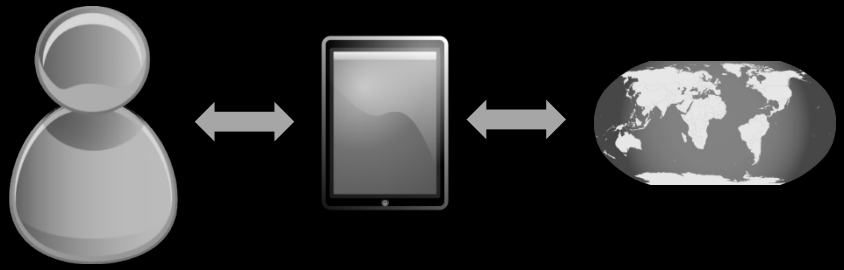
THE UNIVERSITY OF MELBOURNE



GEOM90007

SPATIAL VISUALISATION

LECTURE 10A: INTERACTIVE MAPS
AND INTERACTION DESIGN 2

MENTAL MODELS

Existing **knowledge** (theories and beliefs) about a system

Example

- Mental model of interactive maps

Question

"What do people know and believe to be true about the way the systems they interact with are structured?"

(Payne, 2012)

Background knowledge

- Users novice or expert?
  - Design decision: standard cues (e.g., tool icons)

ATTENTION

Following a stimulus, attention is important for filtering information

- **Attention**
  - The collection of processes that allow us to dedicate our limited information-processing capacity to the purposeful (cognitive) manipulation of a subset of available information
    (Welsh et al., 2012)
- **Characteristics**
  - Attention is selective (only a subset of information is processed)
  - Focus can shift from one information source to another
    e.g., symbolic cues such as arrows, numbers, words
  - Attention can be divided (selectively *attend* to one or another)

ATTENTION – Cocktail Party e.g. auditory stimuli (Cherry, 1953)

Image: tracyshaun, Flickr Creative Commons

EXAMPLE: DESIGN FOR ATTENTION (user targets the desired information)

Form	Attention-orienting technique
Still image	▪ Movement/change in shape/size/colour ▪ Use bold outline ▪ Use symbols ▪ Use borders to distinguish
Moving image	▪ Freeze frame followed by a still image ▪ Zoom, close up of an object ▪ Use of transitions (e.g., wipe or dissolve)
Text	▪ Bolt, font size, colour ▪ Formatting, bullet points, indentation, titles/headings
Speech/sound	▪ Familiar voice ▪ Use of silence ▪ Changing tonality/amplitude/pitch/rate ▪ Alarms sounds ▪ Use of markers (words to draw attention)

(Sutcliffe, 2012)

MEMORY (revisiting lecture 2)

Recollection of information in the absence of the original stimulus

(Proctor and Vu, 2012)

- Short term (STM)
  - Limited capacity (e.g., phone numbers), affected by distraction

  HCI: As task complexity increase, performance may slow, potential of overloading

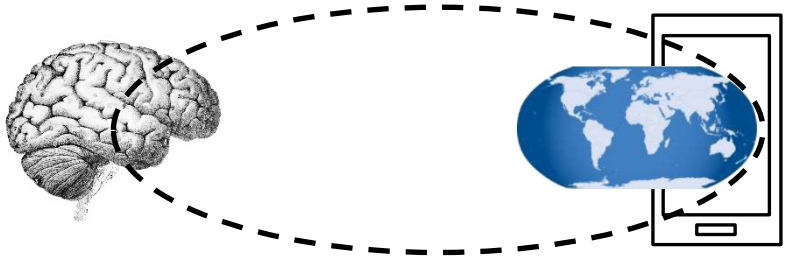
- Long term (LTM)
  - Minutes to years ago
  - Matching between features encoded and retrieval cue is critical

  HCI: Encoding based on shallow perception vs deeper semantics (importance of meaningful symbology)

(Proctor and Vu, 2012)

COGNITIVE LOADING

The brain power required to read or understand the map / interface and perform associated tasks



What kinds of factors may be considered?

COGNITIVE OVERLOADING

Example multi-dimensional load:
NASA Task Load Index
The amount of cognitive processing (tasks and their dimensions) required by the user

Image: Space.com

Stress
Demand can be a form of stress - too much demand (e.g., overloading) or too little (e.g. boredom)

Needs to be incorporated into the design process

ACTION MODELS

User goal, intentions and actions

MODELS - Norman's stages of actions (Norman, 2013)

A **goal** is what we want to have happened in the world

Actions bridge between the goal and the physical action to achieve it

Two parts to an action

- Executing the action
- Evaluating the result (comparing goal and what actually happened)

For everyday tasks, actions may be opportunistic (rather than planned)

- **Opportunistic** actions are where behaviour tasks take advantage of circumstance

MODELS - Norman's stages of actions (Norman, 2013)

Individual actions:

- Conscious (e.g., first time, learning the process)
- Sub-conscious (e.g., familiar, repetitive tasks)

Example: Driving a car and turning the corner

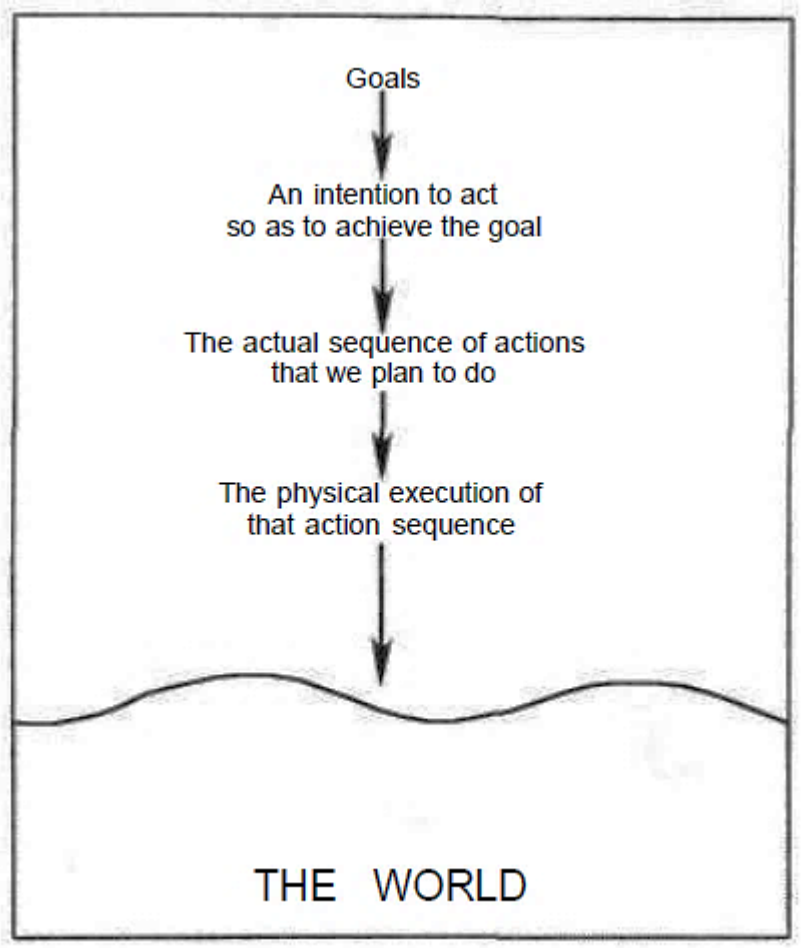
- Sub-conscious: I think turn left, and smoothly execute the action sequence to turn left
- Conscious: Execute actions individually

Example: Wiggle second finger, wiggle third finger

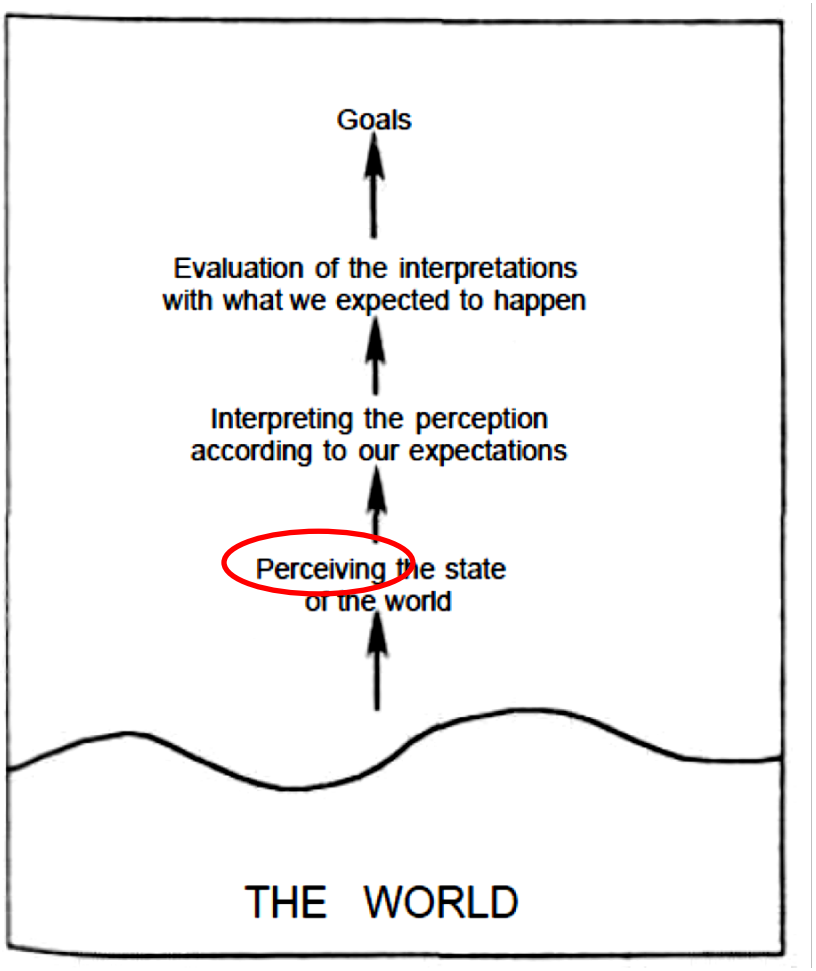
- Describe what you did differently those two times

MODELS - Norman's stages of execution (L) and evaluation (R)

Images: Norman (2002) The Design of Everyday Things, page 47



Executing the actions



Evaluating the actions

MODELS

Roth's adaption of Norman's model to interactive maps

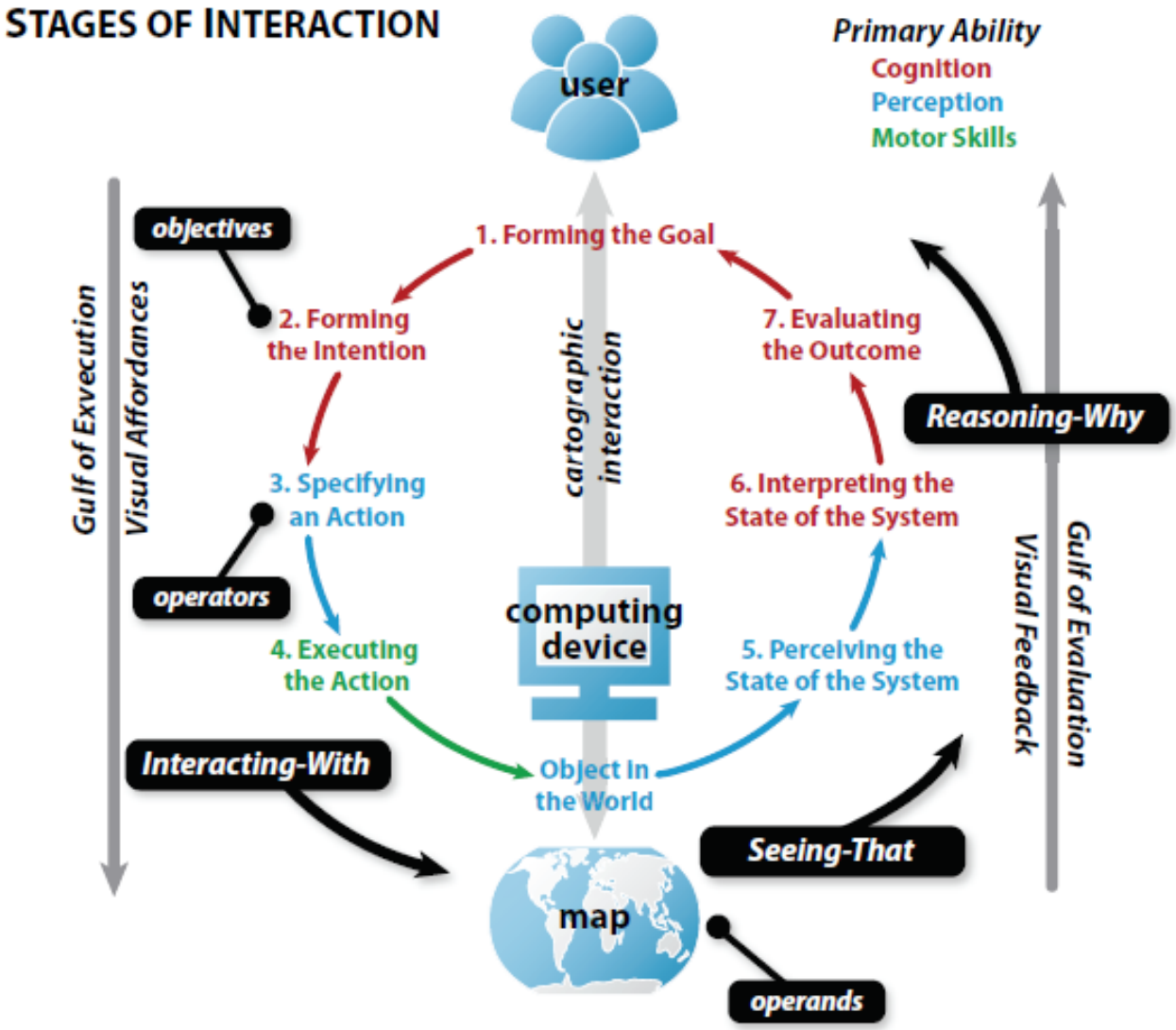


Image: Roth (2013)

DEVICE PERSPECTIVE

(i) TERMINOLOGY

- Human-machine interface (HMI)
  - Human-computer interface (HCI)
  - ...

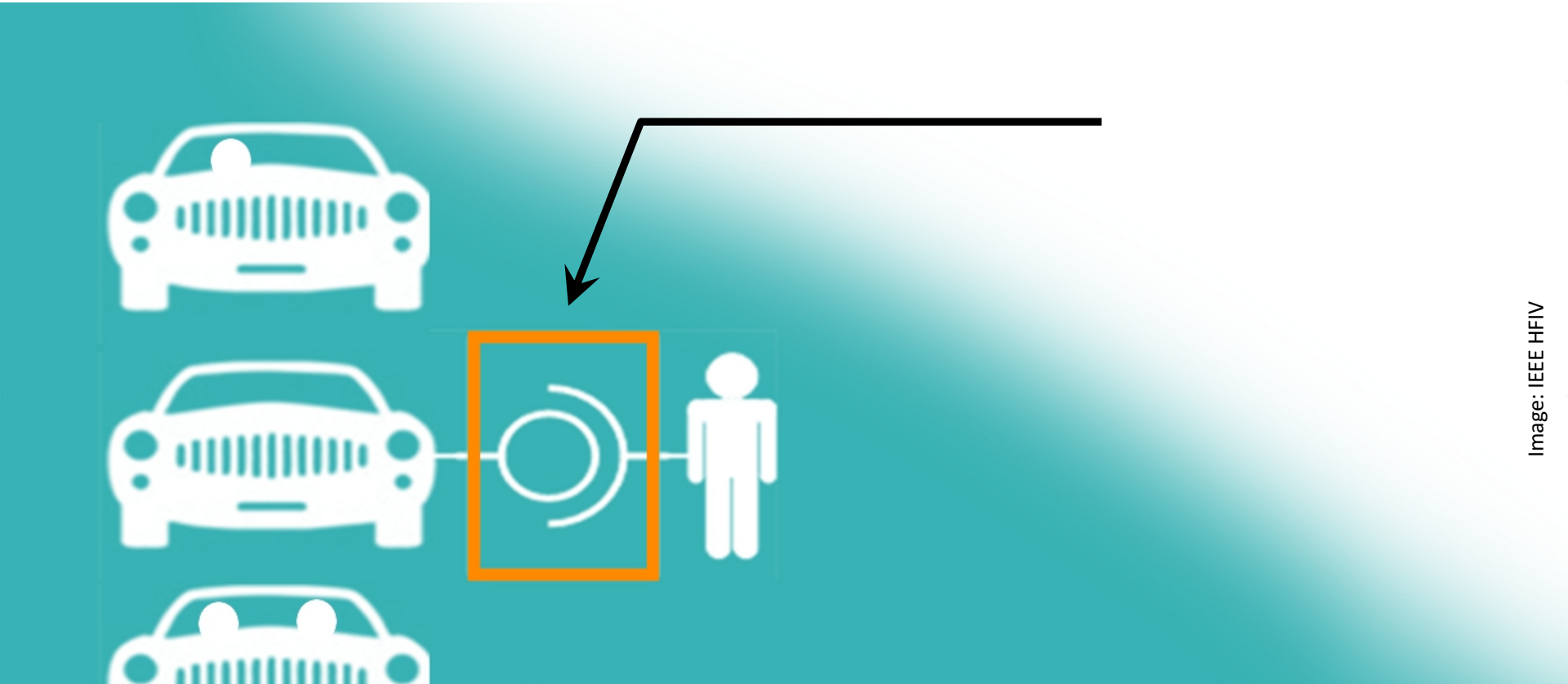


Image: IEEE HFIV

(ii) IO CHANNELS

Examples: IO

- Input: Keyboard, mouse, touch display, web cam, ...
- Output: Display, speaker, printer, ...

Input

- Direct (input and display are unified, e.g., touch display)
  - Direct manipulation, more body movement
- Indirect (input/output are in different spaces, e.g., mouse cursor)
  - Fewer demands on attention, interaction does not occlude

Output

- Single mode (e.g. text or voice)
- Multimodal (e.g., text + voice)
  - Supplementary: alternatives can be used to complete task
  - Complementary: modalities combined to complete task

EXAMPLE DEVICE

a) What are the different kinds of input and output for the iPhone 7?

b) How would these impact on the design of an interactive map?

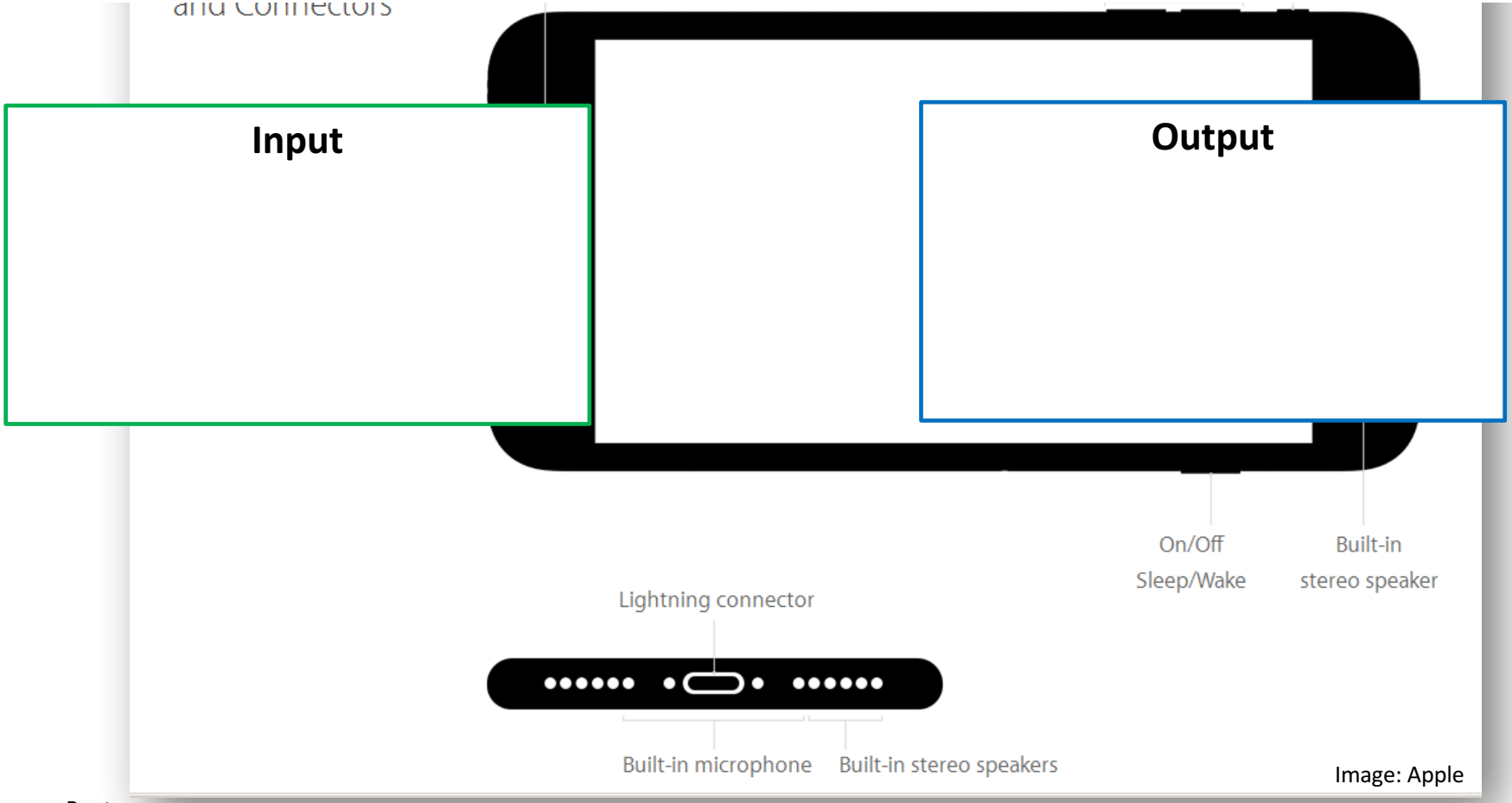


Image: Apple

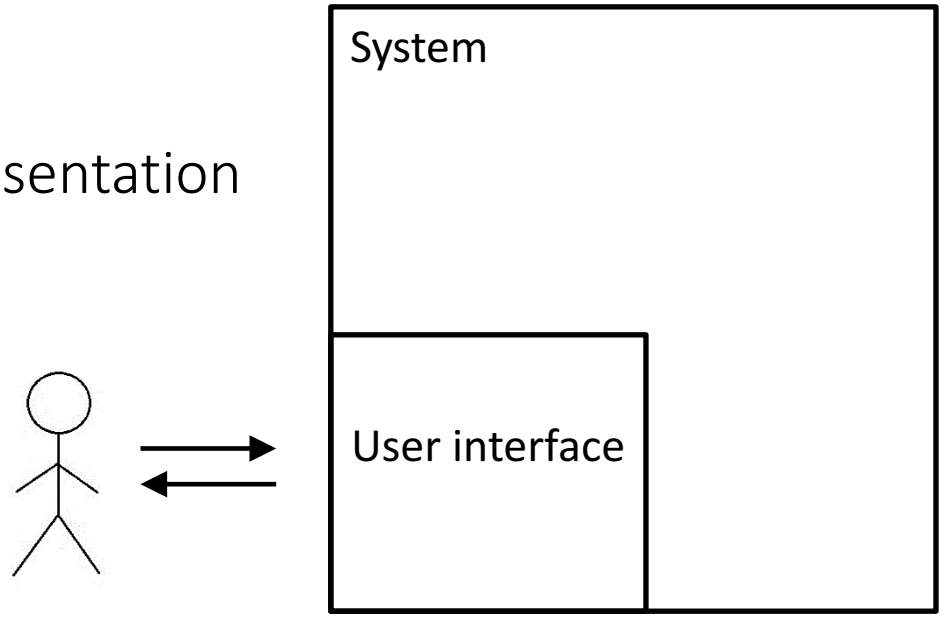
Image: Reuters

(iii) DIALOGUE

- Conversation between two or more parties (user and system)
  - Input, output and feedback

- Interaction structured
  - Syntax (step-wise instructions)
  - Semantics (meaning)

- Common diagrammatic representation
  e.g. UML (e.g. user case)
    - Develop use cases
    - ...



THE USER INTERFACE (UI)

THE USER INTERFACE (UI)

Facilitates a user's (inter)action with a system to perform tasks

Must be sufficiently designed to bridge the user's **goals** and the **system**, otherwise…

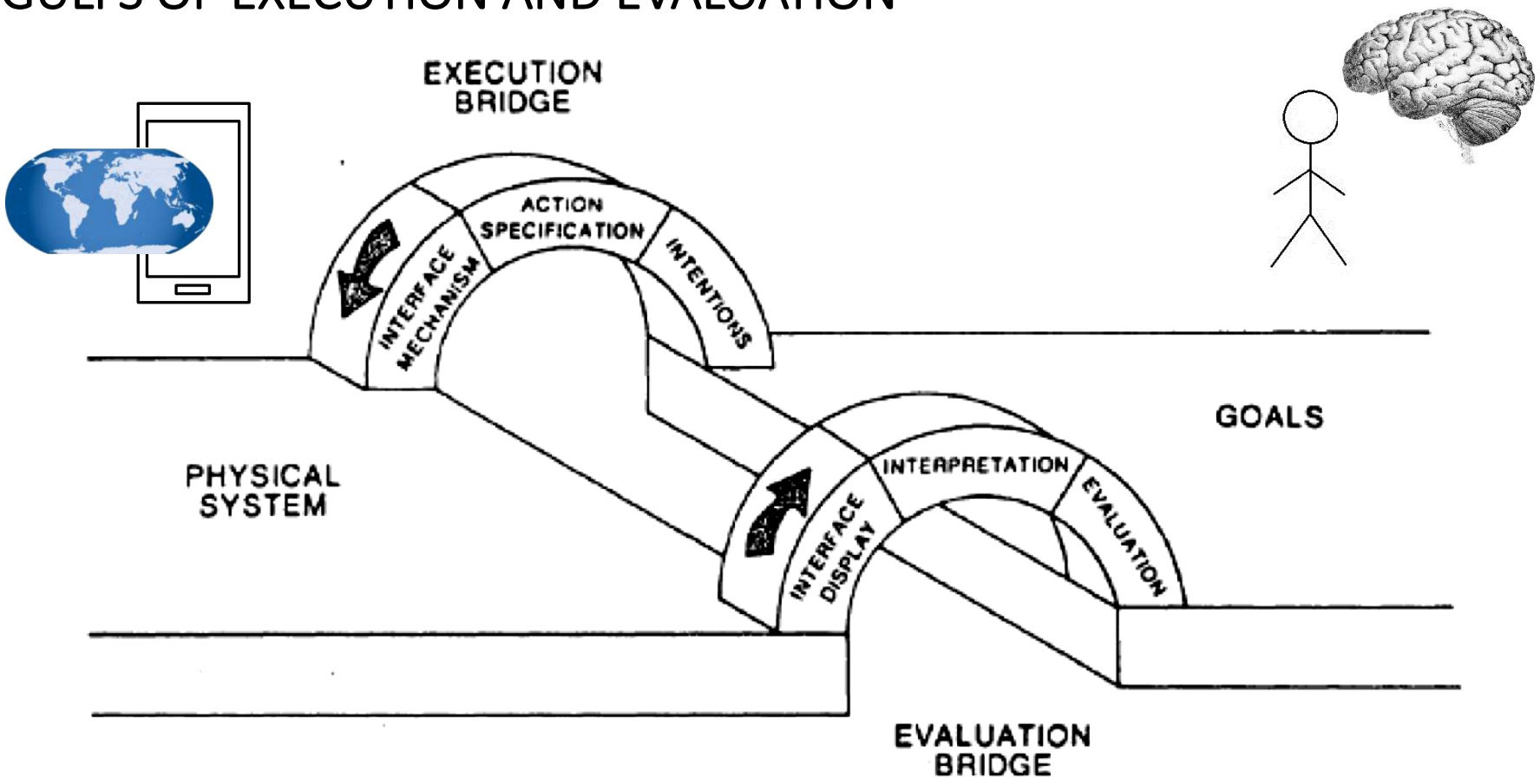
Gulf of execution

When the human variables of goal and intention may not be capable of being adequately translated into a physical action
e.g., a problem occurs in the dialogue from the user to the map UI

Gulf of evaluation

when the map's response may be inadequate for the user
e.g. a problem occurs in the dialogue from the map UI to the user

GULFS OF EXECUTION AND EVALUATION



Design may bridge gulfs from either side:

- System (requiring effort from the designer, e.g., address user context)
- User (requiring effort from the user, e.g. learn new language)

GULF OF EXECUTION

How the user can figure out how the system operates

1. Goals, intentions
2. Actions
3. Interface mechanisms

Interface mechanisms

- Signifiers
- Constraints
- Mappings
- Conceptual model
  - Good model: User can understand interface
  - Poor model: "No evident relationship between the operating controls and the functions…" (Norman, 2013)

GULF OF EVALUATION

How the user can figure out what actually happened

1. Interface display

- Feedback

2. Interpretation

- Conceptual model - Things made sense!

INTERFACE TYPES

1. Command based
2. GUI
3. Multimedia
4. Virtual, augmented and mixed reality
5. Information visualisation
6. Web
7. Consumer electronics and applications
8. Mobile
9. Speech
10. Pen
11. Touch
12. Air-based gesture
13. Wearable
14. Brain-machine

What are some of the devices?

Groupings are not mutually exclusive

e.g., smartphone may be phone or touch

Explore more here: http://wps.aw.com/aw_shneiderman_dtui_5/117/29960/7669931.cw/index.html

DIFFERENT INTERACTION TYPES

INTERACTION TYPES

Types of user interaction with system (e.g., interactive map)

May also be loosely referred to as interaction ‘styles’

Activity-based interaction

1. Instructing
2. Conversing
3. Manipulating
4. Exploring

Rogers et al. (2011)

1. INSTRUCTING

Users carry out a task by telling the system what to do

Different techniques:

- Executing commands
- Pressing buttons

HCI:

Interaction is quick and efficient - good for repetitive tasks

Example:

Command line codes (e.g., R)

Consumer electronics (e.g., microwave, computer)

1. INSTRUCTING

Command line interface (R)

```
> m0 <- ggplot(eurEduMapDf)
> m1 <- aes(long,lat,group=group,fill=rank)
> m2 <- geom_polygon()
> m3 <- scale_fill_continuous(guide="legend")
> m0 + m1 + m2 + m3
```

Microwave UI

Image: http://cwinters.com/2005/01/16/microwave_interface_so_simple_so_broken.html

2. CONVERSING

Users has a conversation with a system and it responds like a human partner (two-way communication)

Different techniques:

- Simple voice recognition
- Menu-driven systems which may adapt

Example: "How do I hard reset my mobile phone?"

- Automated phone menu
- Search engines
- Online help facilities

2. CONVERSING – Software systems

Image: http://www.imore.com/secret-siri-commands-ten-ways-amp-your-digital-assistant#slide11

3. MANIPULATING

User manipulates objects in a manner similar to the physical world

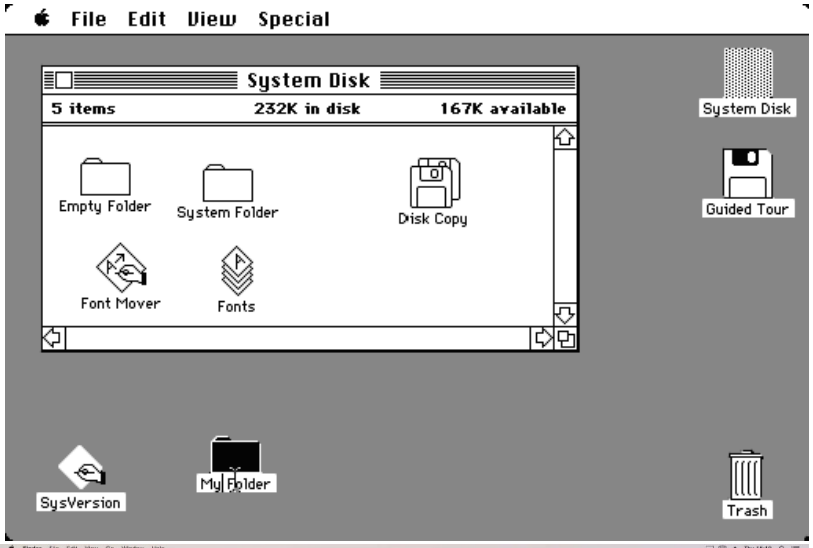
Different interfaces:

- Virtual space (e.g., moving, selecting, opening, zooming, stretching…)
- Physical space (e.g., hand or body gestures using Wii or Kinect)

Direct manipulation – Shneiderman (1982)

> "…makes the interface feel direct by reducing the effort required of the user to accomplish goals"
>
> …a decrease in *semantic* (meaning) and or *articularly* (physiological) distance
>
> (Hutchins et al., 1985)

3. MANIPULATING – Graphical User Interface (GUI)



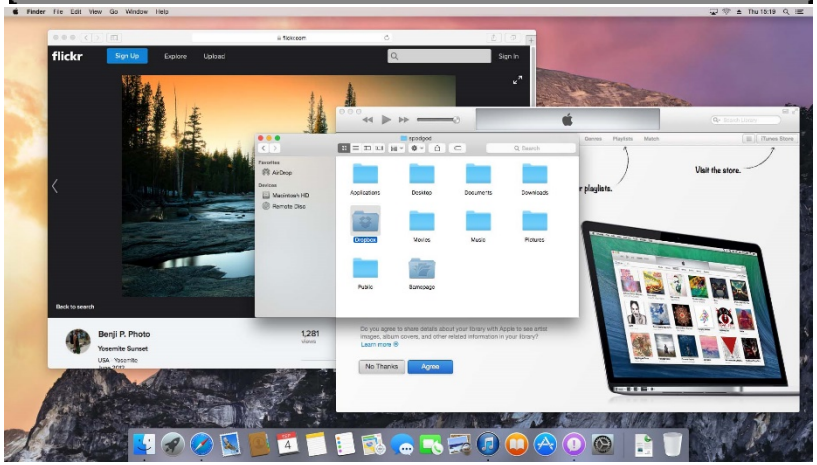
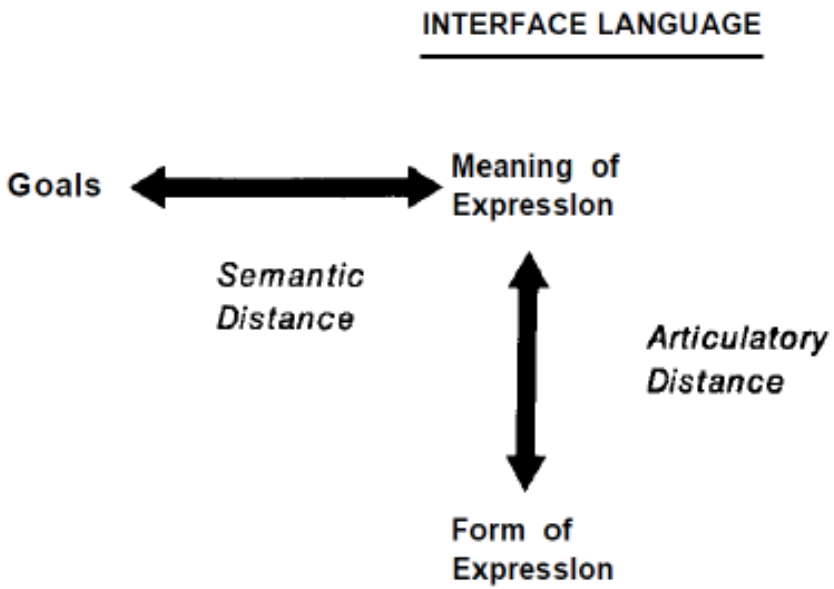


Image: http://www.macworld.co.uk/review/mac-software/

Image: http://www.theoligarch.com/microsoft_vs_apple_history.htm



(Hutchins et al., 1985)

4. EXPLORING

User moves through virtual or physical environments exploiting their knowledge of how they move/navigate existing spaces

Different user interfaces:

- Virtual space (e.g., 3D virtual worlds)
- Physical space (e.g., sensor enabled environments)

Similar to direct manipulation

e.g., users can see things that are normally invisible/impossible to see such as fly overs

4. EXPLORING

Flying in Second Life (Linden Labs)
Image: http://www.onlisareinsradar.com/archives/second_life/

UCSC 'CAVE'
Image: http://news.ucsc.edu/2015/05/cave-lab.html