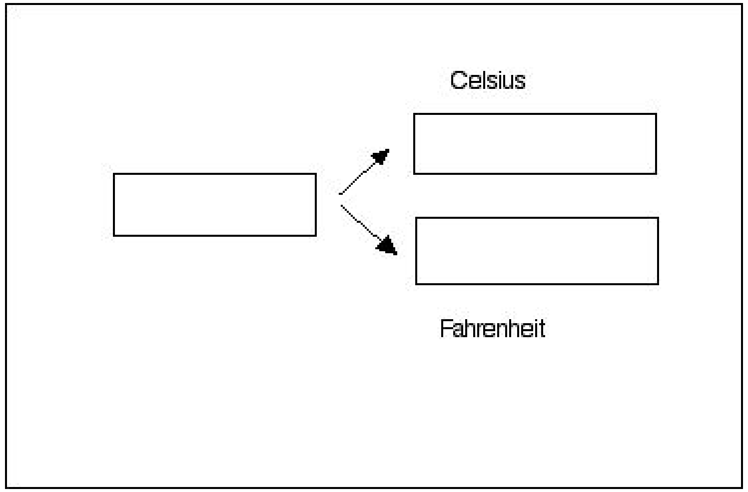
KLM- GOMS: additional operator times

Operator	description	time (sec)
	Move eyes to location on screen	2.3
	Retrieve item from memory	12
	Select among methods	12

Convert temperature between Celsius and Farenheit (example adopted from Raskin, Humane Interface).







This yields a GOMS analysis of: H M P K H M K K K K M K
Adding up the individual times of each of these tasks, yields an average of 5.4 seconds to convert a number using this interface.

This interface can operate quickly when the range and precision are already correctly set. But when the thermometers need adjusting to different scales or ranges, the interface becomes inconvienient. The GOMS analysis on a worst case scenario is: H P K S K P K S K P K S K P K K totalling 16.8 seconds.

The most efficient interface would require only the keystrokes of numbers representing the numerical value needing to be converted.

The GOMS analysis here is: M K K K K totalling only 2.15 seconds.

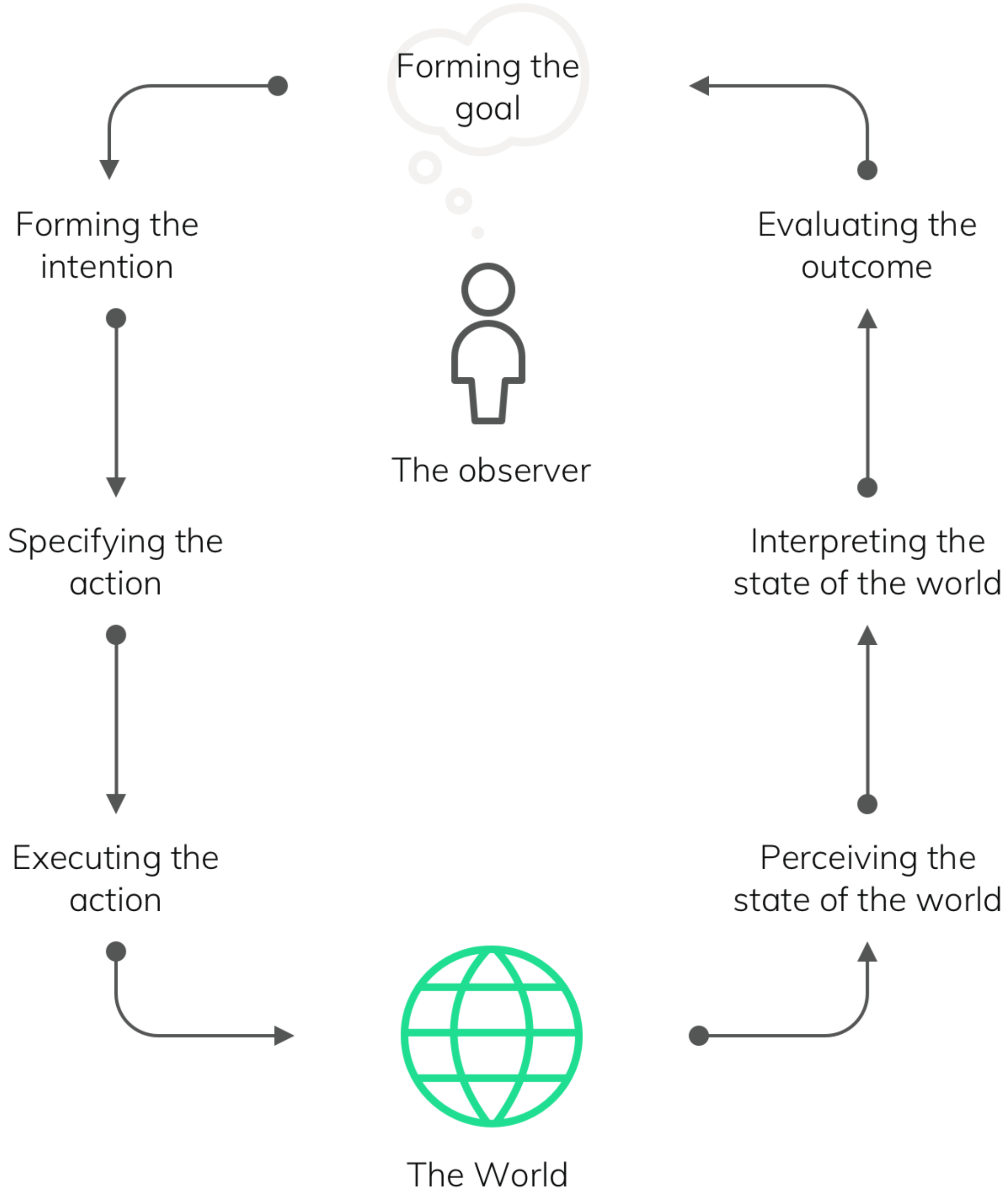
GOMS Symbol K = 0.2 sec; **Keying,** time for pressing a key on the keyboard.
P = 1.1 sec; **Pointing,** time required for pointing to a position on the display.
H = 0.4 sec; **Homing,** the time for a user to move his hand from keyboard to mouse.
M = 1.35 sec; **Mentally preparing,** time to prepare for the next step.

KLM Calculator

http://courses.csail.mit.edu/6.831/2009/handouts/ac18-predictive-evaluation/klm.shtml

Norman's Action Cycle describes how humans interact with computer systems.

Think about how we, as humans, interact with various interfaces (such as a website, a smart phone, an ATM machine, etc).

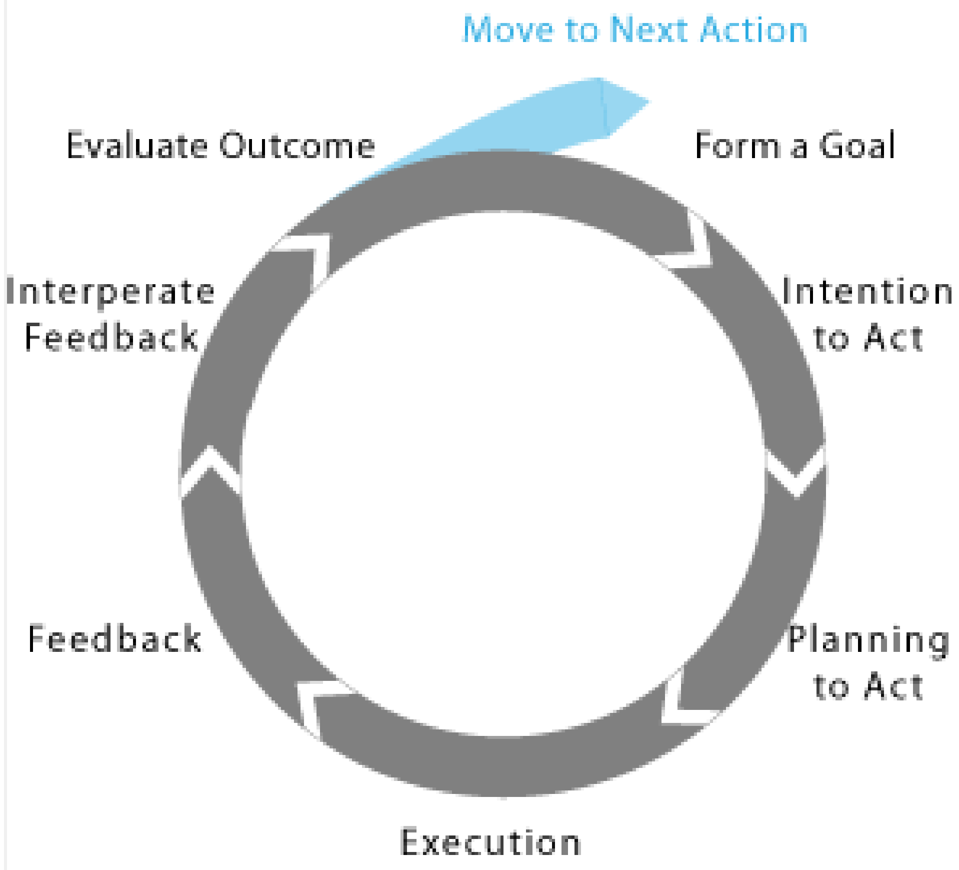


Norman’s Scenario:
A person wants to read a book

Forming a Goal
I can’t read my book because the room is dimly lit.
I need more light in order to read my book.

Intention to Act
There is a light next to my chair. Turning on the light would allow me to read my book.

Planning the Action
I need to reach over and turn on the light.

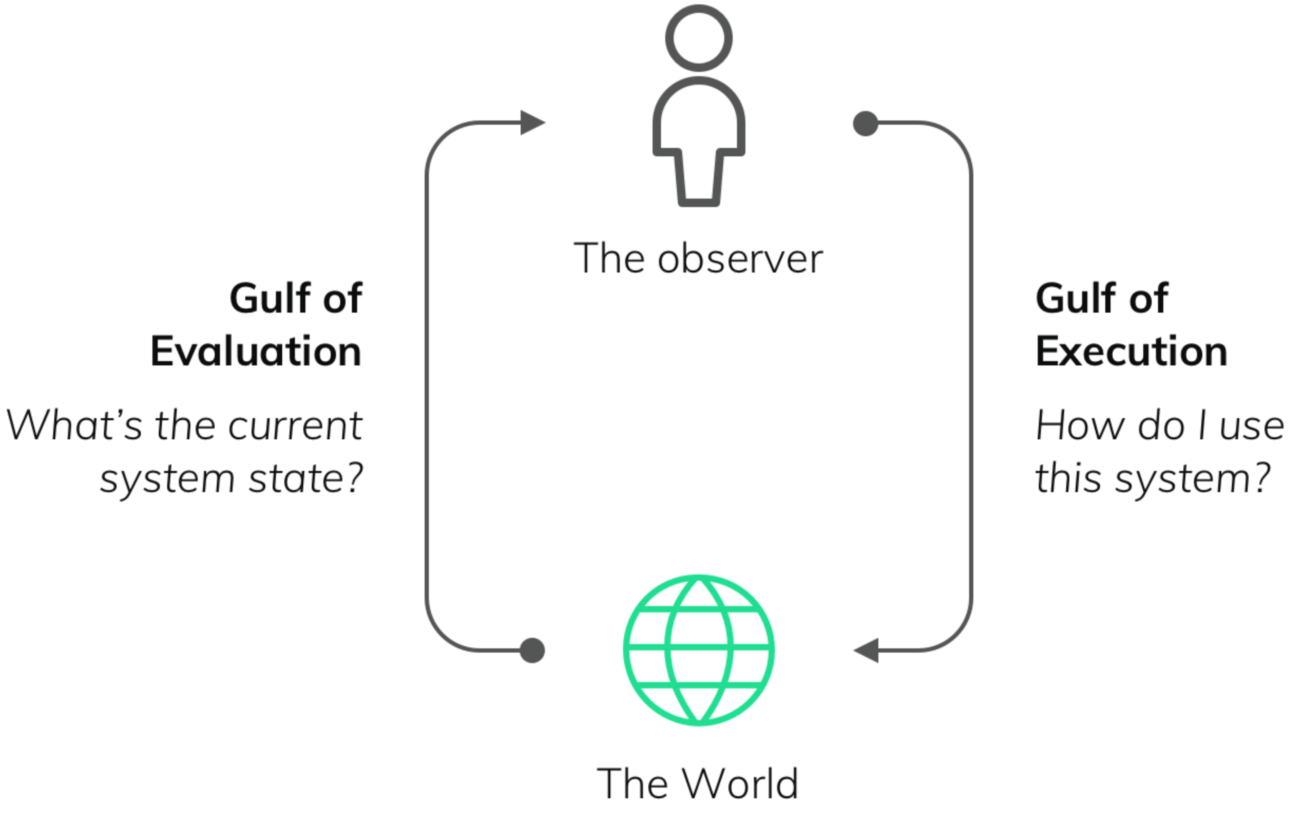


Executing the Action
I reach over to turn on the light.

Feedback from the Action
The light turns on.

Interpret the Feedback
I am now able to see the text and can read my book.

Evaluate the Outcome
Positive - I am able to read my book. No further action is needed.
Negative - The light doe not work. The Action Cycle is either repeated or a new goal is formed.



Gulf of Execution and Evaluation

Norman goes on to describe two areas where poor design fails to support the user's expectations.

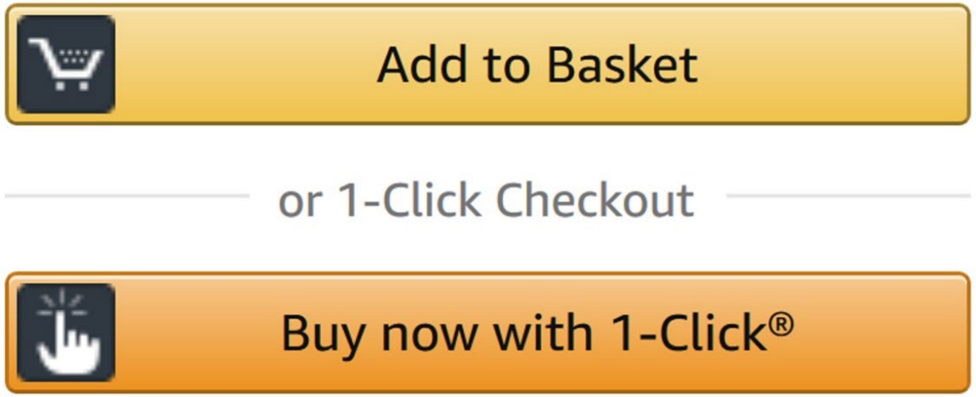
Gulf of Execution
The Gulf of Execution exists when a user is having difficulties determining how to execute a goal.

Gulf of Evaluation
The Gulf of Evaluation occurs when a user has trouble assessing the state of the system.

Gulf of Execution

Amazon Online purchase

What do we see as a **Large gulf of execution** and **Small gulf of execution?**

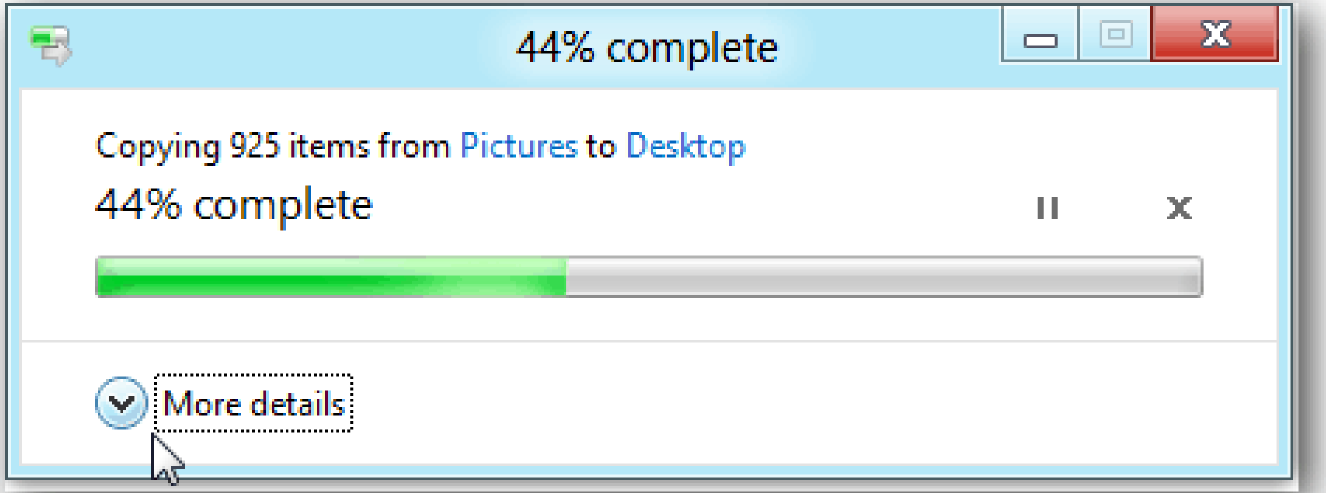


Discussion

Gulf of Execution

Copying files

What do we see as a **Large gulf of evaluation** and **Small gulf of evaluation?**



Discussion

Why the Gulfs Are Important?

Discussion

Avoid the twin gulfs

1. Visibility

Users need to know what all the options are, and know straight away how to access them. In the case of websites, this is an easy win.

2. Feedback

Every action needs a reaction. There needs to be some indication, like a sound, a moving dial, a spinning rainbow wheel, that the user's action caused something.

3. Affordance

Affordance is the relationship between what something looks like and how it's used.

Avoid the twin gulfs

4. Mapping

Mapping is the relationship between control and effect. The idea is that with good design, the controls to something will closely resemble what they affect.

5. Constraints

Constraints are the limits to an interaction or an interface.

6. Consistency

The same action has to cause the same reaction, every time.

Usability Evaluation For Video Games: Gulfs Of Execution, Evaluation