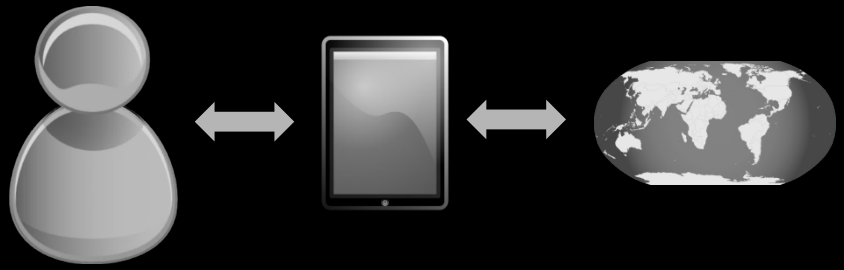
THE UNIVERSITY OF MELBOURNE



GEOM90007

SPATIAL VISUALISATION

LECTURE 9: INTERACTIVE MAPS
AND INTERACTION DESIGN

REVISION

- Coordinate systems and map projections
- Map elements, use of type and labelling guidelines
  - TypeBrewer: https://web.archive.org/web/20160112171434/http://typebrewer.org/typebrewer
- Limitations of the traditional map metaphor
- Cartographic revolution
  - Data drivers (e.g., big data)
  - Technology drivers (facilitating interaction)

How might data and technology influence traditional map design?

Image: GIS Lounge http://www.gislounge.com/spatial-orientation-and-the-brain-the-effects-of-map-reading-and-navigation/

Image redrawn from Roth (2013)

INTERACTIVITY: Animated maps, Interactive maps

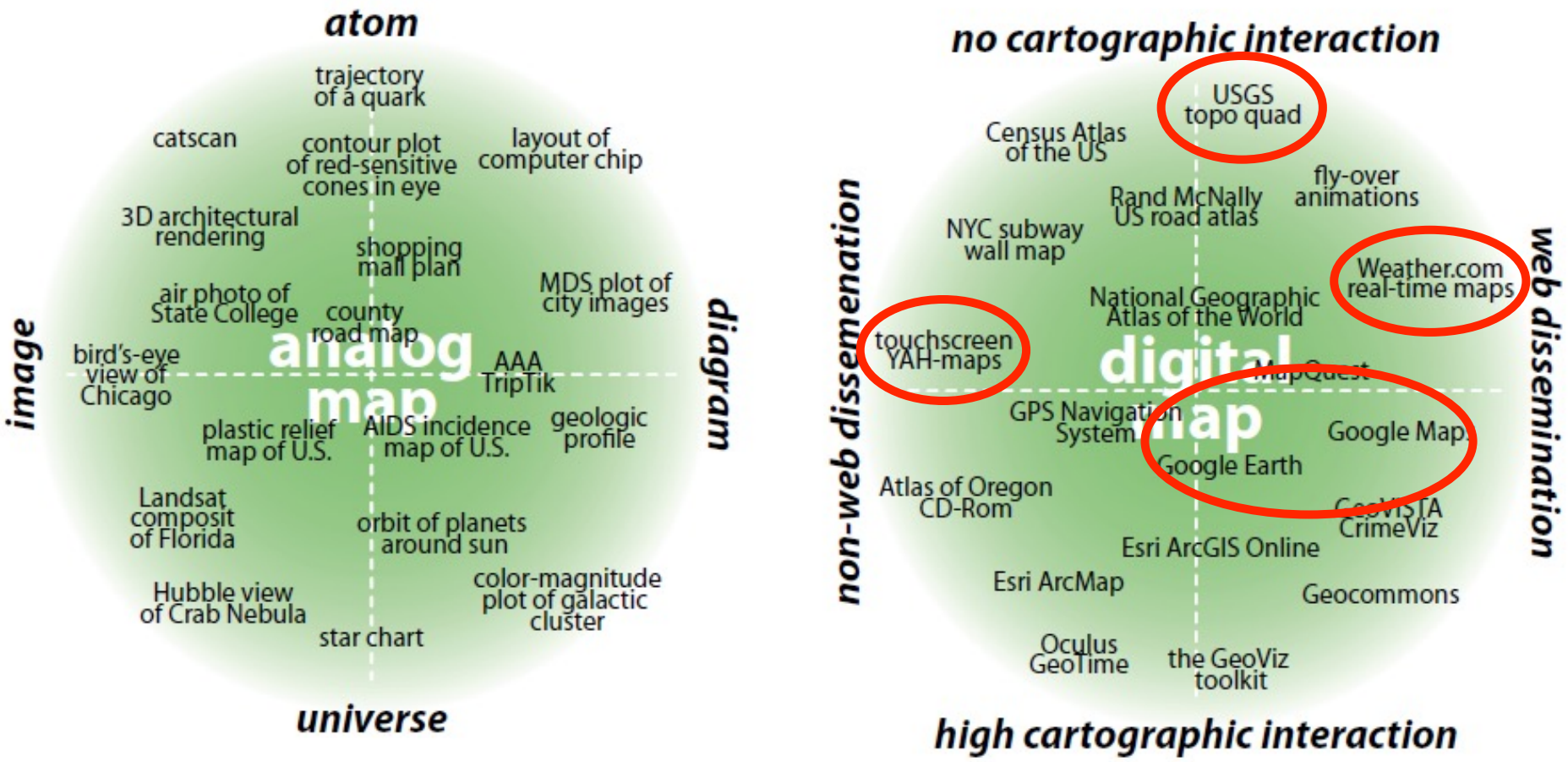


Image: Roth (2013)

INTERACTIVE MAPS

- Non-web dissemination
  - Kiosk style YAH maps

Image: Envent.com.au

- Web dissemination
  - Mobile apps

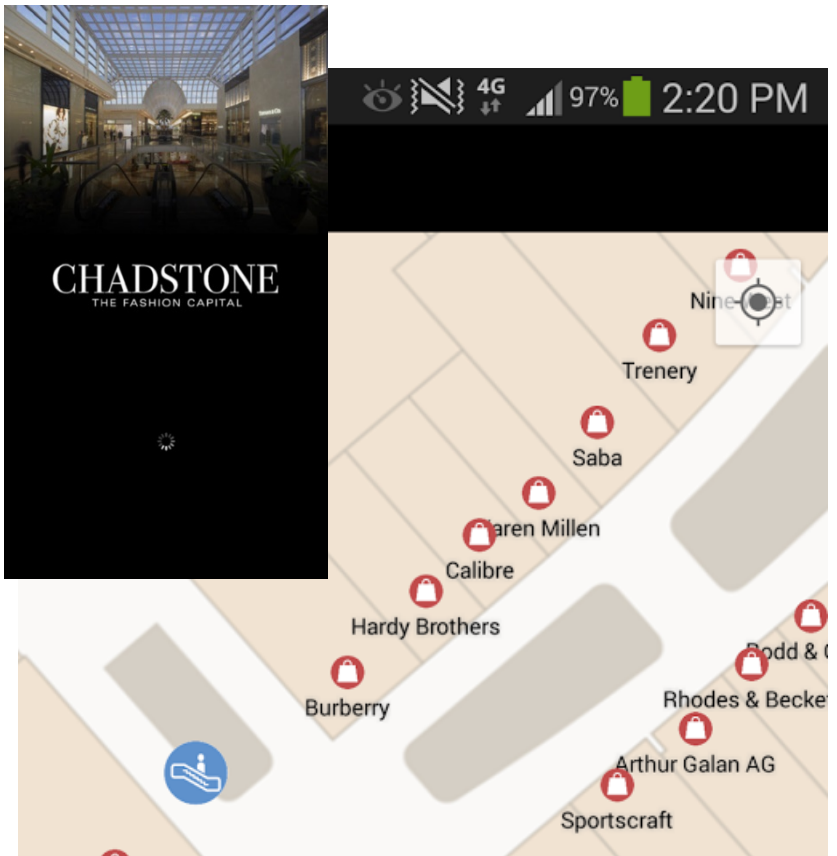


Image: Vicinity.com.au

INTERACTIVE MAPS

- No cartographic interaction
  - Traditional topographic map
- Low cartographic interaction
  - PDF maps

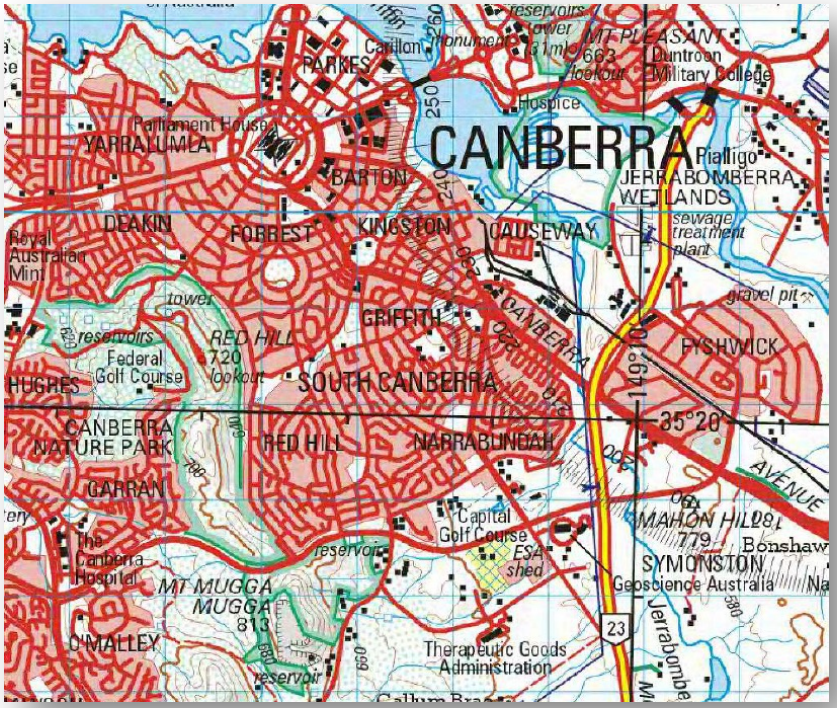


Image: Geoscience Australia
http://www.ga.gov.au/metadata-gateway/metadata/record/gcat_64002

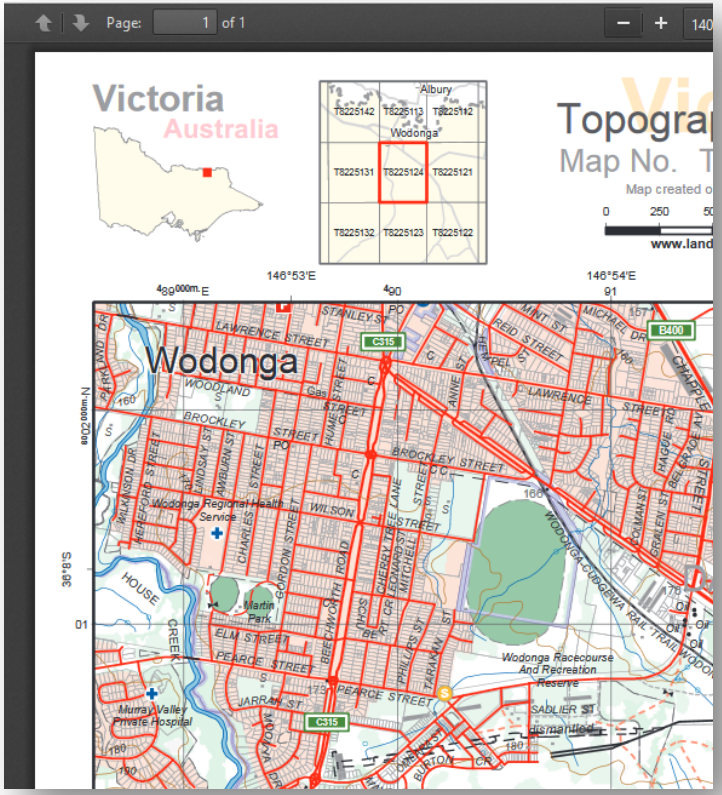


Image: Land Victoria
http://services.land.vic.gov.au/topodocs/VicmapTopo_30k_T8225-1-2-4.pdf

INTERACTIVE MAPS

- Lower cartographic interaction
  - m.bom.gov.au

Image: www.bom.gov.au

- Higher cartographic interactio
  - OpenStreetMap.org

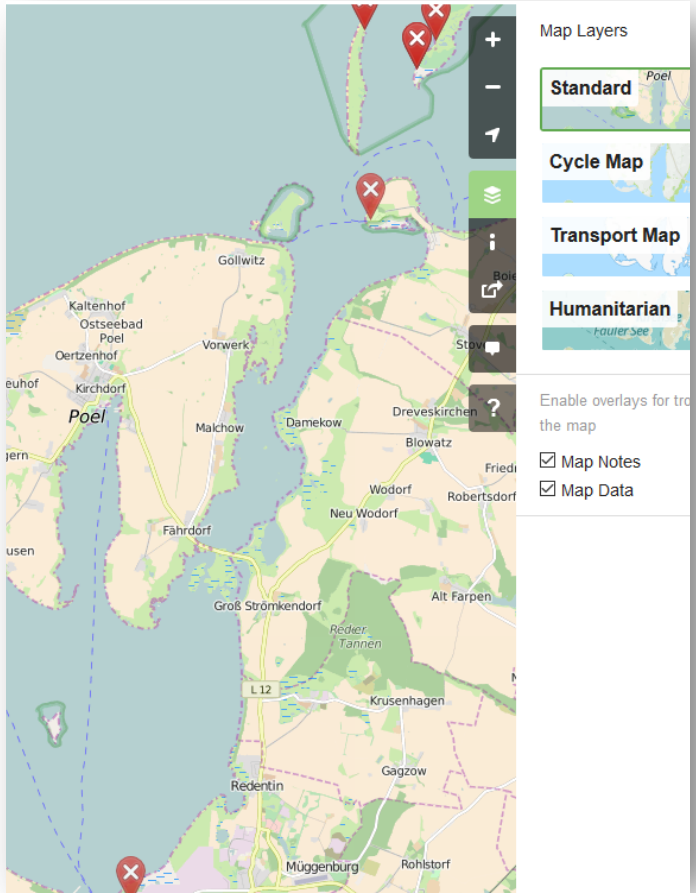
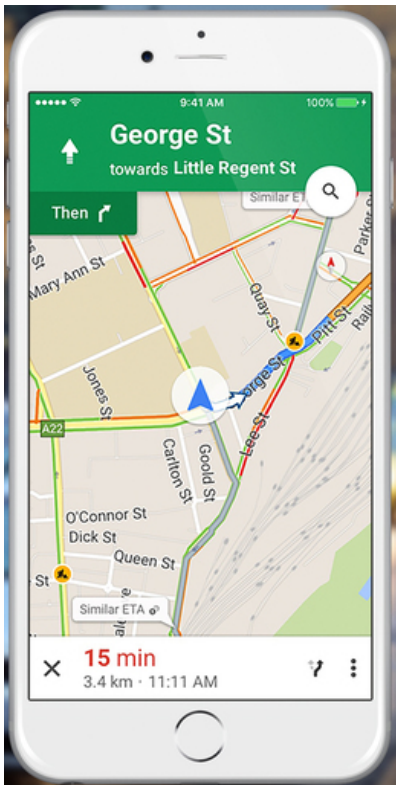


Image: www.openstreetmap.org

INTERACTIVE MAPS

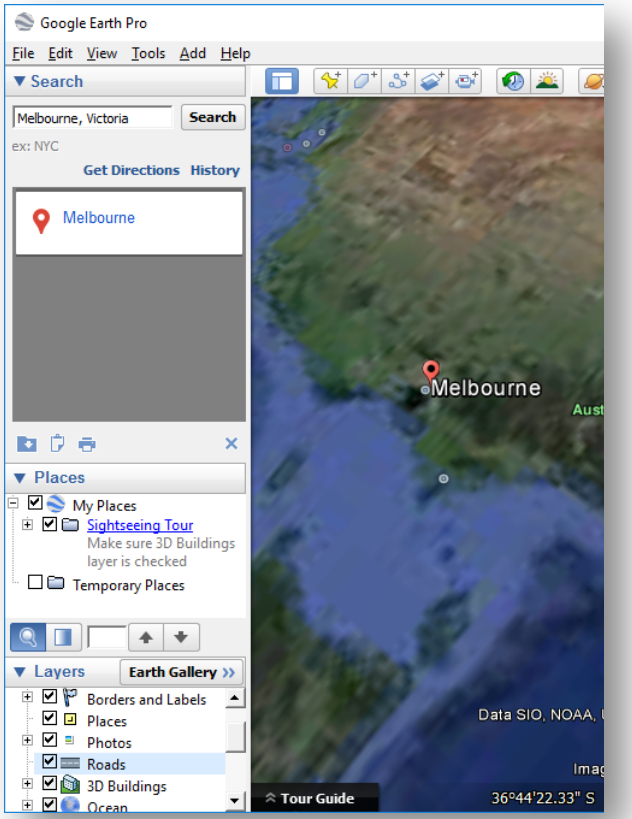
- **Mobile apps**
  Less data/Lower interaction
  Higher web dissemination

Image: Google Maps
https://itunes.apple.com/au/app/google-maps-real-time-navigation/



- **Desktop apps**
  More data/Higher interaction
  Lower mobile dissemination

Image: Google Earth Pro
http://www.google.com.au/earth/download/gep/agree.html



INTERACTIVE MAPS

- Continuum of interactivity
  - No interactivity
  - Low interactivity (play/stop, zoom in/out)
  - High interactivity (add/remove layers, measure distances)

- Level depends on the requirements for interactivity
  - Data
  - Map users (audience)
  - Space (public vs private)
  - ...

…BUT HOW DO WE ACTUALLY DESIGN INTERACTIVE MAPS?

Data graphics

- Visual variables (Bertin)
- Design principles (Tufte)

Cartography

- Cartographic visual variables (MacEachren, Slocum et al.)
- Cartography design principles (Slocum et al.)

Interactive maps

- Interaction variables???
- Interaction design principles???

First, we need to understand interaction design!

INTERACTION DESIGN

INTERACTION DESIGN FOR INTERACTIVE MAPS

- Introduction
- Human perspective
- Action model
- Device perspective
- The user interface (UI)
- Interaction types

- Introduction to the design process

INTRODUCTION TO INTERACTION DESIGN

- "Designing interactive products to support the way people communicate and interact in their everyday and working lives"
  (Rogers et al., 2015)

- Very broad scope and practice focused

INTRODUCTION TO HCI

- Human-computer interaction (HCI) can be considered a subset
  - Traditionally narrow focus (e.g., interactive computing systems)
  - Various crossovers (e.g., CHI, HF&E)

- HCI is concerned with human factors, information systems, computer science, and information science
  (Grudin, 2012)

- Grudin identifies two fields of evolution 1905-2015
  - Design human tools to be used more efficiently
  - Distribute information more effectively

INTRODUCTION TO HCI

- 2016 – drivers
  - Users seeking personalisation and self expression
  - Portable devices
  - Internet of Things
  - Increasing ubiquity (Weiser's vision)
    - "the invisible computer of the future" (Norman, 1988)
    - "interaction is everywhere" (Grudin, 2012)

- What might this mean for cartography?

HUMAN PERSPECTIVE

PERCEPTUAL-MOTOR INTERACTION

- Sensing and perceiving information
  - Relates physiological input, cognition and physiological output
- Walking through the park
  - Stimuli from everywhere!
- Keyboard and mouse devices
  - Sensorimotor mappings to achieve goals
- Gesture (e.g., multi-touch user interfaces)
  - More direct manipulation of virtual objects

Derived from Welsh et al. (2012) Perceptual-Motor Interaction.

HUMAN INPUT CHANNELS

Receptors respond to stimuli, function as input channels

- Visual (sight) -photoreceptors
  - Sensing
  - Perception
- Auditory (hearing) -hair cells (organ of corti)
  - Vibrations
- Haptic (touch) -mechanoreceptors, thermoreceptors
  - Pressure
  - Heat/cold

- Olfactory (smell)
- Gustatory (taste)

HUMAN OUTPUT CHANNELS

Effectors are any part of the body that responds

Examples:

- Physical motor responses (e.g., muscle contraction)
  - Limbs
  - Eyes
  - Head
  - Vocal system

- Glands releasing chemicals

Image: Todd Van Hoosear, Creative Commons

MODEL OF HUMAN INFORMATION PROCESSING

Cognitive process stimulus-response

- **Stimulus identification**
  - Perception of information (e.g., visual variables – colour hue)
  - Feature extraction and identification
- **Response selection**
  - Determining the response to a stimulus (Hicks-Hyman Law)
- **Response execution**
  - Programming and execution of motor responses (Fitts Law)

More information: Sanders, A. F. (1998) Elements of Human Performance

EXAMPLE: Hick–Hyman law

- Time to select the target
- Law predicts the 'reaction time' to select information
  - The amount of time to choose the correct response increases with the number of alternatives

(Hick, 1952)
(Hyman, 1953)

- Stroop colour naming effect – interference

orange green blue

Derived from Welsh et al. (2012) Perceptual-Motor Interaction

EXAMPLE: Fitts Law

- Time to engage the target
  - e.g., hand movement to control a pointing device

- Law used to predict pointing (movement) time as a function of the distance to and the width of the target:

  - To maintain accuracy, movement time must increase as the distance of the movement increases and/or the width of the target decreases

  (Fitts, 1954)

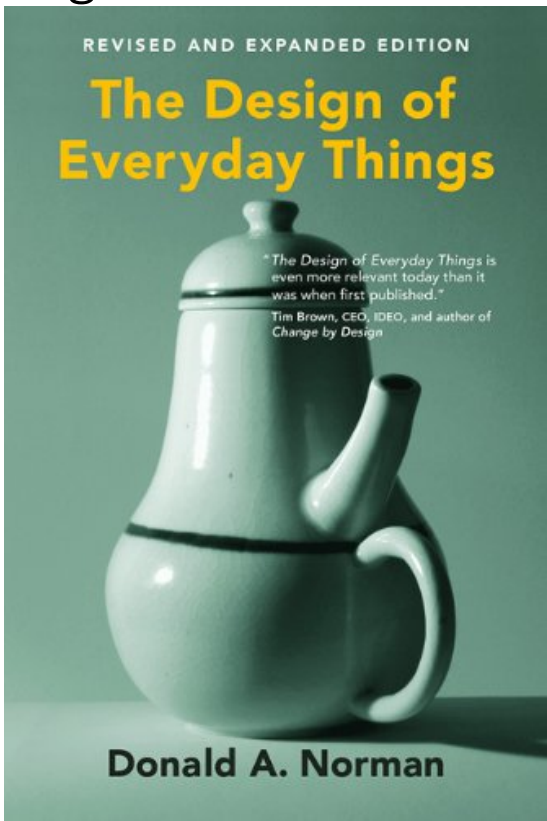
Derived from Welsh et al. (2012) Perceptual-Motor Interaction

FUNDAMENTALS OF INTERACTION

FUNDAMENTALS OF INTERACTION (Norman, 2013)

1. Experience
   - User experience is critical
   - Positive experience comes from understanding
     - Provides a greater sense of control

2. Discoverability
   - Human psychological concepts



2. DISCOVERABILITY

Human Psychological Concepts:

- Affordances
- Signifiers
- Constraints
- Mappings
- Feedback
- Conceptual model

AFFORDANCES (Gibson, 1977)

The world is full of objects, natural and artificial

- Affordances describe relationships (not properties) for what (inter)actions are possible

How do we know how to interact with objects?

Objects signal important information for interaction

- A door knob **affords** ("is for") turning/pushing/pulling
- A chair **affords** support and therefore **affords** sitting

Signalling an affordance is communicated using **signifiers**

SIGNIFIERS (Norman, 2013)

Designers need a way to signal (communicate) which graphic elements can afford interaction, e.g., touch or slide

Signifiers describe *where* an interaction can occur, not *what* is possible, they must be able to be perceived by a person, who becomes the **user**

Intentional signifier:

- A PUSH sign on a door
- An arrow in a hallway

Unintentional signifier:

- The presence or absence of people on a train platform

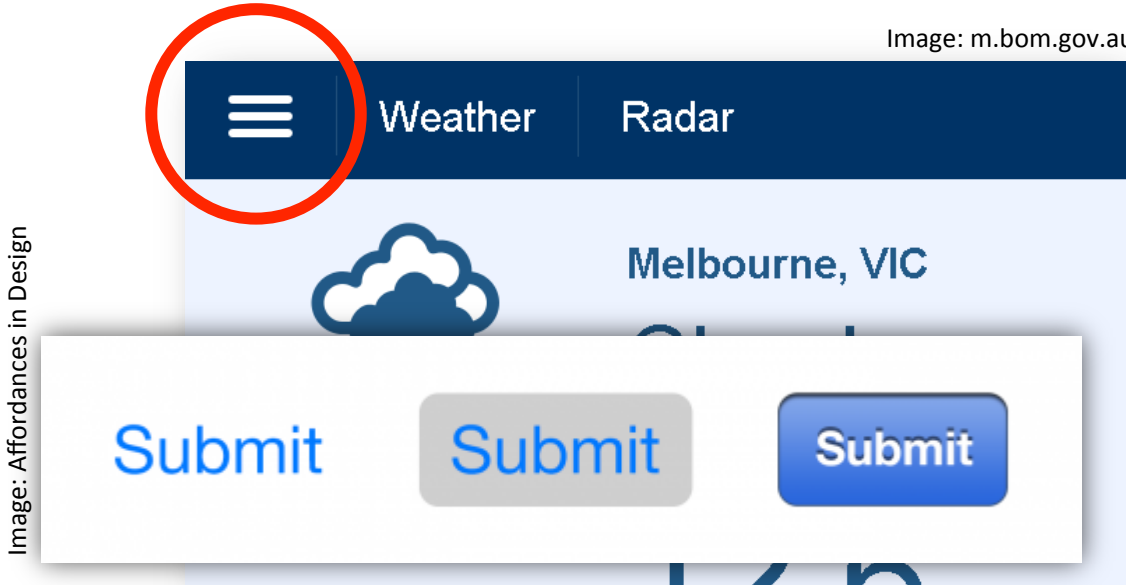


Image: Affordances in Design

SIGNIFIERS

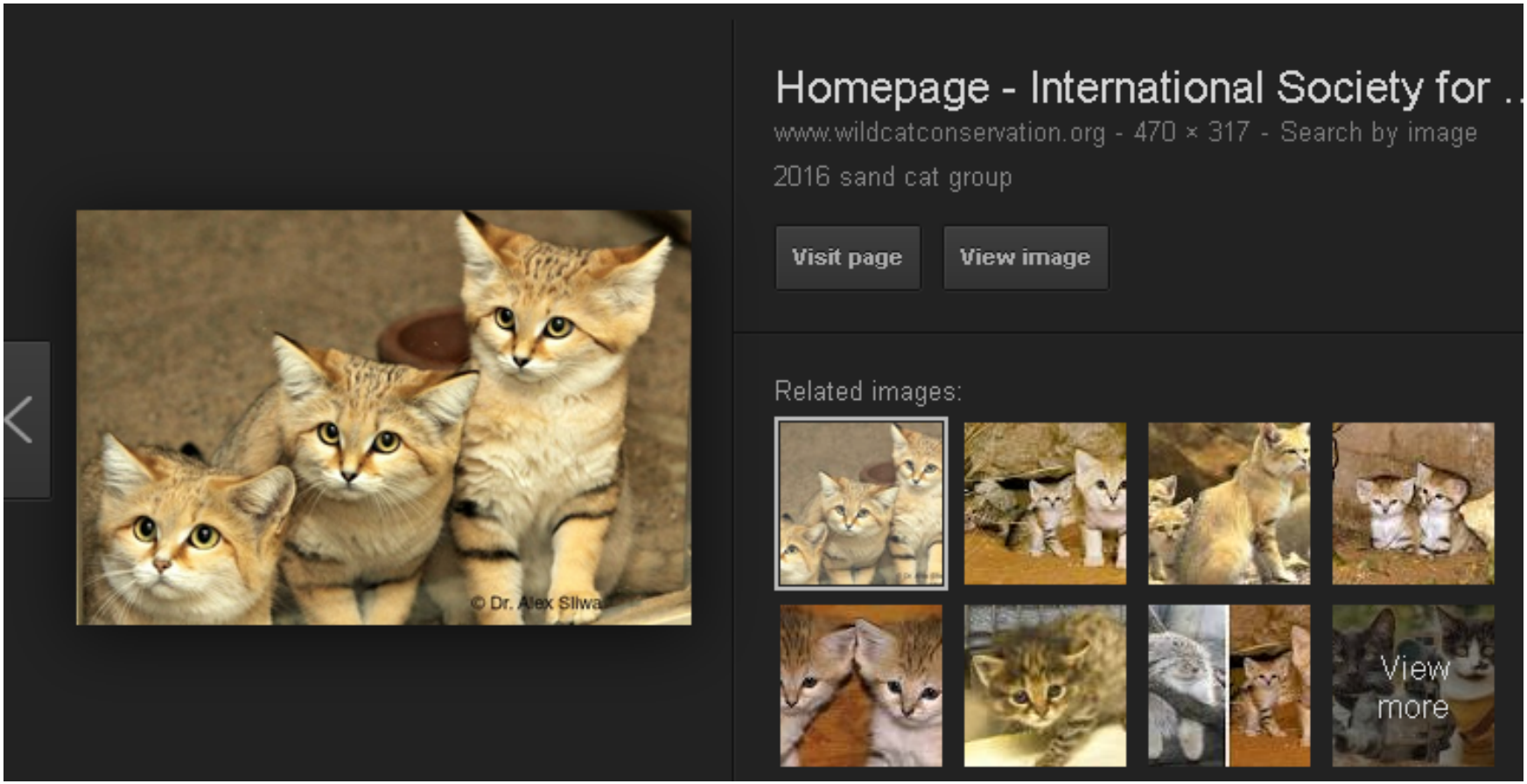


Image: Google Image Search

CONSTRAINTS (Norman, 2013)

1. Physical

   Rely on the properties of the physical world, e.g., devices can be no smaller than their battery or other requirements

Image: Apple

2. Cultural

   Rely a set of actions for social situations that can change with time
   e.g., behaviour in a restaurant or elevator

Image: Georgie Pauwels
Creative Commons

CONSTRAINTS (Norman, 2013)

3. **Semantic**
   Rely upon the meaning of the situation to control the set of possible actions and can change with time
   e.g., meaning of a windshield

Image: Andrew Rivett \Creative Commons

4. **Logical**
   Rely on the natural mapping between things (spatial or non-spatial)
   e.g., left switch should control left light

Image: Marc Falardeau Creative Commons

MAPPINGS (Norman, 2013)

Mapping describes a relationship between an **element** and its function

e.g., visual variable size mapped to total number of accidents

May use **spatial correspondence** between the interface and the object

e.g., driving game: left arrow turns steering wheel left

Natural mappings are easy to understand

e.g., Light switches arranged according spatial position of globes

e.g., Gestalt principle such as proximity to create groups

(refer Lecture 5)

FEEDBACK

An object's response to an action (e.g., a system responding to input)
(Shneiderman, 1998)

Feedback must be immediate, otherwise the human may cease performing the action or lose confidence

Example:

Light on pedestrian crossing button to signify that action has been registered by the system

(otherwise people may keep pressing, worried they will miss the next opportunity)

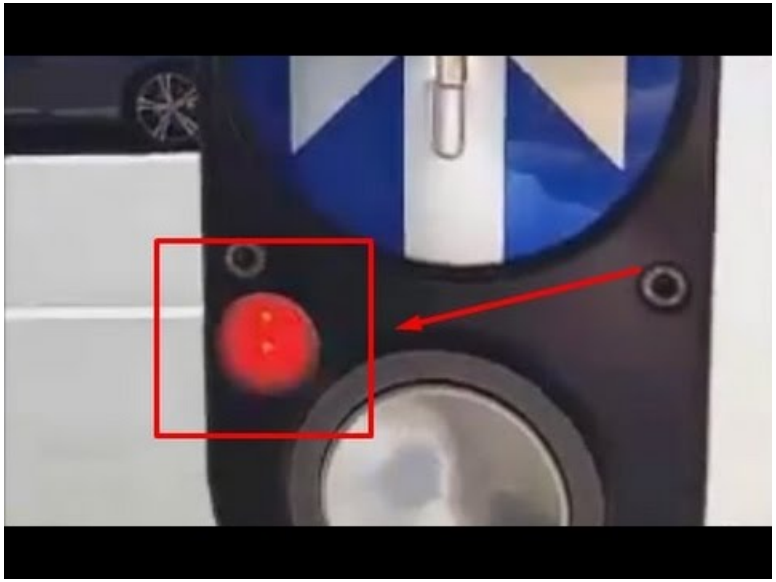
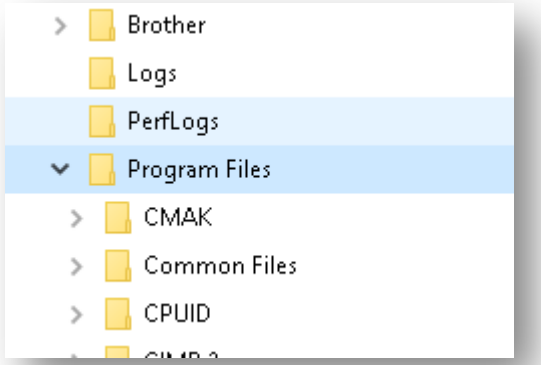


Image: NSW Railways Current Affairs and Archives

CONCEPTUAL MODEL



A **simplified representation** of how something works

E.g., Folder icons in an operating system are conceptualisations that map between the physical experience of filing and a device's memory.
The model works because the mapping effectively ties to a common experience.

However, a model is "valuable only as long as the assumptions that support them hold true" (Norman, 2013)

Mental models are similar – discussed soon

OTHER PSYCHOLOGICAL

What else is important?