



Never Stand Still

# Cognitive Load Theory

Implications for the design of better instructions,  
websites, software, manuals and any other  
information presentation formats.

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Adapted from slides by Dr Nadine Marcus

# Overview

- Our cognitive architecture
- Worked out examples as an alternative learning strategy to means-ends analysis
- The split attention effect
- The redundancy effect
- Expertise reversal effect
- Reduce search
- Diagrams
- The Modality effect
- Animations/Transient Information/Gesture
- Different sources of cognitive load
- Bringing it back to our heuristics

# Our cognitive architecture

- Huge Long-term memory (LTM) used to store vast amounts of information over long periods of time.
  - Information stored in the form of schemas.
- Limited Working memory (WM) used to process current information.
  - Can only store a few items for a short period of time.

# Our cognitive architecture

- *Schemas* allow us to bypass the limitations of WM by chunking large amounts of information together into a single unit.
  - Schemas allow us to ignore the huge amount of detail associated with all the information impinging on our senses, by allowing us to use information stored in LTM to fill in the details of what is being perceived.
  - Eg. PROPOSITION vs OTSPONIIRPO

# Our cognitive architecture

- *Automation* also helps to reduce the burden on WM by allowing us to process information with minimal use of our limited WM capacity.
  - Frees up WM capacity for other processes
- Schema acquisition and automation are the two most important components of learning.

# Our cognitive architecture

- Automated schemas have two functions:
  - Allow us to store information in LTM in an efficient form.
  - Reduce the burden on our limited WM.
- Can use this knowledge of how people learn and acquire knowledge to design better instructions, better learning materials, and better user interfaces.

# Worked examples instead of means-ends analysis

- Although means-ends analysis is a useful problem solving strategy, it is not a particularly good learning technique.
- Means-ends analysis is a very cognitively demanding strategy that focuses all of one's attention on reaching the goal.
- Instead of expecting learners to learn while solving problems, we should rather give them worked out problem solutions to study.
  - Number puzzles experiment (Sweller, Mawer & Howe, 1982).

## **Worked examples:**

1. *Problem*  $2a + b = 4$      $a = ?$

1. *Solution*  $2a + b = 4$

$$\begin{aligned} 2a &= 4 - b \\ a &= \frac{4 - b}{2} \end{aligned}$$

2. *Problem*  $4a + 2b = 6$      $a = ?$

3. *Problem*  $3x + 2y = 10$      $x = ?$

3. *Solution*  $3x + 2y = 10$

$$\begin{aligned} 3x &= 10 - 2y \\ x &= \frac{10 - 2y}{3} \end{aligned}$$

4. *Problem*  $5x + 3y = 4$      $x = ?$

# Worked examples instead of means-ends analysis

- Practical application of theory:
  - New users of a system should not be expected to learn how to use the system through trial and error. This is very cognitively demanding and an inefficient learning strategy.
  - It is better to create a ‘worked out example’ or a tutorial that demonstrates how to use the system.

# The Split Attention effect

- When information is structured such that it requires people to mentally integrate information that is physically split, this imposes an unnecessary burden on our limited WM.
- Mutually referring sources of information should be physically integrated. This reduces the strain on our limited WM and frees up cognitive capacity for other processing.
  - Geometry example

# More split attention

**Figure 15** Example of conventional, numerical control programming instructions using two sections of text

## **Manual instructions**

To commence cutting, move along the carriage towards the head-stock for 16 mm. To finish cut, move along the cross slide away from the component for 1 mm.

## **Numerical control (NC) instructions**

A straight line cut is to be made. The NC command for a straight line cut is G01. The movement for this cut is in the -Z axis. The NC command for a movement of 16 mm in the -Z axis is Z-16. The complete NC command for this instruction is G01 Z-16.

Another straight line cut is required. The movement for this cut is in the +X axis. The NC command for a movement of 1 mm in the +X axis is X1. The complete NC command for this movement is G01 X1.

**Figure 16** Example of integrated, numerical control programming instructions using two sections of text

## **Manual and NC instructions (in parentheses) in integrated format**

To commence cutting, move along the carriage towards the head-stock for 16 mm. (A straight line cut is to be made. The NC command for a straight line cut is G01. The movement for this cut is in the -Z axis. The NC command for a movement of 16 mm in the -Z axis is Z-16. The complete NC command for this instruction is G01 Z-16.)

To finish cut, move along the cross slide away from the component for 1 mm. (Another straight line cut is required. The movement for this cut is in the +X axis. The NC command for a movement of 1 mm in the +X axis is X1. The complete NC command for this movement is G01 X1.)

**Text based example:**  
Eliminating the Split attention effect (from Sweller, Chandler, Tierney & Cooper, 1990).

# Applications of the Split Attention effect

- Text referring to a diagram should, when possible, be integrated into the diagram.
- Related text should be contained on the same screen or page.
- Interfaces should not force users to recall information from one screen, that they need to type into another screen.
- Integrated training packages that do not split users attention between the screen and the manual, should be used.

# **Applications of the Split Attention effect**

- Web navigation should not force users to split attention between where they are and where they want to be, by forcing users to look at many unnecessary pages of information.

The Examination Board provides the Library with some exam papers only and those held date from the past 5 years. Use the following options to access past exam papers:

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Highlights

- Quickly identify peer-reviewed or open access items
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# The Redundancy effect

- If information is not essential for understanding i.e. is redundant, it is better to omit this information.
- Processing non-essential information uses up valuable cognitive resources.
- Paul Chandler and John Sweller (1991) demonstrated experimentally that redundant information is not neutral. It has a negative effect on learning and understanding.
  - Biology example

# Redundancy effect

Figure 19 Electrical wiring diagram with unintegrated, redundant instructions

## Internal wiring for intermediate switching

1. The active wire goes from the active to the common of switch 1.
2. In this type of switching we use an additional switch called the intermediate switch.
3. The wires connecting switch 1 to the intermediate switch and to switch 2 are called strap wires.
4. The switch wire goes from the common of switch 2 to the light.
5. The neutral wire goes from the light to the neutral.
6. Under no circumstances is the gauge of wire used in this type of circuit to be broken.

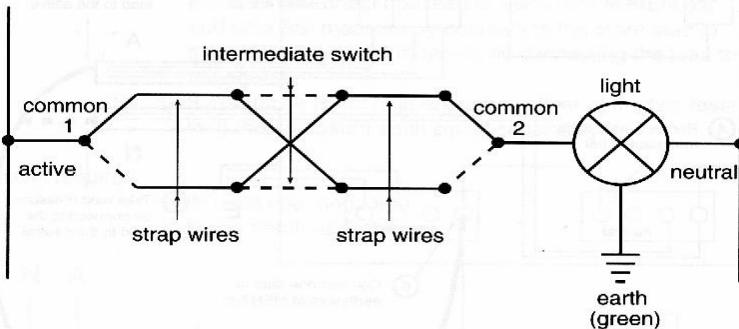


Figure 20 Electrical wiring diagram with integrated, redundant instructions

## Internal wiring for intermediate switching

- 1 The active wire goes from the active to the common of switch 1.
- 2 In this type of switching we use an additional switch called the intermediate switch.
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- 5 The neutral wire goes from the light to the neutral.
- 6 Under no circumstances is the gauge of wire used in this type of circuit to be broken.

**Example of the Redundancy effect**  
(from Chandler & Sweller, 1991).

# Applications of the Redundancy effect

- Manuals
- Screen design

# Applications of the Redundancy effect

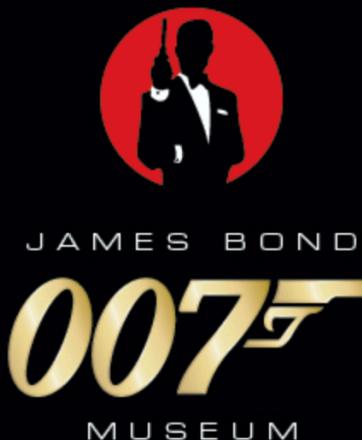
- With websites, navigation information should only appear once on any screen. Redundancy should be avoided - it involves extra processing load as well as creating screen clutter.
- Navigation of a site should not force users to have to go to redundant or unnecessary pages of information, in order to find what is needed.



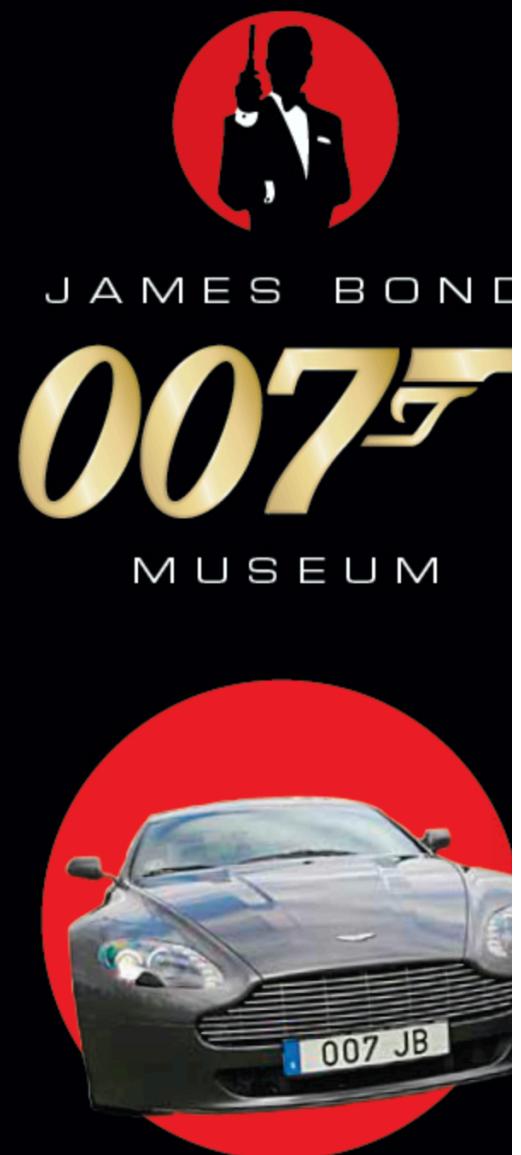
[www.007museum.com](http://www.007museum.com)



A full-sized Gondola from Venice (apparently just like the one that Roger Moore used in Moonraker).



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# Interaction between the Split Attention and Redundancy effects

- Whether information is essential or redundant depends on both the nature of the materials and the level of expertise of the users.
- When the knowledge level of your users is unknown, it is better to assume less knowledge and physically integrate related materials (rather than omit them).

# Expertise reversal effect

- What is a good presentation format for novices learners, may not be an ideal format for experts.
  - see Kalyuga, Chandler & Sweller (2000).

# Reduce Search

- Searching for related information on a screen is cognitively demanding, and wastes valuable cognitive resources.
- Try reduce search by:
  - Not putting too much information on a single screen or page
  - Integrating related information
  - Using a consistent screen layout, so people learn where to find things
  - Highlighting important information - can use colour, fonts, bold etc....
  - Making all web pages accessible from the Home Page

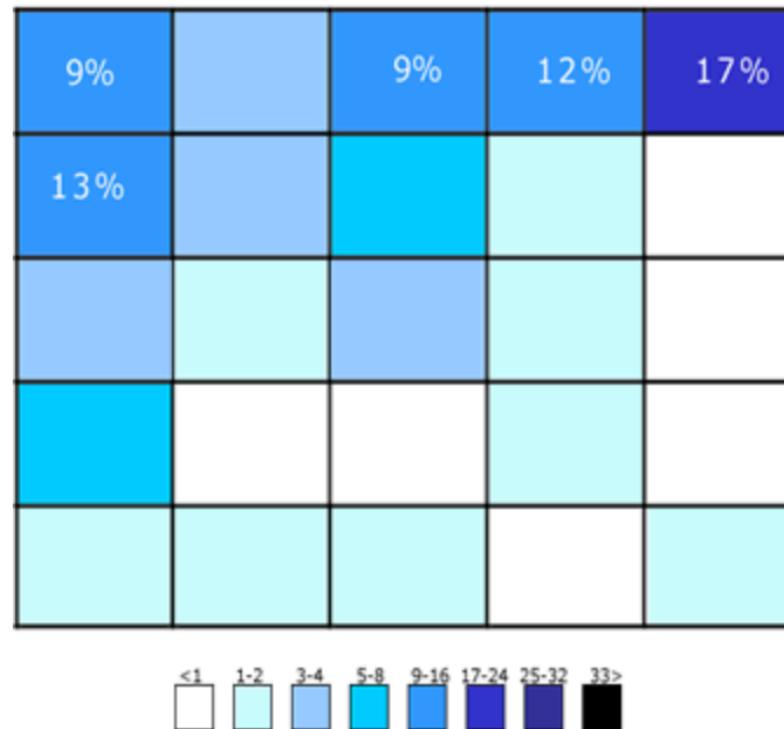
 Search

Stores



Sign in

[Back To School](#) [Home & Living](#) [Electronics](#) [Toys](#) [Women](#) [Men](#) [Kids & Baby](#) [Sports](#) [Gifts & Party](#) [Catalogue](#)[View all Toys](#)[Toys by Age](#)[0-24 Months](#)[Toys by Price](#)[Under \\$10](#)[Toys by Category](#)[Shop All Toys](#)[Brands](#)[Play-Doh](#)[Features](#)[Toys Latest Arrivals](#)[2-4 Years](#)[\\$10-\\$20](#)[5-7 Years](#)[\\$21-\\$30](#)[8 Years & Over](#)[Over \\$30](#)[Bikes, Scooters & Skateboards](#)[Blocks & Construction](#)[Board Games & Puzzles](#)[Play & Activity](#)[Dolls & Accessories](#)[Pretend Play & Dress Up](#)[Impulse & Novelty Toys](#)[Interactive Toys](#)[Kids Art, Craft & Stationery](#)[Musical Instruments](#)[Outdoor Play registration](#)[Disney](#)[Frozen](#)[LEGO Shop](#)[NERF Shop](#)[Our Generation Dolls](#)[Paw Patrol](#)[PJ Masks](#)[Pokemon](#)[Shopkins](#)[Star Wars](#)[The Avengers Marvel](#)[Thomas & Friends](#)[feedback](#)[United States](#)**UNSW**  
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The figure illustrates the areas where participants expected the search to be found. The upper-right corner is still the first place users expect to find search.

Chaparro, B.S., Shaikh, A.D., & Lenz, K. (2006). Where's the Search? Re-examining User Expectations of Web Objects.

# Diagrams

- If the relationship between elements of information is complex, and if a diagram is *meaningful*, familiar and not too abstract, diagrams can improve understanding.

# Diagrams can reduce cognitive load

- Diagrams reduce the load on WM because they:
  - Help to make the relationship between problem elements more concrete and explicit
  - Help to reduce the search for related information
  - Act as an external memory and so help us to visualize the whole problem all at once
  - Help to represent *complex* relations between elements of a problem in a less abstract format
  - Eliminate unnecessary information and so focus our attention on what's crucial to understanding

≡ Menu



# New South Wales

Just select your state to view the most requested locations to search for property.

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# The Modality effect

- Research (eg. Baddeley, 1992) suggests that WM has partially separate processors for handling visual and auditory information.
- Thus presenting information in both an auditory and visual mode can increase the capacity of WM. Some of the information should be in an auditory format and other information in a visual format.
- The Modality effect works by expanding our effective working memory capacity.

# Modality effect

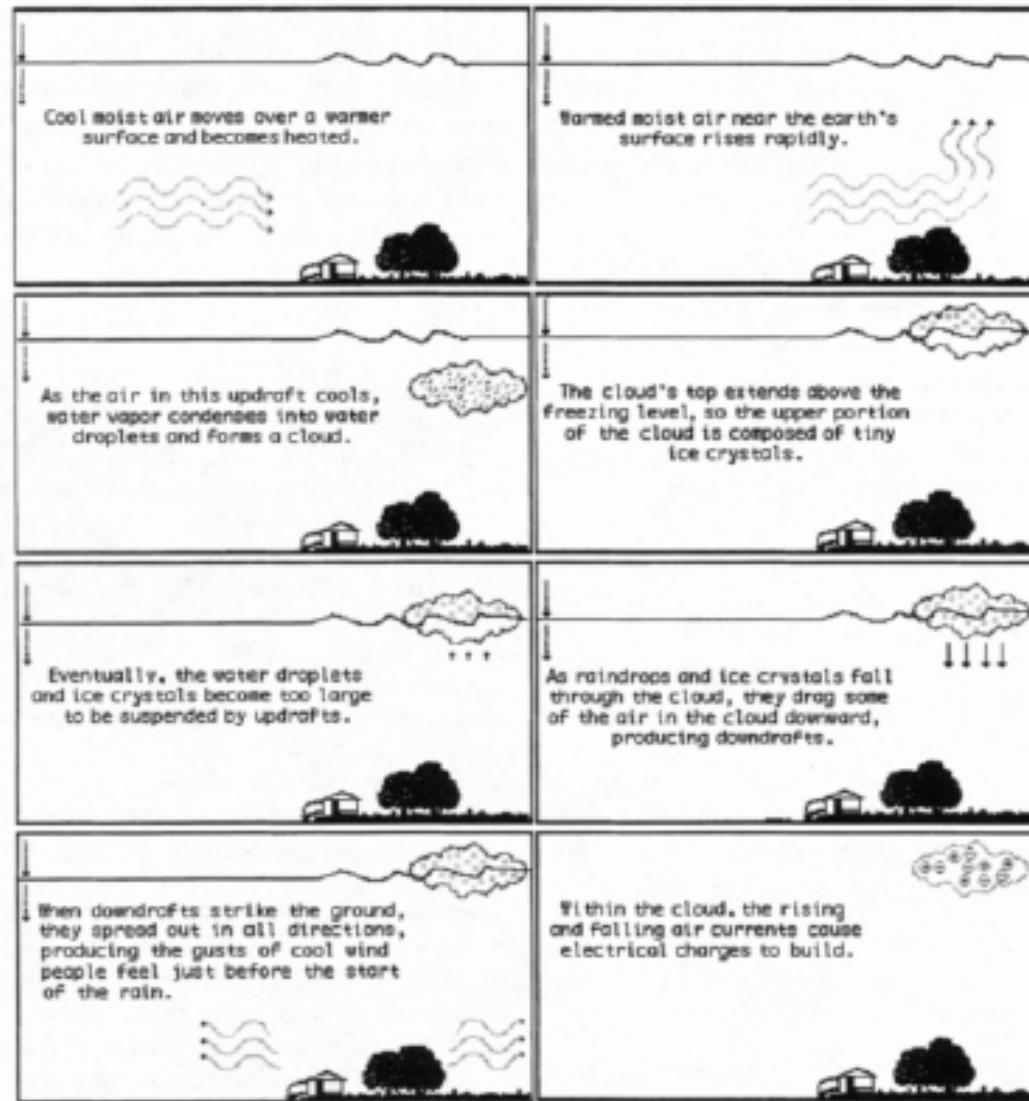
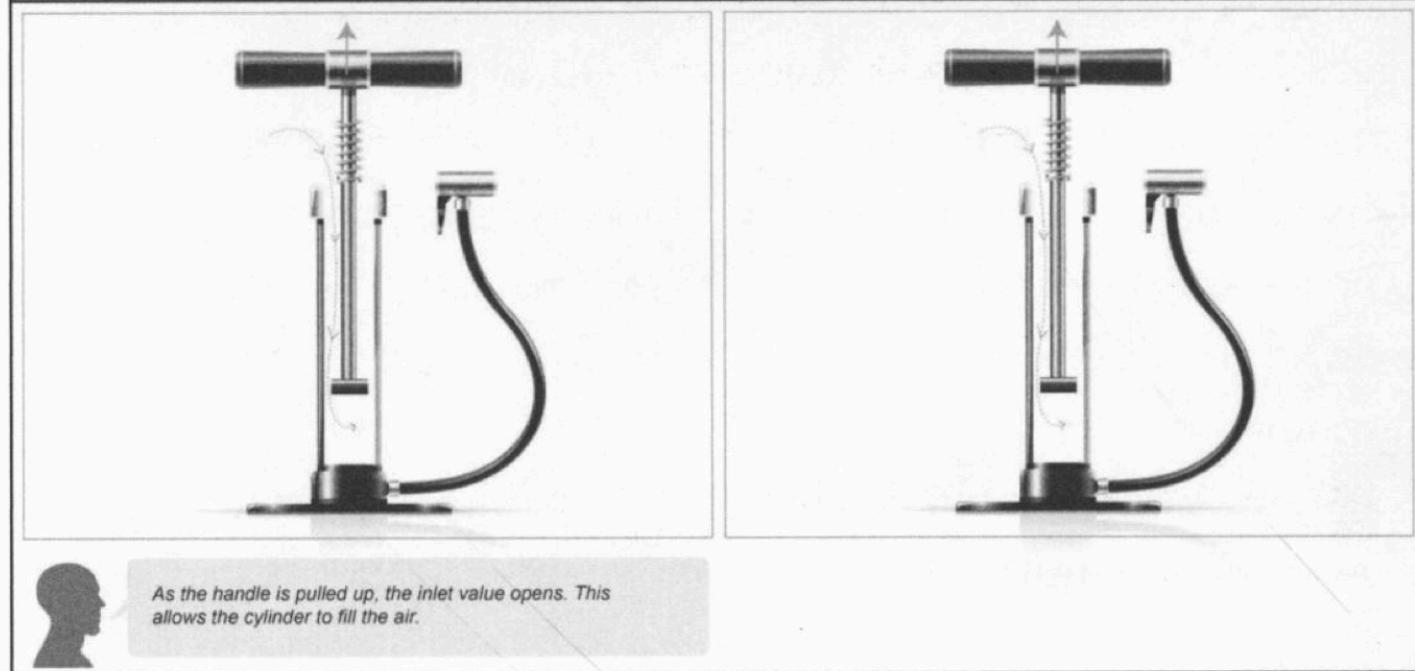


Figure 1. Selected frames from a multimedia lesson on the formation of lightning.

**Example of materials used for modality effect (From Mayer and Moreno, 1998).**

**Figure 3.** Modality Effect. The air pump depicted with complementary spoken text along with the graphical explanation (left panel) allows learners to integrate information using two different types of processing. The air pump without spoken text (right panel) does not. The mixed presentation of information (left panel) demonstrates an integration of the modality effect.



GREER, D., CRUTCHFIELD, S., & WOODS, K. (2013). Cognitive Theory of Multimedia Learning, Instructional Design Principles, and Students with Learning Disabilities in Computer-based and Online Learning Environments. *The Journal of Education*, 193(2), 41-50.

# **Applications of the Modality effect**

- Audio-visual materials are most useful as a method of eliminating the split attention effect
- In a computer interface environment, audio is a useful way of presenting error messages (provided the message can be repeated).

# The Modality effect ...

- One should also avoid an excessively large or complex auditory component.
- Timing of the audio is important.
- Note: For the purpose of universal access sometimes presenting redundant information may be desirable.
- Thus, what is appropriate design, depends on the make-up of the user group.

# Animations

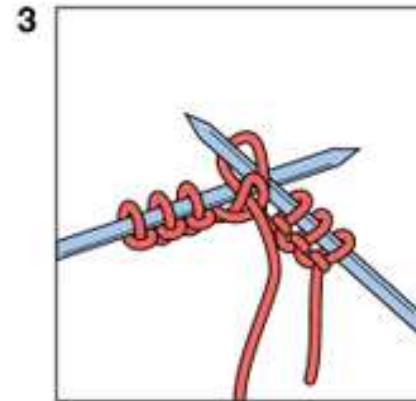
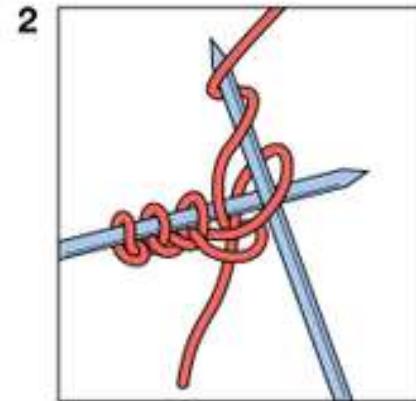
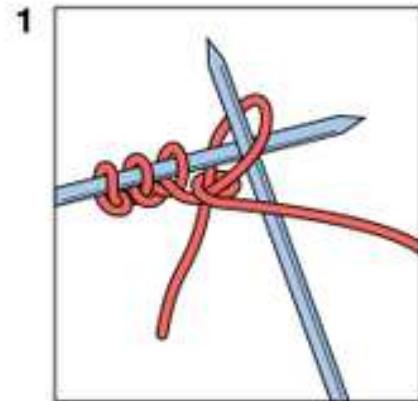
- Be careful when and how you use animation
  - Can be distracting
  - Are transitory
  - Often need to include *user control* and *interactivity*
  - Most useful for more knowledgeable users
  - Good for depicting human movement-based tasks
  - Better if more *realistic*

# This....

## Hand knitting: basic steps

### Purling:

Insert the right-hand needle upwards through the front of the stitch (1). Make a loop over this needle with the thread at the front (2) and pull it through the stitch (3).



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# Versus this:



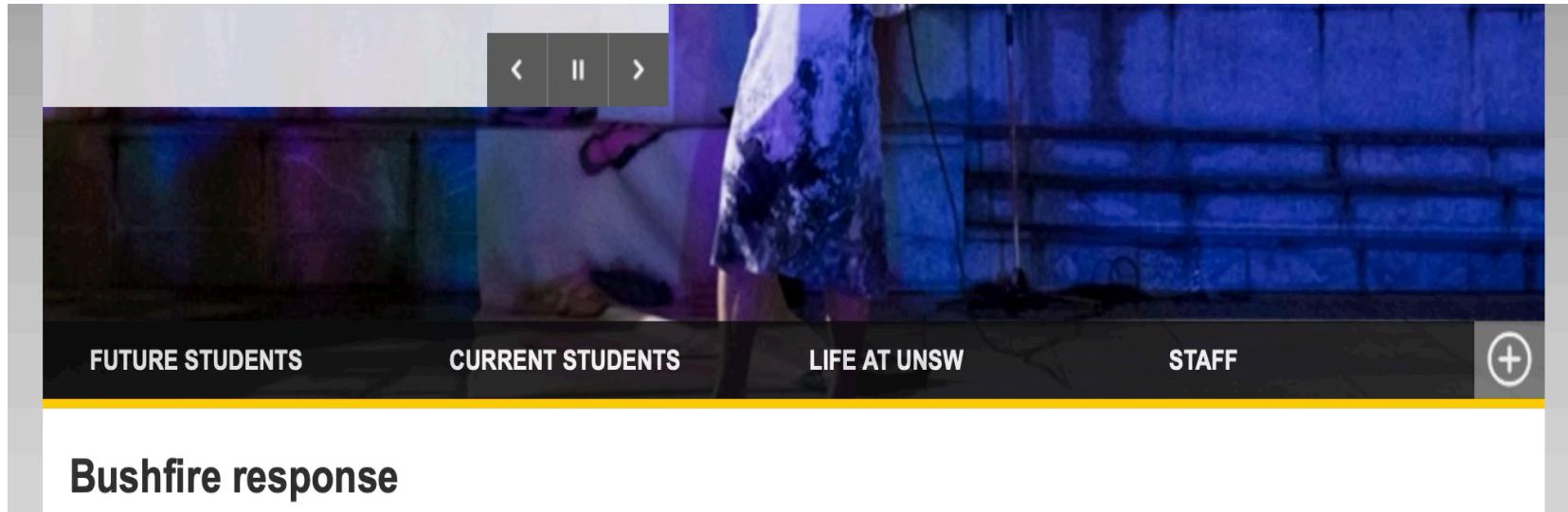
# Animation in web design

- ## • Microinteractions

Accessories	Amazon's Choice	
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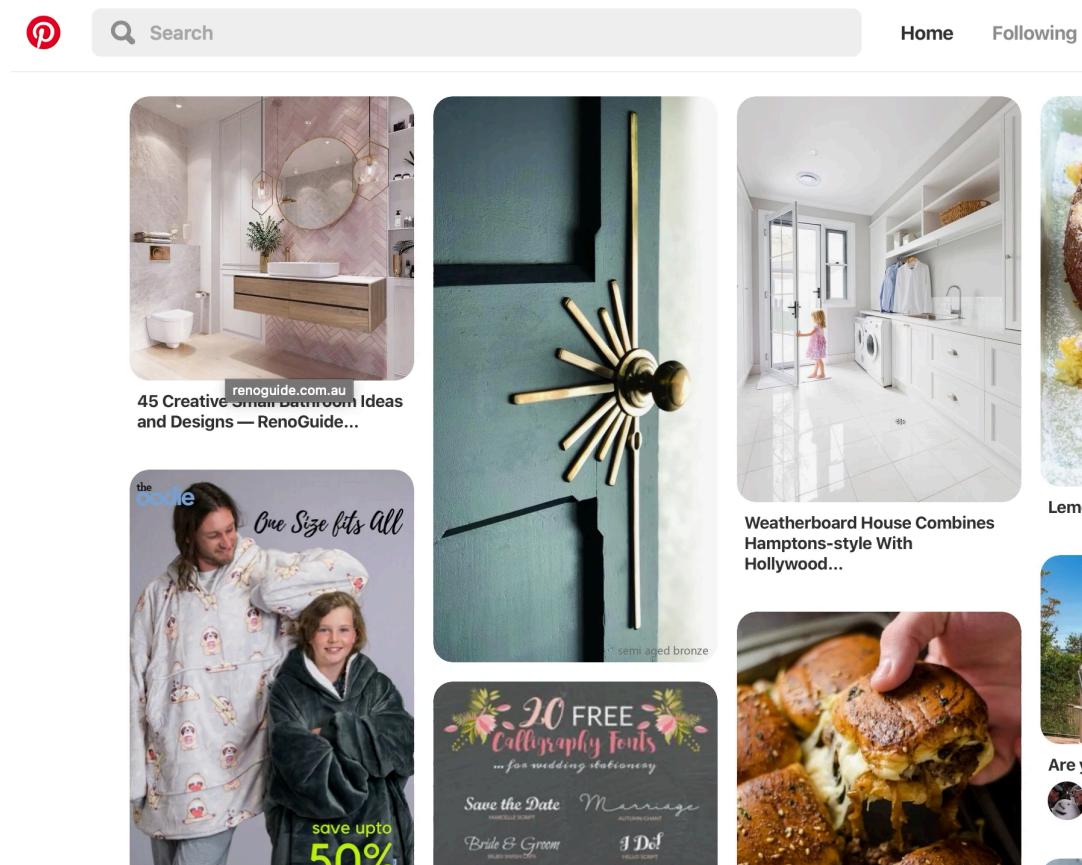
# Animation in web design

- Hidden menus



# Animation in web design

- Hover animations



# Animation in web design

- Sliding galleries using transitions

Received an offer?  
Take the next step. Accept and enrol now to secure your place.  
Accept offer

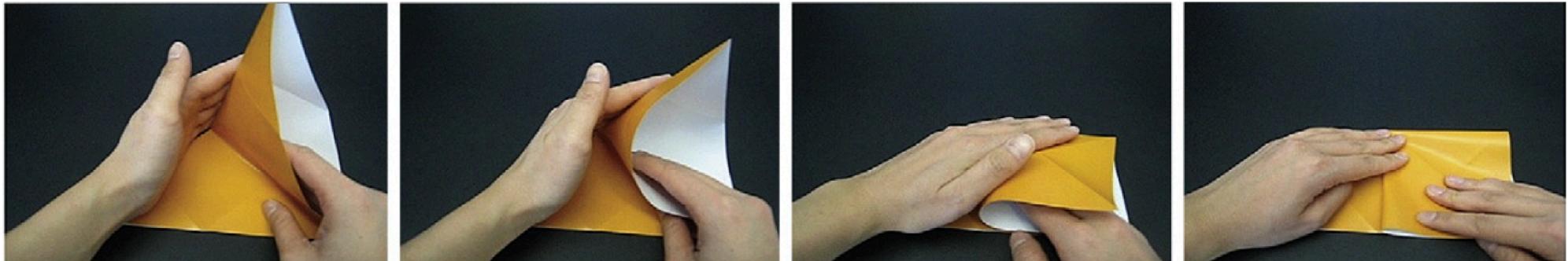
FUTURE STUDENTS	CURRENT STUDENTS	LIFE AT UNSW	STAFF
Domestic Undergraduate	myUNSW	Student Exchange	Teaching Gateway
Postgraduate Coursework	Moodle	Accommodation	Human Resources
Postgraduate Research	Class Timetable	Arc	Services Directory
International	Email	Co-curricular Activities	Finance
Non-award & short courses	Handbook	Professional Development	IT Services

# Transient Information Effect

- Information that is transient should be used sparingly online, for learning
  - Audio content must not be too long or complex
  - Animations should be used with caution

# Transient Information Effect - references

- Wong, A., Leahy, W., Marcus, N., & Sweller, J. (2012). Cognitive load theory, the transient information effect and e-learning. *Learning and Instruction*, 22(6), 449-457.
- Singh, A., Marcus N., & Ayres, P. (2012). The Transient Information Effect: Investigating the Impact of Segmentation on Spoken and Written text. *Applied Cognitive Psychology*, 26, 848–853.
- Singh, A., Marcus, N. & Ayres, P. (2017). Strategies to reduce the negative effects of spoken explanatory text on integrated tasks. *Instructional Science*, 45(2), 239–261.  
DOI 10.1007/s11251-016-9400-2



**Fig. 1.** A step from Experiment 1 static graphics learning materials.

# Different sources of cognitive load

- Three main sources of cognitive load:
  - Extrinsic/extraneous cognitive load
  - Intrinsic cognitive load
  - Germane cognitive load

# Intrinsic cognitive load

- Tasks that involve the simultaneous processing of large amounts of information are considered to be more intellectually complex than tasks in which each element of information can be processed one at a time.

# **Interaction between format of instruction and task complexity**

- For intellectually demanding tasks, that require significant processing capacity, method of instructional presentation is critical

# **Interaction between format of instruction and task complexity**

- Task complexity is also dependant on a person's prior knowledge and schemas. What is intellectually complex and cognitively demanding for one user, may be simple for another more experienced user.
- When presenting information to people you need to take into account:
  - The complexity of the materials
  - The users' level of knowledge
  - The format in which the information is structured

# List of cognitive load effects

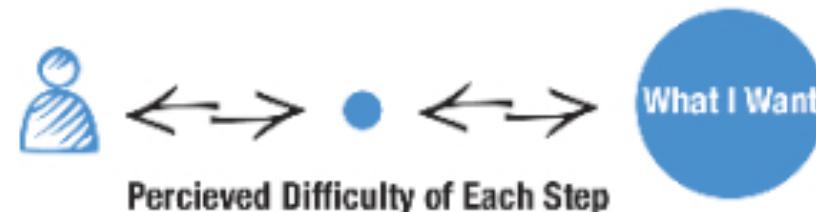
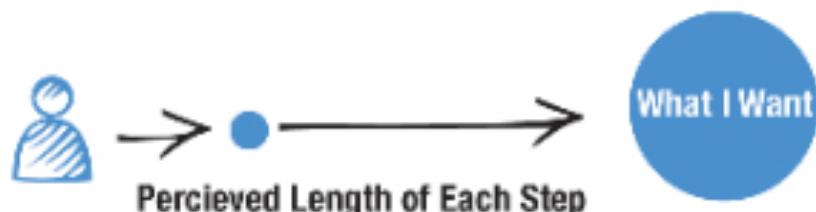
- Goal free effect - (Owen & Sweller, 1985)
- Worked example effect - (Cooper & Sweller, 1987)
- Completion effect - (Paas & Van Merrinboer, 1994)
- Split attention effect - (Tarmizi & Sweller, 1988)
- Redundancy effect - (Chandler & Sweller, 1996)
- Modality effect - (Mayer & Moreno, 1998)
- Imagination effect - (Ginns, Chandler & Sweller, 2003)
- Element interactivity effect - (Marcus, Cooper & Sweller, 1996)
- Guidance fading effect - (Renkl, 1997)
- Expertise reversal effect - (Kalyuga, Chandler & Sweller, 1998)
- Animation effect – (Wong, Marcus, et al, 2009)
- Transient information effect – (Wong, Leahy, Marcus & Sweller, 2012)
- Human Movement effect – (Paas & Sweller, 2012)

# Summary of CLT

- Cognitive load theory can thus be used to help us design more user friendly interfaces that take into account our limited processing capacity. In particular, for novice users of systems that contain information that is intellectually complex, information should be structured to eliminate any extraneous cognitive activities, that place an unnecessary burden on our limited WM
  - eg. avoid splitting attention, unnecessary search, eliminate redundancy, use diagrams etc...

# Cognitive Load Theory in UX

## Cognitive Barriers



## & Cognitive Load



Number of Choices I Have



Amount of Thought Required



Confusion & Choice

# Linking heuristics to cognitive load theory

- These rules of thumb are very useful ways of improving the design of systems.
- They work because ultimately they reduce the load on our limited working memories -> they make information easier to process and make sense of.

# Visibility of system status

- *Always keep the users informed about what is going on, through providing appropriate feedback within reasonable time.*
- Effective and useful feedback increases the chances that users will learn from their mistakes, easily learn how to use the system and integrate new knowledge into their existing schemas.
- *CLT Link:* It also reduces the need for users to search for information. Search uses up cognitive resources and so results in less resources available for other cognitive activities such as learning and understanding.

# Visibility of system status

- Examples:
  - Choices not visible until you scroll over the options

See

- <http://www.webpagesthatsuck.tv/saturn/saturn.html>

(Brown University with mystery meat options)

- <https://www.youtube.com/watch?v=aQoM5qkfCJ8>

# Visibility of System Status - website

No time to

The screenshot shows a search results page for "Bike & Bite" in Paris. The left sidebar lists the event details: "Paris · Bike and taste pace.", "Food & drink experier Hosted by Leo, Anto," with icons for "3 hours total", "1 meal", and "Offered in English". The main content area displays a list of available dates:

- Tue, Jun 6**: Only 2 spots left. [Choose date](#)
- Wed, Jun 7**: Only 1 spot left. [Choose date](#)
- Thu, Jun 8**: [See schedule](#) [Choose date](#)
- Fri, Jun 9**: [Choose date](#)

A large image of people on bicycles is visible on the right side of the page.

Image Credit: <https://medium.com/@elizabeth.nicholas.14/10-examples-of-great-usability-on-airbnb-e47d2ebd0111>

# Match between the system and real world

- *Speak the users' language, using words, phrases and concepts familiar to the user, rather than system oriented terms.*
- *CLT Link:* Designing a system that uses familiar terminology and concepts, allows people to apply their prior knowledge and schemas to the task at hand.
- The system is easier to use, as the information is presented in a manner that is more familiar to the users.

# Match between the system and real world

- Example: Finding a bus timetable on <http://www.transportnsw.info/>
  - Information is listed by route number only, but users may rather know the suburbs they want to travel to.
- In trip planner
  - Can now search using destination, and offers choices for easier search (using recognition)
  - Can also use map to select locations
  - Decreasing search places less burden on WM.

# Match between system and real world – website: AirBnb experience section

FOR YOU    HOMES    EXPERIENCES    PLACES

Categories ^

- Arts & culture
- Entertainment & activities
- Shopping
- Wellness
- Drinks & nightlife
- Food scene
- Parks & nature
- Sightseeing

Cancel

Apply

GUIDE  
**CRAFT BEER**

By Thomas Galvin  
Brewmaster

GUIDE  
**RESTAURANTS  
FOR FAMILIES**

By Joy Cho Founder, Oh  
Joy

GUIDE  
**ALL THINGS  
DRAG**

By Courtney Act Drag  
performer



By Tina Ross



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# Match between the system and real world

- Which is the word that represents the degree you're taking and which is the word that represents the classes that make up the degree?
- UNSW: *programs & courses*  
USyd: *courses & subjects*
- What's the difference between programs & courses, courses & subjects?
- Be careful with jargon, as people very quickly get confused when you give them the same words that mean slightly different things.

# Match between system and the real world - website



The screenshot shows the Facebook login page. At the top, there's a blue header with the word "facebook" in white. Below it, a large white area features a world map with orange user icons connected by dashed lines, symbolizing global connectivity. To the left of the map, the text "Facebook helps you connect and share with the people in your life." is displayed. On the right side, there's a "Sign Up" form with fields for First Name, Last Name, Your Email, Re-enter Email, New Password, and a dropdown for Sex. There are also dropdowns for Month, Day, and Year, and a link for "Why do I need to provide my birthday?". A green "Sign Up" button is at the bottom of the form. Below the form, a link says "Create a Page for a celebrity, band or business." At the very bottom of the page, there are language links: English (US), Español, Português (Brasil), Français (France), Deutsch, Italiano, हिन्दी, 中文(简体), 日本語, ..., and a copyright notice: Facebook © 2012 · English (US). The rest of the page is cut off by a yellow bar.

# Match between system and the real world

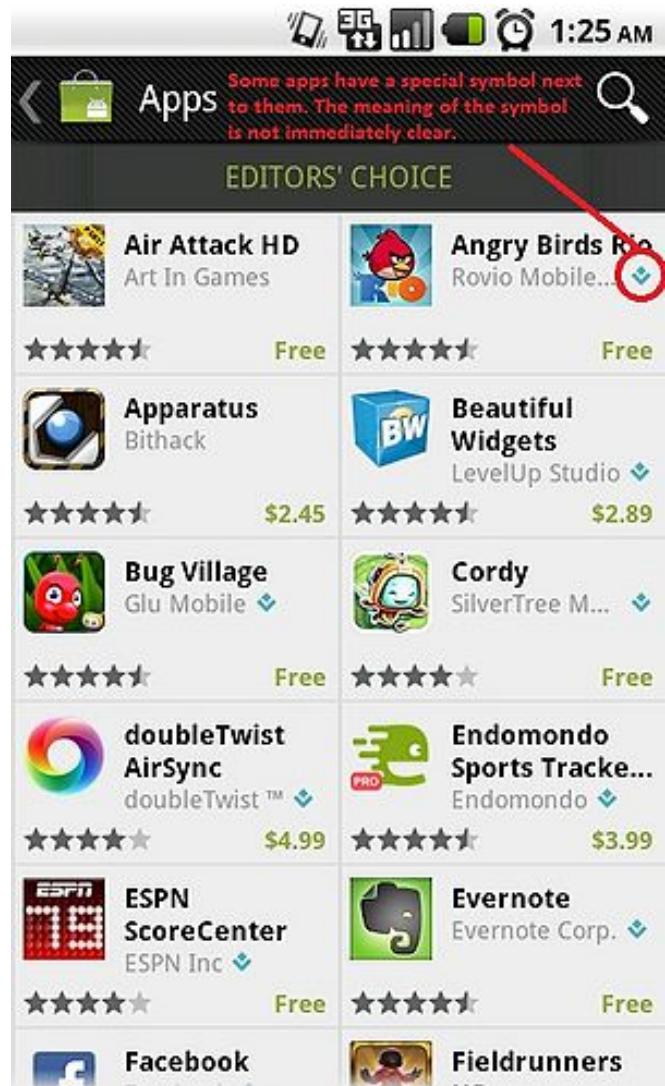
- icons on Facebook/Button Colours and placement



CONFIRM

CANCEL

# Match between the system and real world



What is this icon?

# User control and freedom

- *Provide ways of allowing users to easily escape from places they unexpectedly find themselves, by using clearly marked ‘emergency exits’*
- *CLT Link:* By allowing users to be in control, their cognitive resources can be focused on what they are interested in achieving.
- Be aware, though, that giving users too many ways to do the same thing leads to redundancy, and should be avoided.

# User Control and Freedom

The image displays three separate Twitter profiles for the same user, Oprah Winfrey (@Oprah), to demonstrate how users can have different levels of control over their accounts. Each profile shows a different state of the 'Following' relationship with another user.

**Profile 1 (Left):** Shows a standard Twitter interface. The user has 2,385 tweets and follows 44 accounts. A blue 'Follow' button is visible. The bio reads: "Live Your Best Life Chicago, IL - http://www.oprah.com". It is followed by "The Cut, InStyle" and others.

**Profile 2 (Middle):** Shows the user is currently following the account. The 'Follow' button is now blue and labeled "Following". The bio remains the same. It is followed by "The Cut, InStyle" and others.

**Profile 3 (Right):** Shows the user has unfollowed the account. The 'Follow' button is now red and labeled "Unfollow". The bio remains the same. It is followed by "The Cut, InStyle" and "Noah Everett".

Image Credit: [http://jux.io/wp-content/uploads/2015/10/who\\_oprah\\_combined.png](http://jux.io/wp-content/uploads/2015/10/who_oprah_combined.png)

# User control and freedom

- Do not force users to go to redundant web pages, to get where they want to.
  - <http://www.unsw.edu.au/> ->Timetables
- Need to make sure the user can get back to where they were easily
  - e.g. For transport you go to  
<http://www.facilities.unsw.edu.au/getting-un>

Then try to find transport under  
<http://www.unsw.edu.au>

# User control and freedom

- Examples:
  - PDFs need to be clearly marked; don't let the user open a (potentially large) file without warning



## UNSW TRANSPORT

- [Buses](#)
- [COFA Shuttle Bus](#)
- [Cycling](#)
- [Accessible Routes](#)
- [News](#)
- [Security Shuttle Bus](#)
- [Staff Myzone \(Travelpass\)](#)
- [Trains](#)
- [Transport Links](#)
- [Academic Calendar](#)

[UNSW Home](#) > UNSW Transport

## UNSW Transport

### Transport Information

Get an overview of the key transport routes to and around UNSW.

[\[more\]](#)

Information and timetables are available from:

- FM Assist
- Arc Shops
- Sydney Transport Tel: +61 2 131500 or [www.131500.com.au](http://www.131500.com.au)

### Which ticket do I need?

MyZone makes travelling on public transport easier and covers services provided by CityRail, Sydney Buses, Newcastle Buses, Sydney Ferries and private bus operators.

All MyZone information is available on this site:

<http://www.131500.com.au/tickets/fares/myzone>

### Travel concessions for international students

The NSW Government has not approved travel concessions for international students. You must purchase an appropriate adult ticket to avoid penalties.

### Taxis

UNSW has a direct line to a taxi company from the help point at Gate 14 (Barker Street). For contact details for other taxi companies click [here](#). [\[more\]](#)

### Green Square Bus Service to UNSW

The trial Green Square bus service from Green Square Station to UNSW will not operate in 2012. A request to NSW Transport for consideration of additional morning services and improvement of existing services from Green Square Station to UNSW has been submitted.

Sydney Buses currently operate the 370 bus service from Green Square Station to UNSW via High Street.



**BEAT THE CROWDS TO UNSW**

[\[find out more\]](#)



[\[find out more\]](#)

UNSW TRANSPORT

Buses

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Cycling

Disabled Access

News

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Trains

Transport Links

Academic Calendar

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## UNSW Transport

### Metrobus 10 to UNSW

There is an easier way to get to UNSW from the City and NO CROWDS! The Metrobus 10 is a Prepay only service which runs every 10 minutes during peak periods and every 15 minutes during off peak times. Metrobus takes 20 minutes from Town Hall to UNSW.

#### *Where to catch the Metrobus to UNSW*

- Broadway - Parramatta Road
- Railway Square - Quay Street
- Town Hall Station - George Street
- Museum Station - Liverpool Street
- Taylor Square - Corner Liverpool Street and Flinders Street
- Albion Street - COFA
- From UNSW - Anzac Parade

For further information on the Metrobus service visit <http://www.sydneybuses.info/metrobus.htm>

---

### NEW Route 348 Bondi Junction - Wollie Creek via UNSW

Effective Monday 27 April 2009 this Monday to Friday daytime service will operate between Bondi Junction, Randwick Junction, UNSW, Alexandria and Wollie Creek Railway Station. A map of this new service is available [here](#).

For further information visit [www.sydneybuses.info](http://www.sydneybuses.info) or call 131500

---

### Free Staff Express Bus Trial from Redfern Station to UNSW

Following recent feedback from staff and students, the University has been considering some options to alleviate the current demand for the Monday - Friday 891 bus service from Eddy Avenue (Central Station) to UNSW.

From Monday 23 March the Vice-Chancellor has arranged for Telford's Tours (a private bus company), to transport staff from the Redfern Station direct to the UNSW campus.

From 15th June the new timetable will be introduced to meet passenger demands and numbers. Bus timetable is as follows:

#### Timetable

Monday to Friday mornings only  
7.40am (first bus)



**UNSW**  
AUSTRALIA

2011

# User control and freedom

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1 CONDITION      2 PRICE/FULFILMENT      3 CONFIRM AND COMPLETE

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Product Information		<b>Edit</b>
<b>Product Name:</b>	The Fifth Elephant (Discworld)	
<b>ASIN:</b>	0552147206	
<b>Condition:</b>	Used - Very Good	
<b>Condition Note:</b>	extremely good condition, only listened to once.	
<b>Your price:</b>	£1.90	
<b>Quantity:</b>	1	
<b>Your shipping methods:</b>	Domestic Only	
<b>Amazon.co.uk's Fees (if sold):</b>	£1.47 for Domestic Only *	
<b>Postage charge to buyer on your behalf (if sold):</b>	£2.75 for Domestic Only *	
<b>VAT on Amazon.co.uk's fees:</b>	£0.21 for Domestic Only *	
<b>Total you will receive (if sold):</b>	£2.97 for Domestic Only *	
(Read Amazon.co.uk's <a href="#">Fees &amp; Pricing guidelines</a> and <a href="#">Postage Credits &amp; Delivery policy</a> )		
* - Actual amounts may differ, depending on the final delivery address.		

**Submit your listing**  
(You can always add information later)

How to cancel listing?

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2011

# Consistency and standards

- *Avoid making users wonder whether different words, situations or actions mean the same thing.*
- *CLT Link:* Once people become familiar with the layout, colours and so on, it makes it easier to find information. Consistency allows the users to more easily acquire schemas of where to find things and how to do things.

# Consistency

amazon.com.au All

Hello, Alexandra Account & Lists Returns & Orders Try Prime Cart

firetv stick | \$69

Sale on Alexa devices

echo dot \$79-\$49 echo show \$129-\$99 All-new echo \$149-\$119 echo show \$349-\$299

Hi, Alexandra Customer since 2019

Top links for you

- Your Orders
- Electronics
- Kitchen & Dining
- Health & Household

Recently viewed

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FROM THE WORLD OF JASON BOURNE TREADSTONE AMAZON ORIGINAL

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Ad feedback

Looking for a gift?

Find personalised gift ideas and surprise someone you love

Check out the Gift Finder

Tue, Jan 07

See your browsing history

Optus 4G 13:35 78% amazon.com.au

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amazon.com.au

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Select devices only. Offers end 29/01/2020.

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# Old Engineering & Medicine@UNSW

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**Micro-flight team hits new heights**

The team of Mechanical and Manufacturing Engineering's MAVSTAR unmanned air and ground micro-vehicle team has proven itself to be a world-class outfit by securing a major award – and a chance of research funding from the US Army – against tough international competition. MAVSTAR (for Micro Aerial Vehicles for Search, Tracking and Reconnaissance) – a team of staff, postgraduate and undergraduate students – took part in MAV08, the first US-Asian Demonstration and Assessment of Micro-Aerial and Unmanned Ground Vehicle Technology, in Agra, India, earlier this year. [More...](#)

**Day for good sports**

Aspiring engineers took time out from designing the future to showcase their soccer abilities at the recent UNSW Engineering Sports Day – a welcome return for the event, which has not been held for some years. [More...](#)

**Nuclear partnership boosts eco research**

UNSW's School of Civil and Environmental Engineering, in the Faculty of Engineering, has formed a partnership with the Australian Nuclear Science and Technology Organisation (ANSTO) to tackle major environmental degradation challenges. [More...](#)

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- Postgraduate Coursework Programs
- Postgraduate Research Programs
- International Students
- Scholarships
- Engineering Student Centre
- Industry & Research Partnerships
- Information for Staff
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**Latest Video**

**BionicEye by 2020**

A working bionic eye could be an Australian work of art by 2020 if action is taken quickly, leading researchers at the University of New South Wales say.

[More Engineering and Technology Videos on UNSW YouTube](#)

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**mSAP** Medical Students' Aid Project

**LATEST NEWS & EVENTS**

**Happy and healthy ageing: paradox or possibility?**

2011 Medicine Dean's Lecture  
17 October 2011 [Find out more](#)

**Exercise the body, build the brain**  
"exercise is a cheap and simple lifestyle intervention" says leading neuroscientist, Dr Henriette van Praag [+full story](#)

**Managers have bigger brains**  
Mental demands of managing boosts hippocampus size, reveals Dr Michael Valenzuela, at the Brain Sciences UNSW symposium Brain Plasticity—The Adaptable Brain. [+full story](#)

**Wallace Wurth re-development**

Due for completion March 2014 [Find out more](#)

THE UNIVERSITY OF NEW SOUTH WALES • SYDNEY • AUSTRALIA

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**What's Happening:** Alumni Newsletter [New Ad](#) | **Seminars:** **23/7/2008** "Work and Care in Lone-Mother Families: A Family-Work Project (Professor Jane Millar and Dr Tess Ridge) **25/7/2008** "2008 Seminar Series "Gamer Theory (McKenzie Wark) [More Ad](#)

**New Ad** | **Bachelor of Social Science UNSW Review 2008**

**Bob Carr**  
August 14, 2008

**McKenzie Wark**  
**Gamer Theory**  
July 25, 2008  
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**Numbers high at Indigenous Winter School**  
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**Cindy Blackstock**  
**Indigenous Knowledge**  
August 20, 2008  
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Authorised by Dean, Faculty of Arts & Social Sciences, ©Copyright July 22, 2008>May 22, 2008



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FEAS WIEC Open Day 2012 Student Service Awards 2012 Taste of Research Elite Students

**UNSW Women in Engineering Camp**  
Monday 14 to Friday 18 January 2013  
Do you want your career to be at the forefront of positive change for society?  
Applications close Sunday 30 September 2012.

Find out more >

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**Open Day 2011**  
2011 UNSW Open Day Highlights - discover what it's like to be an engineering student at UNSW and part of our vibrant student community. Open Day is your chance to see the University up close... [See More News »](#)

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Elective Term Enrolment Information 2012 General Education BSc (Med) Honours ILP  
"MAKING a difference to developing world health"

**LATEST NEWS & EVENTS**

**Open Day**  
Saturday 1 September 9 - 4pm  


**New hope for trauma sufferers with addiction**  
An Australian study shows for the first time that people with substance use issues, who are frequently excluded from treatment for post-traumatic stress, can benefit from psychological therapy.  
<more>

**Deep brain stimulation powerful in treating Tourette's**  
Ten out of 11 patients with severe Tourette's Syndrome have reported improvement after receiving deep brain stimulation surgery. UNSW research shows. <more>

**From MBBS to MD: changing the UNSW degree**  
Follow the progress of these proposed changes <more>

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**Open Day 2012**  
UNSW Open Day is your chance to see the University up close, meet the lecturers and chat to current students. Have your questions answered and find the right information to help you choose your ideal degree at UNSW  
[Open Day 2012](#)

**Our highest honour**  
**Age Discrimination Commissioner Susan Ryan and Indigenous leader Professor Patrick Dodson** have been awarded honorary doctorates from the UNSW Faculty of Arts and Social Sciences in recognition of their eminent service to the community.  
**Susan Ryan**, who was presented with an Honorary Doctorate of Letters, served in senior portfolios in the Hawke Government, where she was the first woman to hold a Cabinet post. A committed...  
[Our highest honour](#)

**News**  
**Our highest honour**  
Posted: 21st August  
Digital future or race to the bottom? What journalists really think  
Posted: 20th August  
FASS students help out with assessment project  
Posted: 18th August  
**Postgraduate Research Scholarship Opportunities**  
Posted: 20th June  
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2012

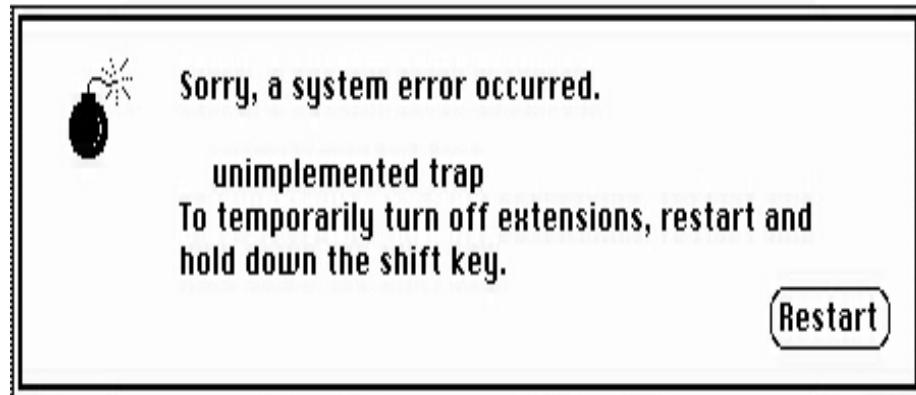


# Help users recognize, diagnose and recover from errors

- *Use plain language to describe the nature of the problem and suggest a way of solving it.*
- *CLT Link:* Effective and useful feedback increases the chances that users will learn from their mistakes and integrate new knowledge into their existing schemas.
- Familiar language increases the chance the users will understand the information.

# Help users recognize, diagnose and recover from errors

- Example of a vague error message using unfamiliar language.



A screenshot of a search interface for "DEX". The top navigation bar includes links for BUSINESS, RESIDENTIAL, GOVERNMENT, and ADVERTISE WITH DEX. The main search area is titled "Basic Search | My last ten searches". A red error message states: "There is no value for the required value state." Below this, step 1 instructions say: "Enter the person's last name or last name & first name:" with input fields for "Last" (containing "smith") and "First" (containing "christian"). There is also a checkbox for "Check this box to find similar names (Example: Bob & Robert)". Step 2 instructions say: "Select a Location:" with input fields for "City" (containing "Provo") and "State" (with a dropdown menu labeled "Select State"). A checkbox for "Check this box to include surrounding area" is checked. At the bottom is a yellow "SEARCH THE LISTINGS" button.

# Help users recognize, diagnose and recover from errors

Microsoft®  
Outlook Web App

Change Password  
Your password has expired and you need to change it before you sign in to Outlook Web App.

E-mail address:

Current password:

New password:

Confirm new password:

**Submit**

The password you entered doesn't meet the minimum security requirements.

Connected to Microsoft Exchange  
© 2010 Microsoft Corporation. All rights reserved.

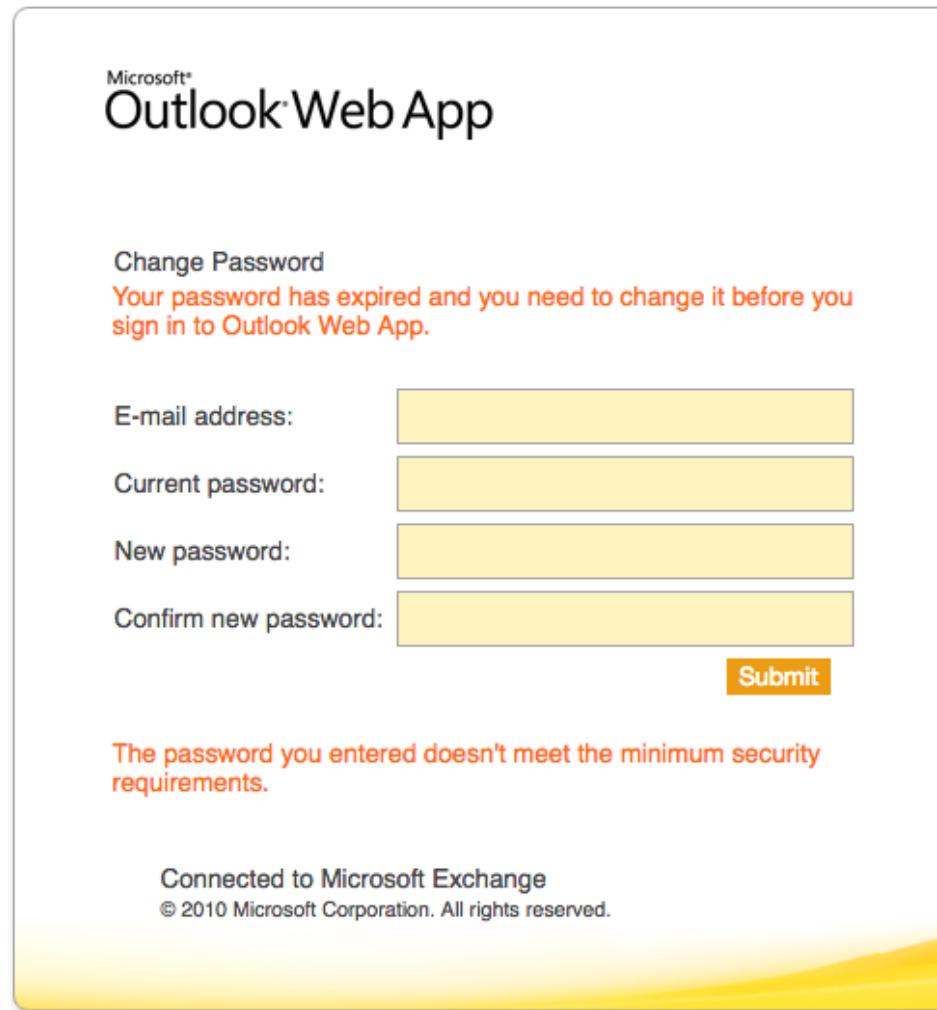
A screenshot of the Microsoft Outlook Web App Change Password page. The page title is "Microsoft® Outlook Web App". Below it, a heading says "Change Password" and a message states "Your password has expired and you need to change it before you sign in to Outlook Web App.". There are four input fields: "E-mail address:", "Current password:", "New password:", and "Confirm new password:". Below the "New password:" field, an error message in red text reads "The password you entered doesn't meet the minimum security requirements.". At the bottom, a note says "Connected to Microsoft Exchange" and "© 2010 Microsoft Corporation. All rights reserved.".

Image Credit: <https://bornoe.org/blog/2016/05/help-users-recognize-diagnose-and-recover-from-errors/outlook-password-change/>

# Error prevention

- *Where possible prevent errors occurring in the first place.*
- *CLT Link:* When a user makes an error, cognitive resources are devoted to fixing and understanding the problem rather than the task at hand. If errors can be avoided, cognitive resources can be focused on the task. This will also lead to faster learning.

# Error Prevention

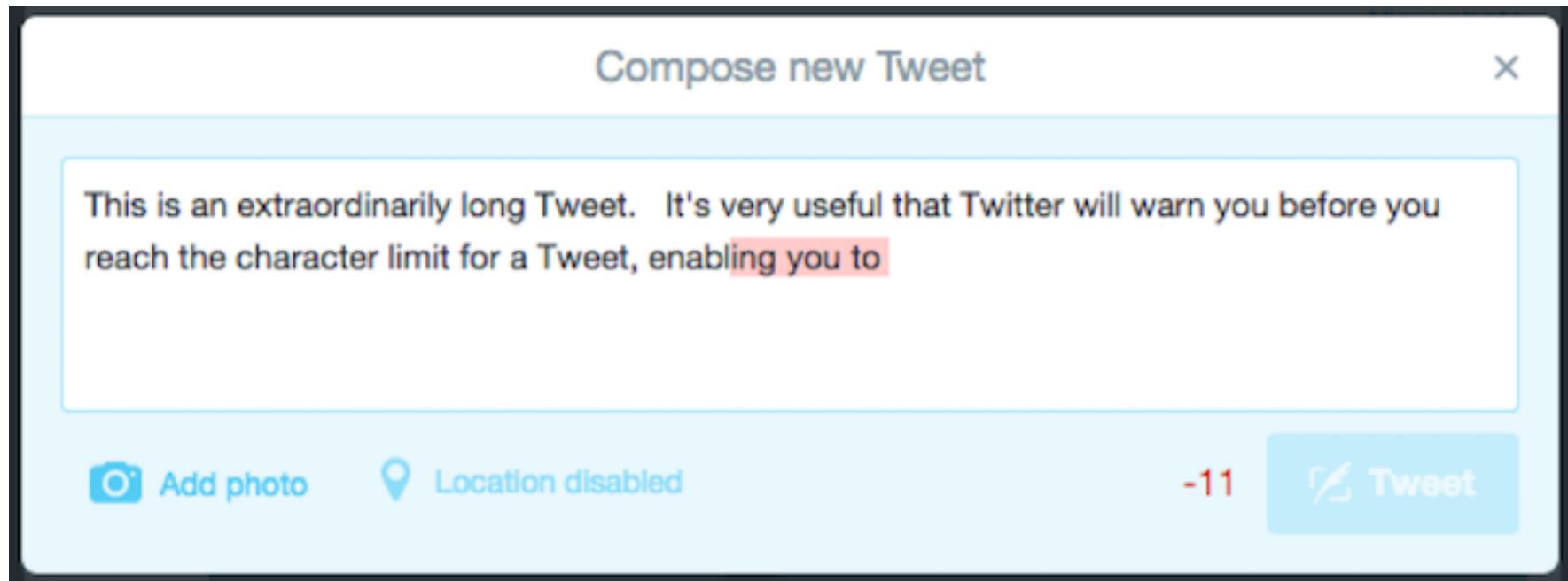


Image Credit: <https://www.nngroup.com/articles/user-mistakes/>

# Error prevention

- Example: Avoid confusing and redundant links.
  - Action of apply online button, UNSW
    - Used to be an icon in some places, and a link in others, but looked the same.
- Use consistency and standards



# Error Preventions

- Liste Rouge Paris shirts

## NEW CUSTOMER

- **Give us your measurements**

Take or ask someone to help take your measurements, by following our easy instructions . It takes just 5 minutes!



- **Send us your best fitting shirt\* (go directly to cart)**

If you prefer not to take measurements, you can mail us your best fitting shirt. Our Master Tailor will take the necessary measurements and will return your shirt along with your order.



\* : Your shirt will be used for measurements only. We will not copy it.

- **Visit our NYC showroom (go directly to cart)**

Contact us at [contact@listerouge-paris.com](mailto:contact@listerouge-paris.com) to plan a private appointment at our New York showroom (Madison Ave & 40th St.).



## EXISTING CUSTOMER

- **Your measurements are on file (go directly to cart)**

If your last order fits perfectly, we will make the new shirts with exactly the same measurements.

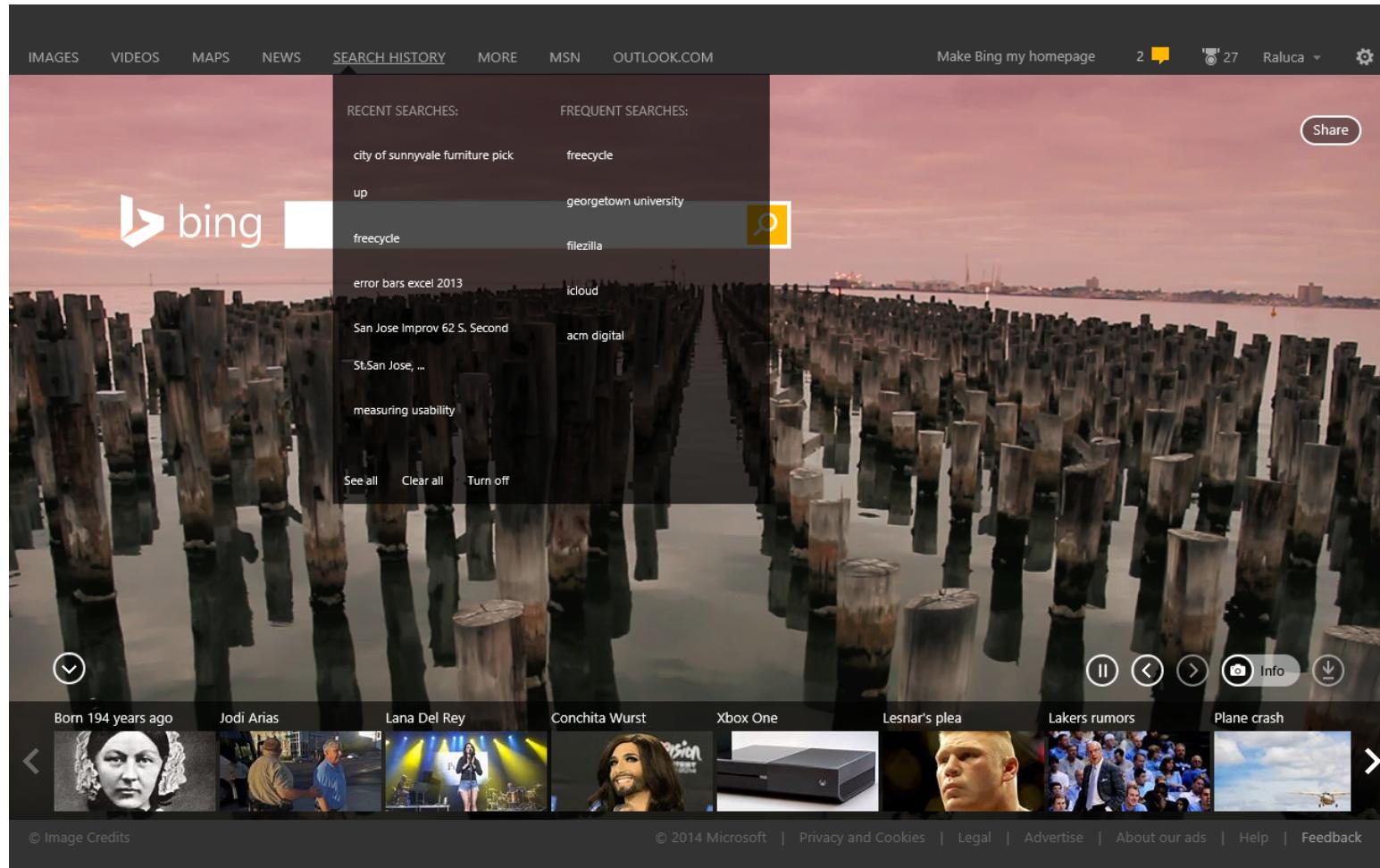
- **If your measurements have changed**

Simply note your measurements changes compared to your previous shirts.

# Recognition rather than recall

- *Make objects, actions and options visible.*
- *CLT Link:* If there is less information to remember, this reduces the burden on our limited WM. This, in turn, reduces the chances of errors and makes the system easier to use.

# Recognition rather than recall



- Bing gives a link to your search history

# Recognition rather than recall

The screenshot shows a web browser window with the Airbnb homepage. The search bar at the top has "Nairobi, Kenya" entered. Below the search bar, there's a "FOR YOU" section with a "Just" heading. Under "Just", there are two items: "Temecula, CA, United States" and "Santa Monica, CA, United States". Further down, under "United States", there are two more items: "cuba" and a photo of three people walking on a street. Below these are two experience cards: "\$52 Local vibe & narrow streets" (44 reviews) and "\$25 Guided walk to the top of the Hollywood Sign" (195 reviews). To the right of these cards are four more experience cards: "\$42 Learn to cook your first paella" (76 reviews), "\$63 Cruise through secret gardens and unique cafés" (128 reviews), and "\$65 Walk, talk, and create with a legend of the wall" (49 reviews). At the bottom, there's a section titled "Experiences" with six cards: "TOMAS JAZZ HANDS", "Timeless Classics", a woman working at a desk, a cityscape view, and "CAPTAIN DEO". A "See all >" link is located above the last two cards.

Image Credit: <https://medium.com/@elizabeth.nicholas.14/10-examples-of-great-usability-on-airbnb-e47d2ebd0111>

# Flexibility and efficiency of use

- *Provide accelerators that are invisible to novice users, but allow more experienced users to carry out tasks more efficiently.*
- *CLT Link:* Accelerators would require extra processing capacity for novices who are still learning to use the system, so it is good to make them invisible.
- In contrast, accelerators/macros/short-cuts allow experts to more easily automate basic functions and thus work more effectively and efficiently.

# Flexibility and efficiency of use

- Examples:
  - Microsoft products, such as Powerpoint, allow users to customise layout, create preferences and macros.
  - Cut and paste using the menus vs. keyboard shortcuts (ctrl-c, ctrl-v)

# Aesthetic and minimalist design

- *Avoid using information that is irrelevant or rarely needed*
- *CLT Link:* If information is well laid out and easy to read, this reduces the amount of search needed to find relevant things. Searching uses up WM capacity, and leaves less resources available for understanding and learning.
- Eliminate redundant information, as processing it uses up cognitive resources.

# Aesthetic and minimalist design

- Examples:
  - Too many graphics, too many flashing ads, poor layout, too much information on a single page
    - [www.smh.com.au](http://www.smh.com.au) vs
    - <http://www.abc.net.au/news/>
  - Good use of aesthetics with only important information included
    - <http://www.rosevillecinemas.com.au/>  
VS.
  - Lots of flashing animations, no basic movie descriptions, workflow not well supported
    - <http://www.eventcinemas.com.au/Movies> (been updated a bit now)
  - Don't force users to fill in lots of forms (Sydney transport site used to do this, but improved now)

# ABC news vs. SMH news

**ABC News**

News Home Just In Local World Business Entertainment Sport The Drum Weather More In Depth Programs My Topics

World

Top Stories

**'Execution style'**  
The Syrian army has been accused of mass summary executions after more than 200 bodies were found in a suburb of Damascus.

**Refinery blast**  
The largest oil refinery in Venezuela has been rocked by a massive explosion that killed at least 26 people and injured dozens more.

**New chapter**  
Survivors of Anders Behring Breivik's massacres say they hope they can finally put their year of "hell" behind them.

**Apple triumphs**  
Apple wins more than \$1 billion in a massive US court victory over Samsung - a verdict that could have huge market repercussions.

**More Stories**

- Philippines to cut deployment of maids overseas
- Aussie diggers return to Milne Bay
- Typhoon Bolaven bears down on southern Japan
- Dozens killed in China road accident
- Crash inferno kills dozens in China
- Tiger mauls zookeeper to death
- Fresco a drawcard after botched restoration

**Humble daredevil**

Neil Armstrong, who placed mankind's first footprint on an extraterrestrial world and became an instant hero, has died at the age of 82 after undergoing heart-bypass surgery.

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- Gaffes aside, Romney still a chance at winning
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Russian punks without a praver, 33 Charles Waterstreet

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Today's News Video: Aussie Paralympians Hot Topics Julian Assange | Swans | Hakoah bombing Search here... Search

**Mega Shark vs Giant Octopus** Prehistoric sea creatures battle each other for supremacy. MOVIES ON SMH.TV

**Scent of spring** Spring is well and truly in the air at Sydney's Royal Botanic Gardens. SPRING WALK

**200 MPH** A young amateur racer is plunged into the harrowing world of illegal street racing. MOVIES ON SMH.TV

**'Mugged by the truth'** Wayne Swan says Tony Abbott torpedoed his own scare campaign over claims of the impact of the carbon tax.

**Neil Armstrong 'an American hero'** The man who became a global hero when he stepped on to the moon, dies aged 82. 188 | Poll

**Crash victims 'lucid and happy'** Hours before four young people were killed in a fiery crash, their car was stopped by police.

**Cash thrown out of car during chase** Man threw bundles of cash out of car window while being chased by police in Sydney's west.

**Assange actions 'not a crime'** Ecuador's president says allegations against Julian Assange would not be crimes in other countries.

- At 4, he's a pack-a-day happy customer
- Fares to nose dive as Qantas gambles
- US woman, 49, gives birth to grandson
- Bomber hunt back on after 30 years

GO BACK TO WHERE YOU CAME FROM

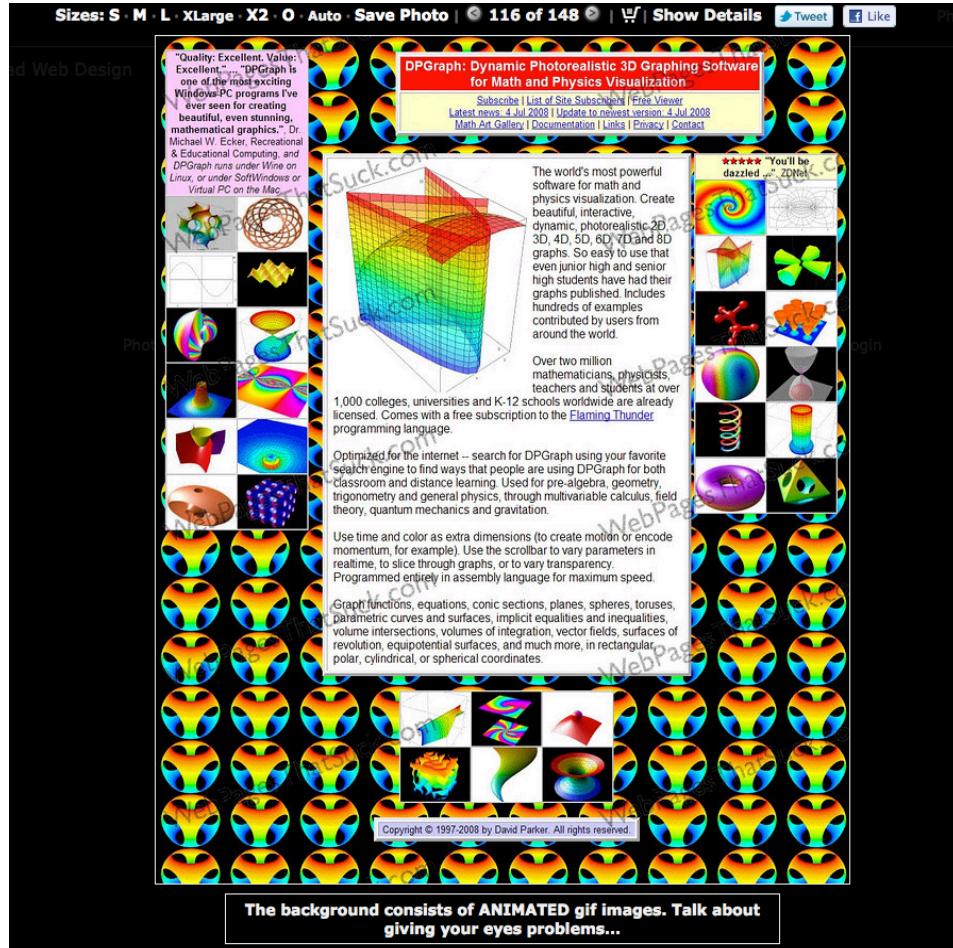
FOLLOW: [Twitter](#) [Facebook](#) [YouTube](#)

ROLL OVER TO EXPAND

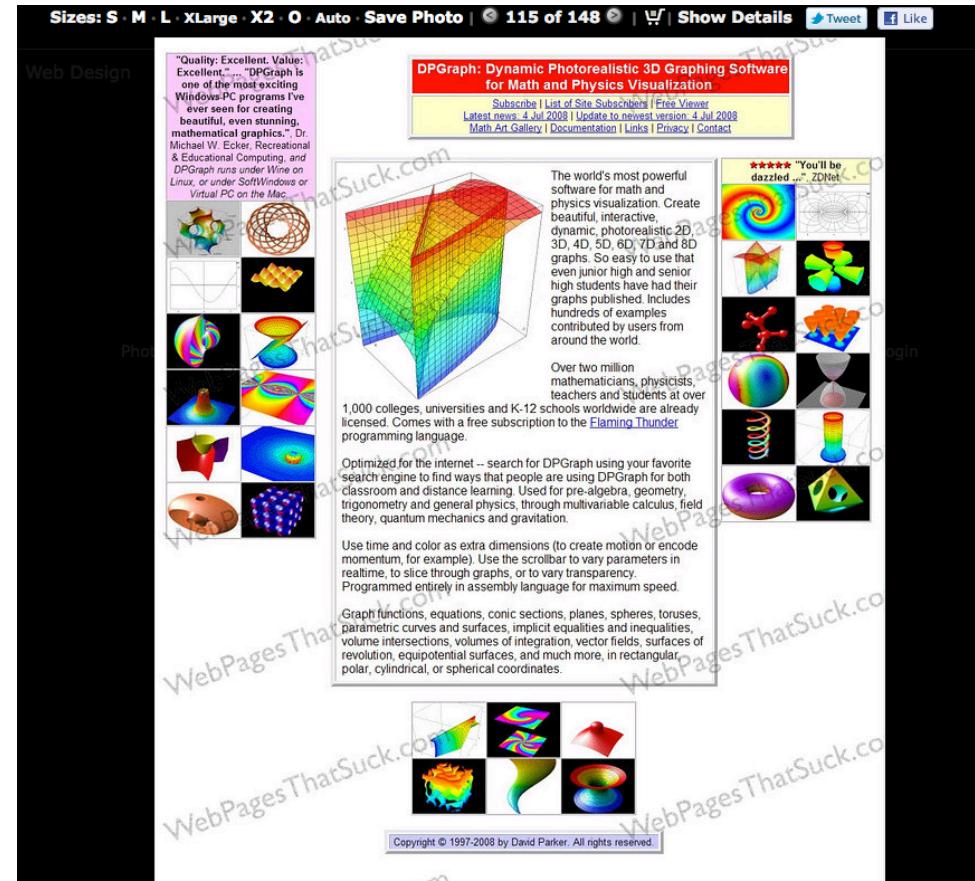
# Roseville cinema vs Event cinema

The screenshot shows the homepage of Roseville Cinemas. The main navigation bar includes links for HOME, ABOUT, TICKETING, BOOKINGS, FAQ, and CONTACT. A sidebar on the left lists movies like 'The Best Offer', 'What Maisie Knew', and 'Blue Jasmine'. The main content area features a large image of two men in sunglasses sitting by a pool, with a play button overlay. Below this, a banner for 'Now Showing: Behind the Candelabra' is displayed, along with other movie thumbnails for 'The Best Offer' and 'What Maisie Knew'. Social media links for Facebook and Twitter are at the bottom.

The screenshot shows the homepage of Event Cinemas. The top navigation bar includes links for 'When would you like to see it?', 'Where would you like to go?', 'What would you like to see?', 'FIND TIMES AND BOOK', 'cinebuzz', 'SIGN UP | LOGIN', and 'Hornsby'. The main content area features a search bar and a sidebar with links for 'Movies', 'Cinemas', 'Advanced Tickets', 'Alternate Content', 'Premium Cinema', 'Events & Promotions', and 'Member Programs'. The main banner highlights 'Alternate Content' with images of Pompeii ruins and a woman in a white dress. Other sections include 'Pompeii from the British Museum' (7 & 8 SEPTEMBER), 'Matthew Bourne's SLEEPING BEAUTY A GOthic ROMANCE' (7 & 8 SEPT 3PM), and 'DEF LEPPARD' (MON 16TH SEPT - 7PM, SELECT LOCATIONS ONLY). An orange button on the right says 'ENCORE SCREENINGS BY POPULAR DEMAND!'.



This background is much too busy



All this site had to do was remove its ANIMATED images from the background to make the web site 500% better.

A plain background makes a huge difference!

# Text color, formatting, menu and image obscuring text.



**UNSW**  
AUSTRALIA

# Help and documentation

- *Provide information that can be easily searched and provide help in a set of concrete steps that can easily be followed.*
- *CLT Link:* Help and documentation that is easy to use, understand and locate makes it easier to learn how to use the system. Information that is easier to learn, uses up less cognitive resources.
- Make sure the help system provides meaningful headings and cues to locate relevant information.

# Help and documentation

- However, there is a caveat to all of this - only develop help systems if the application needs it!
  - How NOT to use help and documentation:  
[www.smh.com.au/saturn](http://www.smh.com.au/saturn)
  - Gets out of date too quick and still there

## Cleaner style

- A quick snapshot of the weather, click on the weather icon to dig deeper

## More video

- Video covering news, sport, business, entertainment, technology, travel and Life & Style

## More time out

- Find out all the "water cooler" stories - the ones you will want to tell your friends about

## More business information

- More business stories, charts and market information
- A quick and easy way to delve into Small Business, Money Manager and our other business sections

The screenshot shows the smh.com.au homepage with a clean design. At the top, there's a weather forecast for Sydney (Now: 15°C, Max: 29°C, Sunny) with a sun icon. Below it is the main navigation bar with links like NEWS, MY CAREER, DOMAIN, DRIVE, FINANCE, MOBILE, RSVP, STAY, MEMBER CENTRE, LOG IN, and REGISTER. A 'SPECIAL OFFER NOW ON' banner for Citibank is visible. The main content area features a large image of Queen Elizabeth II. Below it are several news stories: 'Man quizzed over Maddie' (6:10am), 'Danger station right off the rails' (Jordan Baker | Town Hall station, one of Sydney's busiest, is accident-prone.), 'Man to plead guilty' (Janet Gibson | Entertainer Matthew Newton will plead guilty to assaulting Brooke Satchwell.), 'Aussie drag racer sued' (Tray Critchley is being sued by the father of one of six people killed when he crashed into a crowd.), 'Breaking news' (4:21pm: Sudan's presidential adviser dies; 4:26pm: Retail Food Group extends Brumby offer; 4:27pm: One Nation in NSW dumps Pauline Hanson), and 'National' news about US soldiers kidnapped by al-Qaeda. There are also sections for 'World', 'Business Day', and 'Life & style'. A prominent advertisement for Citibank offers a 2.9% p.a. balance transfer for 12 months.

## Opinion leaders

- Our bloggers and columnists

## Simpler navigation

- Quick links that show you the breadth of our site
- New feature "show site sections", so you can find the sections you love in just one click

## What's on in Sydney

- Get the latest bar, restaurant, TV, movie and arts reviews here
- You can also get the latest reviews on your mobile free

## Keep up-to-date

- Find out what is coming up in your paper, *The Sydney Morning Herald*

# Help and documentation

Wordy documentation  
mobile.



Your application purchases are tied to your Google Account and can be installed an unlimited amount of times on any device. So, for example, if you remove 'My Favorite Game' to save memory, you can reinstall it at a later date with no charge by simply visiting **My Apps**. Note: free applications are not saved to **My Apps** after you remove them.

If you are being asked to purchase an application you have already purchased through Android Market on an existing or previous device, you might be using a different account than the one you were using at the time you made your purchase. Because the application is associated with a different Google Account, you are being charged to



# Help and Documentation – website

Email Address  Secure  
We won't share your private email address with other Airbnb users. [Learn more.](#)

Phone Number  +1 \*\*\* \*\*\* 6035  Confirmed

[+ Add a phone number](#)

This is only shared once you have a confirmed booking with another Airbnb user. This is how we can all get in touch.

Preferred Language  English ▼  
We'll send you messages in this language.

Preferred Currency  USD ▼  
We'll show you prices in this currency.

Where You Live  e.g. Paris, France / Brooklyn, NY / Chicago, IL

Describe Yourself

Airbnb is built on relationships. Help other people get to know you.

Tell them about the things you like: What are 5 things you can't live without? Share your favorite travel destinations, books, movies, shows, music, food.

Tell them what it's like to have you as a guest or host: What's your style of traveling? Of Airbnb hosting?

Tell them about you: Do you have a life motto?

Image Credit: <https://medium.com/@elizabeth.nicholas.14/10-examples-of-great-usability-on-airbnb-e47d2ebd0111>

# Summary

- These heuristics lead to improved designs because they reduce the load on our limited working memories.
- If we understand why they work, we can more adequately apply them.
- They work because they make information easier to process and make sense of.

# Some links for poor websites

- <http://www.webpagesthatsuck.com/> (see ‘mystery meat’ navigation, under Bad Web Design menu)
  - <http://mikeroweWORKS.com> (poor navigation/user control/visibility and more)
  - <http://www.flatpakhouse.com> (mystery meat navigation)
  - Mandarin Ducks  
[https://www.youtube.com/watch?feature=player\\_detailpage&v=zZ\\_aaCYCxVQ](https://www.youtube.com/watch?feature=player_detailpage&v=zZ_aaCYCxVQ)

# Modality effect example

<http://www.youtube.com/watch?v=BpaBw5fZPzw>

# Worked example links

- Photoshop video on creating Photofilters

[http://www.youtube.com/watch?v=8M2hsbYT\\_EY&feature=user](http://www.youtube.com/watch?v=8M2hsbYT_EY&feature=user)

- good worked example where details shown and explained

- Photoshop Pen tool

<https://www.youtube.com/watch?v=AzyvN3EqYds>

- good worked example, with audio descriptions, zoom in and highlights to draw your attention

- Adobe Encore CS5 CUSTOMIZING MENUS

- customizing a menu in Photoshop

<https://www.youtube.com/watch?v=L4i2xHPO2Zg>

- worked example using sound and extra descriptions when needed

# Animations - references

- **Ayres, P., Marcus, N., Chan, C. & Qian, N. (2009).** Learning Hand Manipulative Tasks: When Instructional Animations are Superior to Equivalent Static Representations. *Computers in Human Behavior*, Vol 25(2), p 348-353.
- **Wong, A., Marcus, N., Ayres, P., Smith, L., Cooper, G., Paas, F. & Sweller, J. (2009).** Instructional Animations can be Superior to Statics when Learning Human Motor Skills. *Computers in Human Behavior*, Vol 25(2), p 339-347.
- **Wong, A., Marcus, N. & Sweller, J. (2011).** Instructional Animations: More Complex to Learn from than at First Sight? INTERACT 2011 -13th IFIP TC13 Conference on Human-Computer Interaction, Sept 7-9, Lisbon, Portugal. Proceedings in *Lecture Notes in Computer Science*, Part IV, LNCS 6949, p.552.
- **Marcus, N., Cleary, B., Wong, A., & Ayres. P. (2013).** Should hand actions be observed when learning hand motor skills from instructional animations? *Computers in Human Behavior*, Vol 29 (6), 2172-2178.

# Measuring Cognitive Load in real-time

- Other research looks at how can measure load in real-time unobtrusively, so can adjust interface to better meet users needs and not overload them.
  - Khawaji A., Chen F., Zhou J., Marcus N. (2014). 'Trust and cognitive load in the text-chat environment: the role of mouse movement', pp. 324 - 327, Proceedings of the 26th Australian Computer-Human Interaction Conference on Designing Futures: the Future of Design (OzCHI 2014), Sydney, Australia, 2 - 5 December 2014. <http://dx.doi.org/10.1145/2686612.2686661>
  - Khawaja, A., Chen, F. & Marcus, N. (2014). Measuring Cognitive Load using Linguistic Features– Implications for Usability Evaluation and Adaptive Interaction Design. *International Journal of Human Computer Interaction*. 30(5), 343-368.
  - Khawaja, A., Chen, F. & Marcus, N. (2012). Analysis of Collaborative Communication for Linguistic Cues of Cognitive Load. *Human Factors: The Journal of the Human Factors and Ergonomics Society –Special Section: Methods for the Analysis of Communication*, 54(4), 518-529.



## Cognitive Psychology & Human Memory

Never Stand Still

COMP3511/9511 Human Computer Interaction  
Dr Alexandra Vassar

Adapted from slides by Dr Nadine Marcus

1

### What is cognitive psychology?

- **Definition:** Cognitive psychology refers to all processes by which sensory input is transformed, reduced, elaborated, stored, recovered and used (Ulric Neisser, 1967).
- Cognitive psychologists are interested in
  - how people think *and*
  - **cognitive processes** which includes perception, attention, pattern recognition, memory, visual imagery, language, reading, learning, problem solving, planning & decision making.



3

Lady



An  
ambiguous  
figure



4

## Three major branches of cognitive psychology

- **Experimental cognitive psychology**
  - mainly involves empirical work on normal subjects.
- **Cognitive science**
  - combines experimentation & the computational modelling of human cognition.
  - use either neural networks (connectionist approach) or production systems (computational approach).
- **Cognitive neuropsychology**
  - tries to map the relationship between different parts of the brain and specific cognitive processes.



5

## Why Cognitive Psychology is useful to HCI

- Interacting with technology is cognitive.
- We need to take into account cognitive processes involved and cognitive limitations of users.
- We can provide knowledge about what users can and cannot be expected to do.
- Can help identify and explain the nature and causes of problems users encounter.



6

## Why Cognitive Psychology is useful to HCI

- Supply theories, modelling tools, guidance and methods that can lead to the design of better, easier to use, interactive products.
- Once we understand what people are good at, can use this knowledge to design technologies that both *extend* human capabilities and *compensate* for weaknesses.
- *Key Learning Outcome:* To understand the strengths and limitations of human cognition and memory and apply these to the design of more usable interfaces that do not cognitively overload users.



7

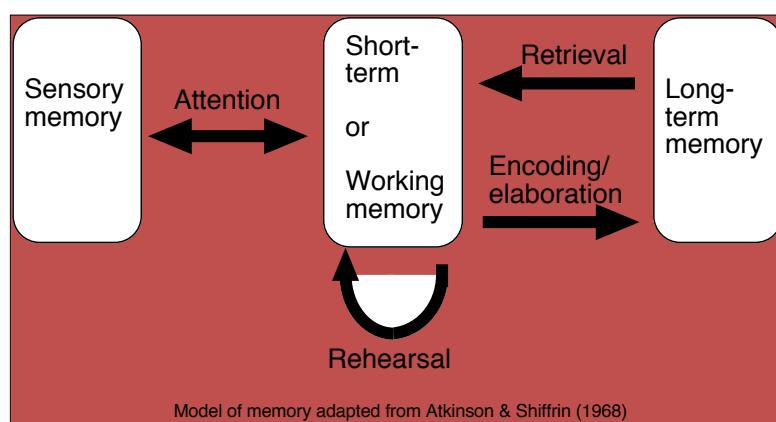
## Information processing approach

- The acquisition, storage, retrieval and use of information involves a number of separate stages, and the information processing approach attempts to identify what happens during these stages.
- This approach was inspired by a computer metaphor.



8

## Stages in information processing



9

## Information processing approach

- **Cognition** is sometimes referred to as the “acquisition of knowledge”. This emphasises the importance of *knowledge* to the information processing approach.
- Cognitive processes overlap and don’t occur isolation eg. reading a book.



10

## MEMORY - Sensory memory

- Sensory memory preserves information in its original sensory form for a very brief period of time.
- Sperling's (1960) experiment demonstrated that visual memory is very limited in duration but not as limited in capacity.
- Echoic or auditory memory has similar limitations.



12

## Sperling's experiment

- Sample data

<u>Display</u>	<u>Tone</u>
X L B J	High
N A E P	Medium
O W R T	Low



13

## Perception – what can you see?



14

## Perception

- Perception refers to how information is acquired from the environment, via the different senses, and transformed into experiences of objects, events, sounds and tastes (Roth, 1986).
- Perception is an active process which involves integrating what is in the environment with what we already know.



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## Perception

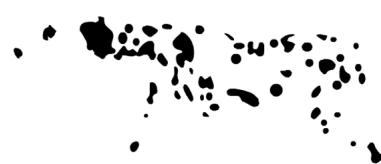
- Perception is heavily influenced by **context**.

THE CHT

- The same stimulus is perceived as an 'H' in the first word and an 'A' in the second word.



16



17

## Perception

- Visual illusions often exist because of the context in which information is perceived.
- Gestalt principles of perceptual organization
  - Proximity, Similarity, Closure, Symmetry and Continuity

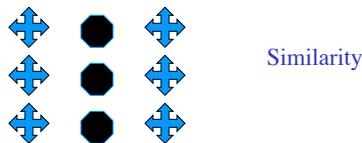


19

## Gestalt principles of perceptual grouping



Proximity



Similarity



Closure

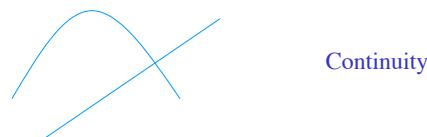


20

## Gestalt principles of perceptual grouping



Symmetry



Continuity



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## Proximity Example

The screenshot shows the homepage of booktopia, Australia's local bookstore. The layout demonstrates proximity through several design choices:

- Header Area:** The top navigation bar includes links for Help Centre, Track My Order, 1300 187 187, My Wishlist, Sign In, Join, and Like Us! on Facebook.
- Search Functionality:** A prominent search bar at the top right allows users to search by title, author, or ISBN.
- Category Navigation:** Below the search bar, a horizontal menu offers categories like BOOKS, EBOOKS, AUDIO BOOKS, DVDs, MAGAZINES, CALENDARS & DIARIES, GIFT IDEAS, BLOG, and CHECKOUT.
- Left Sidebar:** A sidebar on the left contains sections for Favourites (Browse Fiction, New Releases, Bestsellers, Coming Soon, Gift Guide, Fiction Bargains), Publisher Showcases (A & R Australian Classics, Alma Classics, Mills and Boon, Penguin Black Classics, Popular Penguins, Text Classics, Vintage Classics), and Popular Authors (Stephen King, Dan Brown, Liane Moriarty, Di Morrissey, James Patterson, Matthew Reilly, Nora Roberts, Michael Robotham, Tim Winton).
- Right Sidebar:** A sidebar on the right highlights "Over a hundred thousand in-stock titles ready to ship" and features sections for Subjects (Australian Fiction, Modern & Contemporary Fiction, Crime & Mystery, Thrillers & Suspense, Paranormal Fiction, Romance, Adult & Contemporary Romance, Rural Romance, Young Adult Fiction, Classic Fiction, Historical Fiction, Historical Romance, Science Fiction, Erotic Fiction, Graphic Novels, Film & TV Tie-Ins), and more.
- Center Content:** The main content area features a large banner for "CHOOOL" (a book series) and "TOP 100" (a list of books). Below these are smaller thumbnail images for "HARRY POTTER" by J.K. Rowling, "FOR LIFE", "YOUNG DARKNESS", "CRAWDADS SING", "thinanity", "BOSH! Healthy Vibes", and "HARRY POTTER" again.
- Bottom Navigation:** A yellow footer bar at the bottom contains the UNSW Australia logo.

22

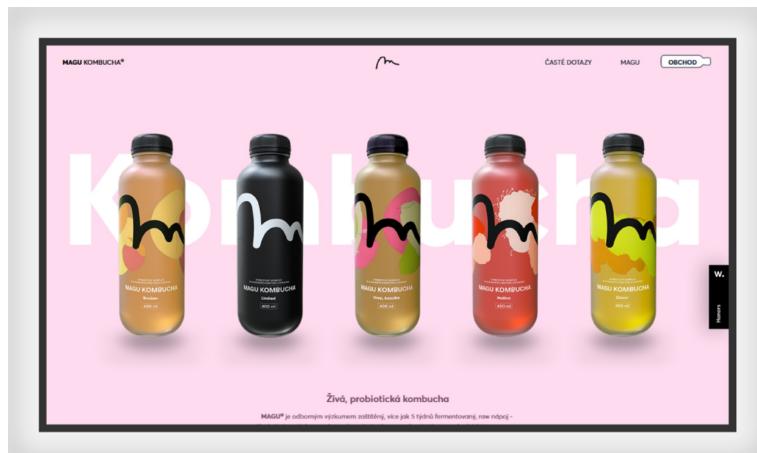
## Similarity Example

The screenshot shows the influenster website, which displays reviews and product recommendations based on user similarity. The layout follows these principles:

- Header:** The header includes the influenster logo and links for Get CashBack, Sign Up / Log In, and a menu icon.
- Navigation:** A "Browse by Category" menu with links to Makeup, Nail, Skincare & Bath, Fragrance, Hair, Food & Snacks, Beverages, Health, Pets, Family, and a "See All" link.
- Content:** The main content area is titled "Recent Reviews & Trending Products" and is organized into three columns: HAIR, HEALTH, and FRAGRANCE.
- HAIR Column:** Features reviews for "THE MET BRUSH Detangler" and "BRIDGE Don't Despair Repair! Deep Conditioning Mask 5 oz".
- HEALTH Column:** Features reviews for "NATURE'S BOUNTY Optimal Solutions® Skin & Nails Complex" and "BAND-AID Brand Adhesive Bandages Johnson & Johnson 20 ct Box".
- FRAGRANCE Column:** Features reviews for "VICTORIA'S SECRET Heavenly Eau De Parfum Spray 100ml 3.4oz Ladies Fragrance" and "DOB Zadore Eau De Parfum".
- Bottom Navigation:** A yellow footer bar at the bottom contains the UNSW Australia logo and a link to the source article: <https://www.smashingmagazine.com/2019/04/spaces-web-design-gestalt-principles/>.

23

## Closure Example



<https://www.smashingmagazine.com/2019/04/spaces-web-design-gestalt-principles/>



24

## Symmetry Example



25

## Continuity Example



26

## Visual Illusions

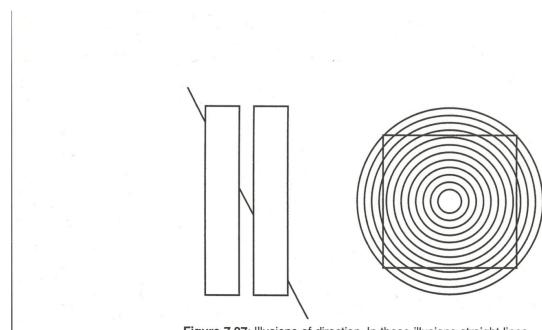


Figure 7.27: Illusions of direction. In these illusions straight lines appear distorted. Lay a ruler along the diagonal in the left figure (the Poggendorf illusion) to see where it actually goes. Do the same on the edge of the bent square to see that the line is actually straight.



27

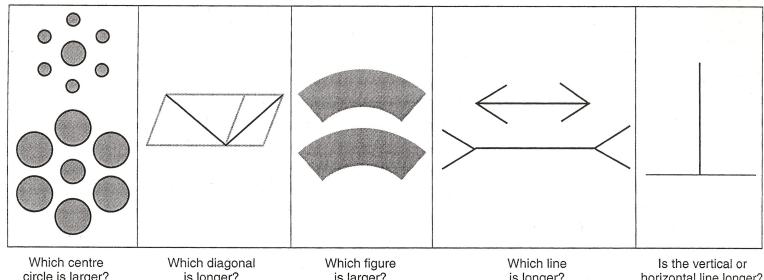


Figure 7.28: Illusions of extent. In every instance one of the two identical sizes appears to be larger. The figures with the angles at the ends in the fourth panel make up the Müller-Lyer illusion.



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## Visual Illusions

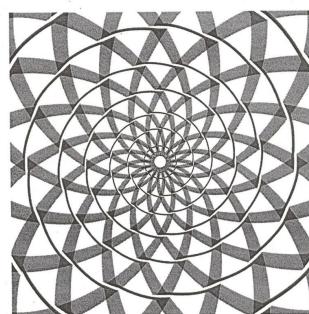


Figure 7.35: The spiral version of the Fraser, or twisted cord, illusion. While the entire figure is perceived as a spiral, if you follow any particular contour you will find it is a circle. The local orientation of the line elements, the twisted cords, contributes to the illusion of a spiral.



29



30

## Colour as a perceptual tool

- Powerful way of dividing display into separate regions
- Useful for search tasks
  - spotting an object in a list, but of less use for tasks requiring categorisation or memorisation
  - too many colours will increase search times
- More effective with inexperienced users



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## Which is easiest to read and why?

What is the time?



32

## Is color contrast good? Find italian

Black Hills Forest	Peters Landing	Jefferson Farms	Devlin Hall
Cheyenne River	Public Health	Psychophysics	Positions
Social Science	San Bernardino	Political Science	Hubard Hall
South San Jose	Moreno Valley	Game Schedule	Fernadino Beach
Badlands Park	Altamonte Springs	South Addison	Council Bluffs
Juvenile Justice	Peach Tree City	Cherry Hills Village	Classical Lit
Results and Stats	Highland Park	Creative Writing	Sociology
Thousand Oaks	Manchesney Park	Lake Havasu City	Greek
Promotions	Vallecito Mts.	Engineering Bldg	Wallace Hall
North Palermo	Rock Falls	Sports Studies	Concert Tickets
Credit Union	Freeport	Lakewood Village	Public Radio FM
Werner Hall	Slaughter Beach	Rock Island	Children's Museum
Performing Arts	Rocky Mountains	Deerfield Beach	Writing Center
Italian	Latin	Arlington Hill	Theater Auditions
Coaches	Pleasant Hills	Preview Game	Delaware City
Mckees Rocks	Observatory	Richland Hills	Scholarships
Glenwood Springs	Public Affairs	Experts Guide	Hendricksville
Urban Affairs	Heskett Center	Neff Hall	Knights Landing
McLainsboro	Brunswick	Grand Wash Cliffs	Modern Literature
Experimental Links	East Millinocket	Indian Well Valley	Studio Arts
Graduation	Women's Studies	Online Courses	Hughes Complex
Emory Lindquist	Vacant	Lindquist Hall	Cumberland Flats
Clinton Hall	News Theatre	Fisk Hall	Central Village
San Luis Obispo	Candlewood Isle	Los Padres Forest	Hoffman Estates



33

## Are borders and white space better? Find french

Webmaster Russian Athletics Go Shockers Degree Options Newsletter	Curriculum Emergency (EMS) Statistics Award Documents Language Center Future Shockers	Student Life Accountancy McKnight Center Council of Women Commute Small Business	Dance Gerontology Marketing College Bylaws Why Wichita? Tickets
Geology Manufacturing Management UCATS Alumni News Saso	Intercollegiate Bowling Wichita Gateway Transfer Day Job Openings Live Radio	Thinker & Movers Alumni Foundations Corbin Center Jardine Hall Hugo Wall School	Career Services Doers & Shockers Core Values Grace Wilkie Hall Strategic Plan Medical Tech
Educational Map Physical Plant Graphic Design Non Credit Class Media Relations Advertising	Beta Alpha Psi Liberal Arts Counseling Biological Science Duerksen Fine Art EMT Program	Staff Aerospace Choral Dept. Alberg Hall French Spanish	Softball, Men's McKinley Hall Email Dental Hygiene Tenure Personnel Policies
English Graduate Complex Music Education Advising Center Medical School Levitt Arena	Religion Art Composition Physics Entrepreneurship Koch Arena Roster	Parents Wrestling Philosophy Wichita Lyceum Fairmount Center Women's Museum	Instrumental Nursing Opera Sports History Athletic Dept. Health Plan



34

## Activity

- Weller (2004) found people took less time to locate items for information that was grouped
  - using a border (2nd screen) compared with using color contrast (1st screen)
- Some argue that too much white space on web pages is detrimental to search
  - Makes it hard to find information
- Do you agree?



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## Perception - applications

- Present information so that it can be perceived in the manner intended.
  - For instance, with talking agents, speech needs to be coordinated with animation of agent's face to make it easier to perceive what is happening.
- Sounds should be clear and audible so users can understand what they represent
- Bordering and spacing are effective visual ways of grouping information
- Icons and other graphical representations should be easy to interpret
- Text should be legible and distinguishable from the background



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## Attention

- Attention is a very **limited mental resource**. It is the mechanism by which some materials are selected for further processing and the rest are excluded.
- Involves selecting things to concentrate on at a point in time from the mass of stimuli around us.
- Broadbent's (1958) filter model of attention - attention works like a filter allowing us to select which incoming sensory information to attend to.



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## Attention

- Shadow experiments
  - Different but continuous message given to each ear.
  - Listener asked to ‘shadow’ or repeat aloud one of the messages
  - Findings indicate listener can occasionally report information from unattended channel eg. hear name
  - Suggests attention not totally all or none process



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## Multitasking and attention

- Is it possible to perform multiple tasks without one or more of them being detrimentally affected?
- Ophir et al (2009) compared heavy vs light multi-taskers
  - heavy were more prone to being distracted than those who infrequently multitask
  - heavy multi-taskers are easily distracted and find it difficult to filter irrelevant information

[www.id-book.com](http://www.id-book.com)

39

**Activity: Find the price of a double room at the Holiday Inn in Bradley**

```

Pennsylvania
Bedford Motel/Hotel: Crinaline Courts
(814) 623-9511 S: $18 D: $20
Bedford Motel/Hotel: Holiday Inn
(814) 623-9006 S: $29 D: $36
Bedford Motel/Hotel: Midway
(814) 623-8107 S: $21 D: $26
Bedford Motel/Hotel: Penn Manor
(814) 623-8177 S: $19 D: $25
Bedford Motel/Hotel: Quality Inn
(814) 623-5189 S: $23 D: $28
Bedford Motel/Hotel: Terrace
(814) 623-5111 S: $22 D: $24
Bradley Motel/Hotel: De Soto
(814) 362-3567 S: $20 D: $24
Bradley Motel/Hotel: Holiday House
(814) 362-4511 S: $22 D: $25
Bradley Motel/Hotel: Holiday Inn
(814) 362-4501 S: $32 D: $40
Breezewood Motel/Hotel: Best Western Plaza
(814) 735-4352 S: $20 D: $27
Breezewood Motel/Hotel: Motel 70
(814) 735-4385 S: $16 D: $18

```

[www.id-book.com](http://www.id-book.com)

40

**Activity: Find the price for a double room at the Quality Inn in Columbia**

City	Motel/Hotel	Area code	Rates	
			Phone	Single Double
Charleston	Best Western	803	747-0961	\$26 \$30
Charleston	Days Inn	803	881-1000	\$18 \$24
Charleston	Holiday Inn N	803	744-1621	\$36 \$46
Charleston	Holiday Inn SW	803	556-7100	\$33 \$47
Charleston	Howard Johnsons	803	524-4148	\$31 \$36
Charleston	Ramada Inn	803	774-8281	\$33 \$40
Charleston	Sheraton Inn	803	744-2401	\$34 \$42
Columbia	Best Western	803	796-9400	\$29 \$34
Columbia	Carolina Inn	803	799-8200	\$42 \$48
Columbia	Days Inn	803	736-0000	\$23 \$27
Columbia	Holiday Inn NW	803	794-9440	\$32 \$39
Columbia	Howard Johnsons	803	772-7200	\$25 \$27
Columbia	Quality Inn	803	772-0270	\$34 \$41
Columbia	Ramada Inn	803	796-2700	\$36 \$44
Columbia	Vagabond Inn	803	796-6240	\$27 \$30

[www.id-book.com](http://www.id-book.com)

41

## Attention - applications

- Attention grabbing techniques - these should be used sparingly.
  - includes use of colour, bold, underlining, animation, flashing text, reverse video, auditory warnings.
- Attention can be guided using categories and meaningful groupings and by using appropriate spacing.



42

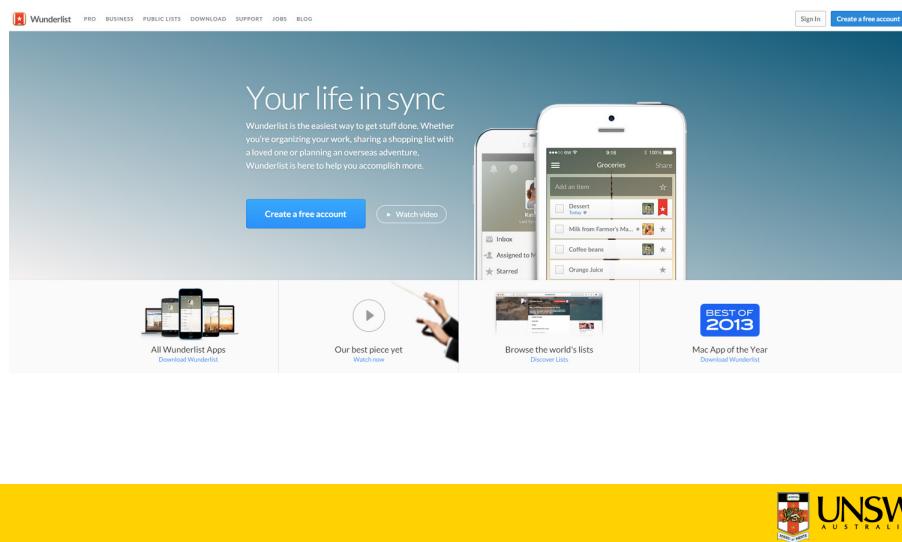
## Attention - applications

- Important information should be in a prominent position
- Information not need very often (eg. help), should only be displayed on request. Avoid cluttering the interface.
- Reminder prompts should be displayed for routine background tasks that are easily forgotten eg. saving a file



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## Attention Example



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## Automatic Processes

- Processes that are highly practiced and require little or no attention are referred to as **automatic processes**.



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## Automatic processing

- requires no conscious control
- is effortless, fast and difficult to alter or suppress once learned
- requires no attention or awareness
- is parallel in nature
- is virtually unaffected by working memory load.



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## Controlled processing

- needs conscious attention
- is slow, easily established, altered or reversed
- is under conscious control
- is serial in nature
- is strongly dependant on working memory load



47

## Automatic Processes....

- Being an expert within a domain involves automating basic skills and processes.
- Highly practiced skills are often difficult to suppress eg. Key press sequence
- The **Stroop effect** exists of a result of automation.



48

## The Stroop effect -

Name the colour of the following words:

Green

Blue

Red

Purple

Orange

Yellow



49

**Now name the colour of these words as quickly as possible:**

Blue

Purple

Red

Green

Orange

Yellow



50

## **Short-term or working memory**

- Often referred to as **consciousness**.
- Short-term memory is limited in both **capacity** and **duration**.
- **Span of attention** - the largest number of items one can recognise in a single glance.
- **Memory span** - the number of items one can remember after reading a list once.



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## Span of attention

- Can you tell how many dots there are at a single glance?



52

## Span of attention

- Can you tell how many dots there are at a single glance?



53

## Span of attention

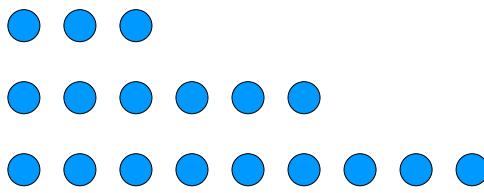
- Can you tell how many dots there are at a single glance?



54

## Span of attention

- Notice how chunking could make the task easier



56

## Short-term memory (STM) - applications

- **Chunking** - one can increase the amount of information stored in STM by grouping or chunking items together into larger meaningful units. eg.  
B M I H P B N Z A    vs.    IBM BHP ANZ
- Limitations of STM must be applied with care to interface design.
- Do NOT expect the user to process large amounts of information simultaneously *or* overload their memories with complicated procedures for carrying out tasks.



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## Chunking to improve memory

- Using chunking
- <https://www.youtube.com/watch?v=sBzYK8Qwnps>



58

## Working memory (WM)

- Temporary storage buffer for the processing of current information.
- It is a more modern conception.
- Focus on memory being an active process, rather than just a storage medium.
- Focus on the *parallel* nature of information processing.
- Switch from a computer metaphor to a brain metaphor.
- More recent research suggests the number of unfamiliar items we can store in WM is actually 4 and not 7 (Baddeley, 1986; Cowan, 2001).



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## Working memory

- It consists of the following 3 subsystems:
  - **Phonological loop** stores and rehearses speech-based or auditory information.
  - **Visuospatial sketchpad** allows people to temporarily hold and manipulate visual imagery.
  - **Central executive processor** controls the operations of working memory and allocates resources to the other two subsidiary systems. It is an attentional controlling system.



60

## What is working memory

- Brief overview:

<https://www.youtube.com/watch?v=TN13Sfyar0U>



61

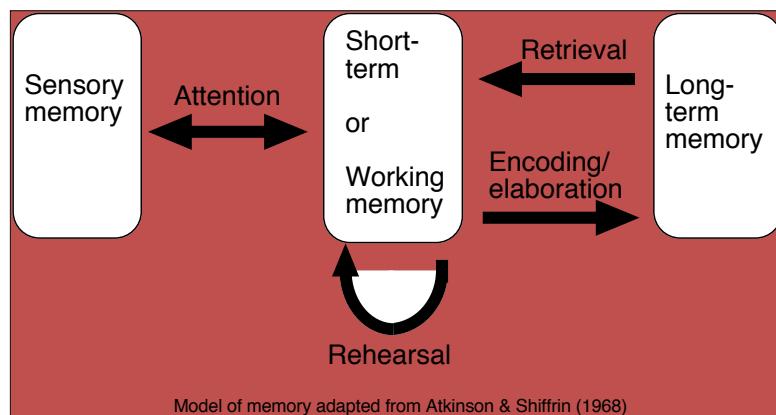
## Lecture activity

- For an interactive that considers student note taking app, consider how you would take what you've just learnt about memory, attention and perception in terms of our limitations, into account?
- What are some design decisions you would make now that you understand a bit about our cognitive limitations?



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## Stages in information processing



63

## Encoding

- **Maintenance rehearsal** - information is rehearsed at a superficial level. It is repeated over and over again without thinking about it.
- **Elaboration** - information is rehearsed in terms of its meaning and is linked to other stimulus at the time of encoding.
  - The more we elaborate on an idea and link it to other information, the more likely we are to later remember it.
  - Craik & Tulving's (1975) study



64

## Encoding

- **Organisation** - material that is well organised in terms of meaningful groups or categories will be better encoded.
  - This is a form of elaboration -> are making information more meaningful by organizing it into a more coherent form.



65

## Retrieval

- **Context** and **emotional state**
  - can serve as cues in the retrieval of information
  - Context -> can be both the physical situation or related information
- Tip-of-the-tongue-phenomena
  - are aware of information, but cannot retrieve it
  - used to investigate the way in which information is retrieved from LTM
  - information available includes the sound of word, first letter of the word and the meaning



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## Retrieval

- **Recall**
  - involves retrieving information from memory
  - eg. writing a short answer question
- **Recognition**
  - involves selecting previously learned information from an array of options
  - eg. multiple choice
- Recognition is easier than recall
  - recognition uses context which helps you to remember



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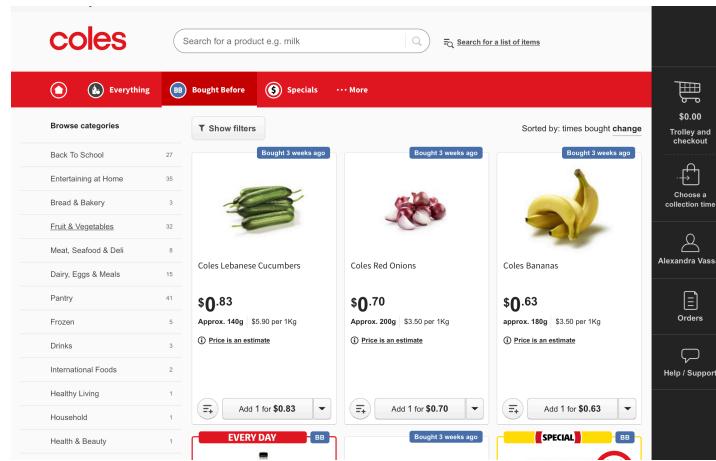
## Recognition versus recall

- Command-based interfaces require users to recall from memory a name from a possible set of 100s
- GUIs provide visually-based options that users need only browse through until they recognize one
- Web browsers, MP3 players, etc., provide lists of visited URLs, song titles etc., that support recognition memory



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## Recognition Rather than Recall



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## Retrieval - applications

- Recognition is easier than recall
  - Use of menu based systems over command based systems (particularly for novice and intermittent users).
- Use retrieval ‘cues’ to aid in the recall of relevant information
  - eg. Help systems
- Naming conventions
  - Use names that are meaningful, distinguishable, and consistent across applications



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## Retrieval - applications

- Use terminology that is meaningful to your users, and that will activate the appropriate prior knowledge.
- When training users, one should try to make the context and the cues as similar as possible to the ‘real thing’
- Provide users with many ways of encoding information (eg. files, emails, images) so that it can be more easily remembered - can use colour, time stamps, icons etc.



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## Retrieval cues

A screenshot of the Booktopia website homepage. The top navigation bar includes links for Help Centre, Track My Order, 1300 187 187, Like Us!, My Wishlist, Sign In, Join, Australian Business Awards 2018 WINNER, and fast 100. The main search bar has a placeholder "SEARCH TITLE, AUTHOR OR ISBN" and a "BOOKS" dropdown. Below the search bar are categories: BOOKS, EBOOKS, AUDIO BOOKS, DVDS, MAGAZINES, CALENDARS &amp; DIARIES, GIFT IDEAS, BLOG, 0 Items, and CHECKOUT. A banner at the top features a woman sitting on a blue chair with the text "BE YOUR BEST UNLOCK YOUR CAREER POTENTIAL" and a "SHOP NOW" button. Another banner shows a window with a view of a city skyline and a "TOP 100" badge with "Save 25%". Below these banners are several book covers including "Where The Crawdads Sing", "The Handmaid's Tale" by Margaret Atwood, "The Giver", "The Beast", "Andy Griffiths", "Rachael Johns", and "Kitty Flanagan Rules For Life". Navigation arrows are visible on the left and right sides of the book grid.



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## Organization of knowledge

- **Schema**

- cognitive structure in memory that allows us to organise information according to how it will be used (Sweller).
- patterns of thought, or organized knowledge structures, that render the environment relatively predictable (Westen).
- Schemas allow us to filter, organise and process large amounts of information quickly and economically -> reduces the burden on our limited working memories.



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## Organization of knowledge

- Schemas aid learning, remembering, understanding and problem solving
- Research demonstrating the effect of schemas on memory
  - eg. Brewer and Treyens' (1981) "office"
  - eg. Carmichael et al.'s (1932) ambiguous figures
- Mental models and schemas are very similar theoretical concepts, used by different theorists.

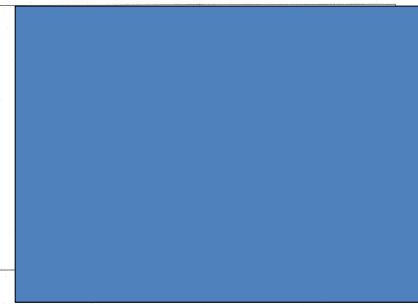


76

## Figures reproduced in ambiguous figure study with different labels

BOX 8 • 4 Effects of Verbal Labels on Memory for Ambiguous Figures

- Figure presented to subjects
- 1.
  - 2.
  - 3.
  - 4.



77

## Figures reproduced in ambiguous figure study with different labels

BOX 8 • 4 Effects of Verbal Labels on Memory for Ambiguous Figures

- Figure presented to subjects
- 1.
  - 2.
  - 3.
  - 4.

- Figure reproduced by subjects with label list 1
- eyeglasses
- hourglass
- seven
- gun

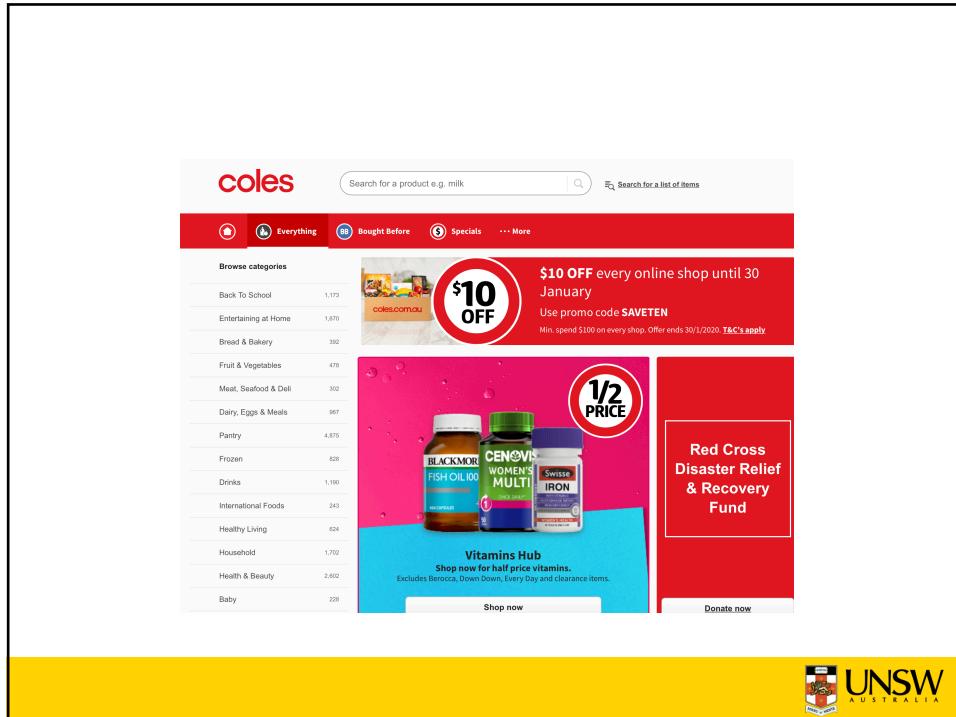
- Figure reproduced by subjects with label list 2
- dumbbell
- table
- four
- broom

Adapted from Carmichael, Hogan, and Walter (1932)

Mayer (1992)



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## Passage

The procedure is actually quite simple. First you arrange items into different groups. Of course one pile may be sufficient depending on how much there is to do. If you have to go somewhere else due to lack of facilities, that is the next step, otherwise you are pretty well set. It is important not to overdo things. That is, it is better to do too few things at once than too many. In the short run this may not seem important but complications can easily arise. A mistake can be expensive as well. At first, the whole procedure will seem complicated. Soon, however, it will become just another facet of life. It is difficult to foresee any end to the necessity for this task in the immediate future, but then, one never can tell. After the procedure is completed one arranges the materials into different groups again. Then they can be put into their appropriate places. Eventually they will be used once more and the whole cycle will then have to be repeated. However, that is part of life (from Bransford and Johnson, 1972).

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## Organization of knowledge

- **Mental model**

- The model people have of themselves, others, the environment, and the things with which they interact (Norman, 1988)
- Internal constructions of some aspect of the external world that are manipulated enabling predictions and inferences to be made (Craik, 1943)

- Running a mental model

- The process of generating the model  
eg. visualizing your lounge room to see how the furniture can be rearranged
- Allows one to make predictions without having to test things in the real world



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## Mental models

- Well designed interactive systems are more likely to lead to users developing appropriate mental models of the system
- The system should provide:
  - Useful feedback in response to input
  - Intuitive ways of interacting with system
  - Clear and easy to follow instructions
  - Appropriate online help and tutorials
  - Context-sensitive guidance for users, set at their level of experience.



84

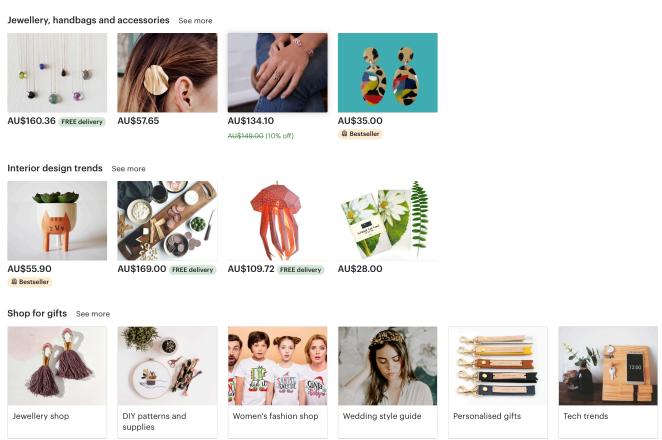
## Improving memory

- Techniques that have already been mentioned include:
  - Elaboration
  - Organising materials
  - Automating skills
  - Chunking
  - Imagery



85

## Chunking



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## Improving memory

- Further techniques that reduce the burden on memory and so improve functioning:
  - Using **external memory aids** eg. diaries, shopping lists, to-do lists, calendars etc.
  - *Computational offloading* -> using a tool or device in conjunction with an external representation to help us carry out a computation eg. using pen and paper to solve a maths problem
  - *Annotating* (modifying external representations eg. crossing off items) & *cognitive tracing* (externally manipulating items into different orders & structures eg. playing cards or scrabble)



87

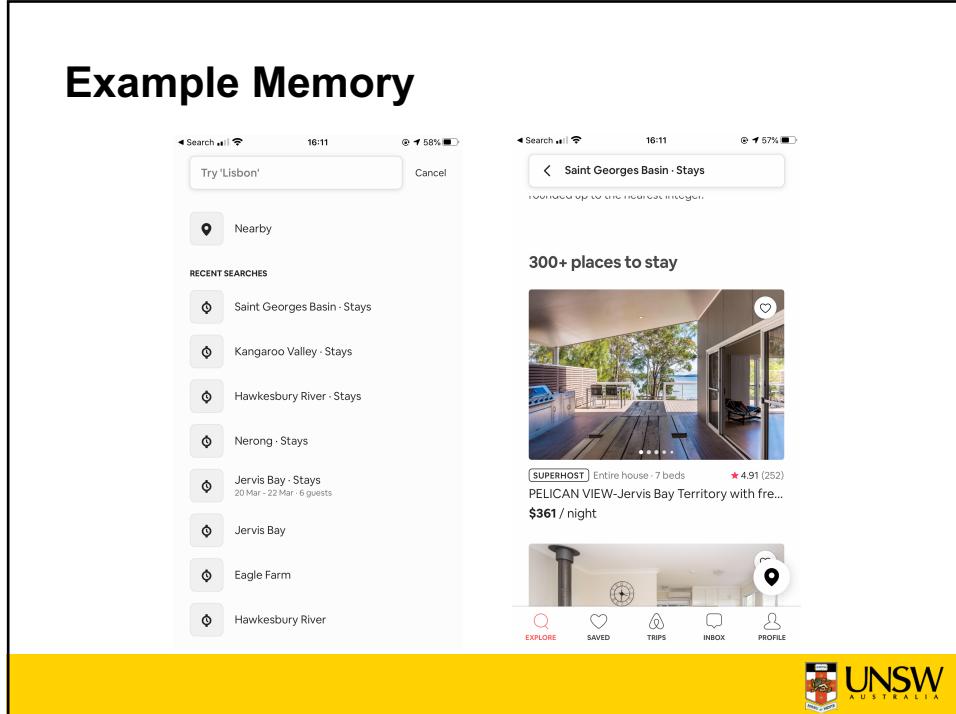
## Improving memory

- Other useful methods include:
  - **Summaries**
    - Help to make key points more memorable
  - **Advance organisers**
    - Provide an introductory framework that is familiar, which users can use to interpret new information
  - Other **Mnemonic devices** (methods of improving memory)
    - Stories
    - Acronyms eg. ROY G BIV
    - Linking new information to previously mastered information that already has a particular structure



88

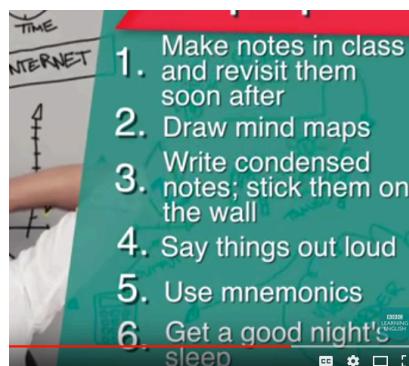
## Example Memory



89

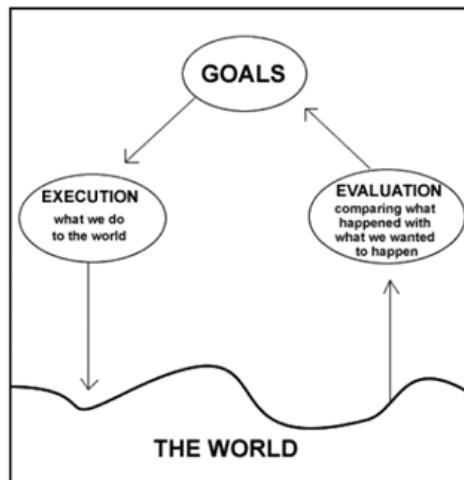
## Improving memory

- see <https://www.youtube.com/watch?v=2Kr25sizHyA>



90

## Norman's (1986) Theory of action



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## Norman's (1986) Theory of action: Design Implications

Stage of Action	Design Question: How easily can the user ... ?
Form the goal	Determine the function of the product or system
Form the intention	Tell what actions are possible
Specify an action	Determine mapping from intention to action
Execute the action	Perform the action
Perceive the state of the world	Tell if the system is in the desired state
Interpret the state of the world	Determine the mapping from system state to interpretation
Evaluate the outcome	Tell what state the system is in

<http://learnline.cdu.edu.au/units/hit381/resources/popups/normantheoryofaction.html>



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## An example: reading breaking news on the web

- (i) Set goal to find out about breaking news  
*decide on news website*
- (ii) Form an intention  
*check out BBC website*
- (iii) Specify what to do  
*move cursor to link on browser*
- (iv) Execute action sequence  
*click on mouse button*
- (v) Check what happens at the interface  
*see a new page pop up on the screen*
- (vi) Interpret it  
*read that it is the BBC website*
- (vii) Evaluate it with respect to the goal  
*read breaking news*



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## How realistic?

- Human activity does not proceed in such an orderly and sequential manner
- More usual for stages to be missed, repeated or out of order
- Do not always have a clear goal in mind but react to the world
- Theory is only approximation of what happens and is greatly simplified
- **Help designers think about how to help users monitor their actions**



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## The gulfs

- The ‘gulfs’ explicate the gaps that exist between the user and the interface
- The gulf of execution
  - the distance from the user to the physical system
- The gulf of evaluation
  - the distance from the physical system to the user
- **Need to try to bridge the gulfs in order to reduce the cognitive effort required to perform a task**



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## Bridging the gulfs

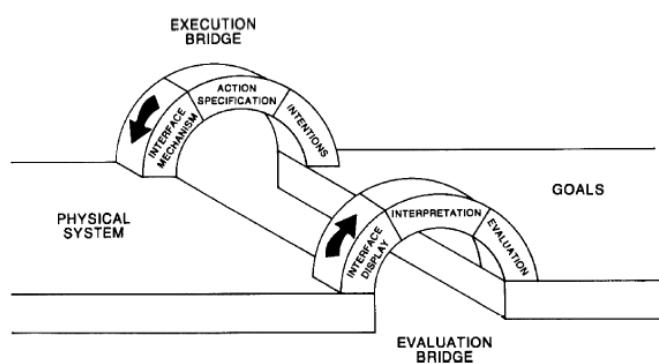


Figure 3.7 Bridging the gulfs of execution and evaluation

Source: User centered system design: new perspectives on human-computer interaction by D Norman.  
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[www.id-book.com](http://www.id-book.com)



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## Applications of memory research

- **To educators**

- Try not to overload limited working memory when learning new information
- Relate new information to prior knowledge to improve understanding and recall
- Use diagrams and analogies to help improve understanding
- Keep information well organized and meaningful
- Automation of basic skills allows for further mastery



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## Applications of memory research

- **To HCI professionals**

- Can be used to explain user interaction and predict user performance
- Improve information presentation
  - relate information to prior knowledge
  - information must be well structured
  - use meaningful subdivisions
  - use diagrams, headings & numbering



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## Applications of memory research to HCI professionals.....

- The way an interface is designed can greatly affect how well users can perceive, attend, learn and remember how to do their tasks.



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## Applications of memory research to HCI professionals.....

- **Design interfaces that**
  - Are more attention grabbing
  - Are more memorable
  - Are easier to make sense of and to use
    - Take into account users' schemas or mental models
  - Use consistent terminology and layout
  - Do not overload our limited working memories
  - Present information in an appropriate context
  - Use retrieval 'cues' to aid recall



102



Never Stand Still

# Experts versus Novices

Development of expertise

COMP3511/9511 Human Computer Interaction

By Dr Sasha Vassar

Adapted from slides by Dr Nadine Marcus

# Reading

- Cooper, A., Reimann, R., & Cronin, D. (2007). 'Chapter 3: Beginners, Experts and Intermediates' In About face 3: the essentials of interaction design. John Wiley & Sons., pp41-48
- Additional reference: Ch 9 in Anderson on the Development of Expertise (available via UNSW library)

# Introduction

- **Novice** - Someone who has little knowledge or experience within a domain
- **Expert** - Someone who has a large amount of knowledge and experience within a domain
- Becoming an expert involves extensive practice
- The *distinguishing feature of expertise* is a large and varied knowledge base, stored in the form of schemas, that takes many years to acquire

# Relevant definitions

- **Problem solving**
  - finding a path (or solution) that overcomes some obstacle, permitting us to reach a desired goal state.
- **Means-ends analysis**
  - the problem solver compares the *current problem state* with the *desired goal state* and tries to find problem solving *operators* that will bring them closer to the goal state.

# Relevant definitions

- **Schema**
  - domain specific knowledge structure that allows people to categorize multiple elements of information as a single unit
- **Declarative knowledge**
  - knowledge about facts or things
- **Procedural knowledge**
  - knowledge about how to perform various actions or cognitive activities

# Three stages in skill acquisition

## 1. Cognitive stage

- facts are learnt; encoding of declarative knowledge

## 2. Associative stage

- basic procedural knowledge is acquired

## 3. Autonomous stage

- procedures become automated and rapid

# Proceduralization

- As a skill is acquired and then automated there is a change in the degree to which subjects rely on declarative knowledge versus procedural knowledge.
- *Proceduralization* refers to the process by which people switch from explicit use of declarative knowledge to direct application of procedural knowledge.

# Difference between expert and novice problem solvers

Three main bodies of research:

1. Pattern learning and memory
2. Problem representation and categorisation
3. Problem solving strategies

# Pattern learning and memory

- Experts can *chunk* large amounts of meaningful information into a single unit and accordingly have better memories of meaningful patterns
  - De Groot study (1965) with chess players
  - Cooper & Sweller (1985) replication with algebra equations
  - Jeffries, Turner, Polson & Atwood (1981) replication with meaningful lines of computing code vs. random lines of codes

# Pattern learning and memory

- Experts have a huge domain-specific knowledge base, which allows them to recognize a large number of familiar patterns or ‘chunks’, and thus exhibit outstanding memories for familiar problem states.

# Pattern learning and memory...

- Experts chunking abilities allow them to more easily
  - i) navigate through a menu system that is ‘deeper’, and
  - ii) remember shortcuts
  - iii) learn to use a complicated interface similar to something they’ve used already.

# Problem representation and categorisation

- Experts can instantly recognise and categorise a problem in terms of its solution
  - Chi, Glaser & Rees (1982) compared categorisation skills of experts and novices.
  - Adelson (1981) compared expert/novice recall of lines of code presented in random order.
- Experts can use their huge store of domain-specific knowledge to build a rich and detailed problem representation.

# Problem representation and categorisation

- One of the distinguishing characteristics of good problem solving is the ability to form a representation of a problem in terms of the problem solution.
- Experts group problems together differently to novices. Novices focus on surface similarities while experts focus on deeper principles.
- **Be careful to create categories that are meaningful to your user group.**

# Problem solving strategies

- Experts tend to use schema based strategies to solve problems. This usually involves working forwards from the givens to the goal.
  - Eg. *working forwards* involves choosing equations that contain the given information, then calculating all the unknowns until finally the goal is reached.
  - See Larkin (1981) for a comparison of expert versus novice problem solutions.

# Problem solving strategies

- Novices tend to use search based strategies, such as means-ends analysis, to solve problems. This often involves working backwards from the goal to the givens.
  - Eg. *working backwards* involves selecting equations that contain the goal, and then setting subgoals of finding all the unknowns in these equations. Once all the unknowns become subgoals, activity can proceed in a forward direction.

# Problem solving strategies...

- Novices users of a system have little prior knowledge or schemas in the area and so tend to use means-ends-analysis (a trial and error type strategy) to navigate their way around. They need **lots of meaningful cues and feedback**.
- Experts users can use their prior knowledge and schemas to easily navigate through the system. *Lots of feedback can be redundant and irritating.*

# Interaction between knowledge level and instructional presentation mode

- Experts need less information - too much detail can become redundant
- Novices need more details - these should be presented in an integrated format
- One needs to know something about the learners' knowledge level to decide whether information is redundant or essential
  - see Kalyuga, Chandler & Sweller (2000) for a comparison of instructional presentation formats preferred by experts versus novices

# Intermediates

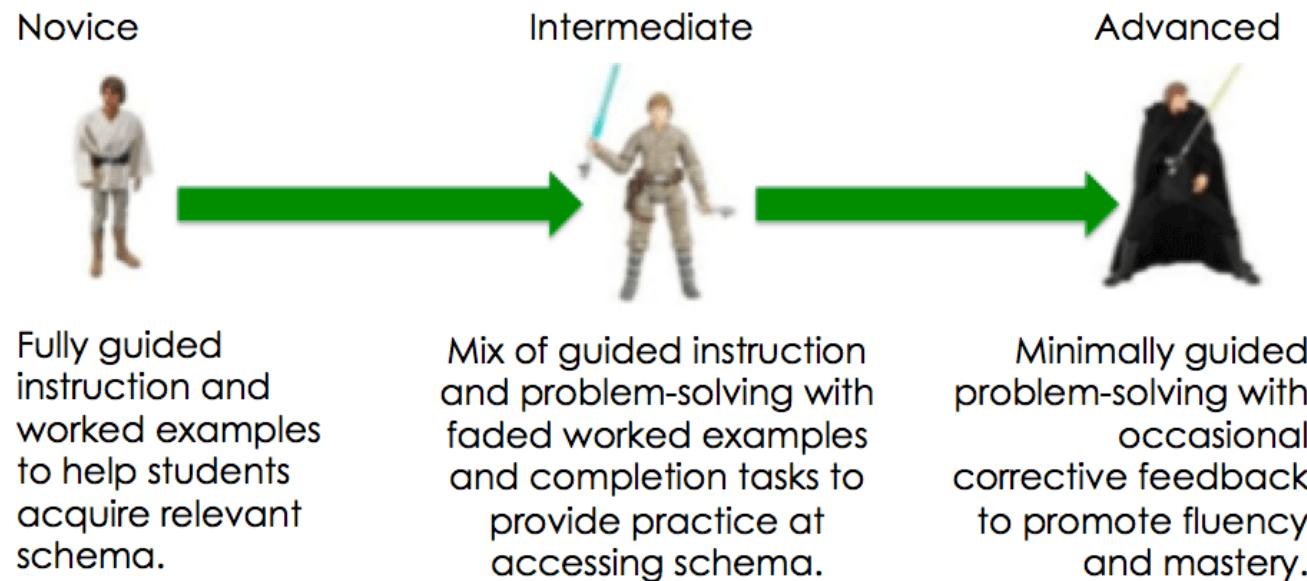
- In reality most users are neither experts or novices but intermediates
  - Don't stay beginner for long
  - High level of expertise in all aspects of system is unusual
  - Most intermediates would like to learn more about the program, but don't have time
- Ski slope analogy (From Cooper and Reimann, 2003)

# Intermediates

- Programmers who develop software are often experts ->tendency to create code that includes all possible options
- Sales and marketing people generally demonstrate software to novices -> demand training wheels and lots of beginner support
- Intermediate user may then get forgotten....

# Intermediates

- Goals of design should thus be:
  - Rapidly and painlessly get beginners to intermediacy
  - Avoid obstacles for intermediates who want to become experts
  - Keep perpetual intermediates happy
- Want to accommodate experts and novices but not at expense of intermediates
- Remember if people can't use a system, it is the system's fault and not the user!



# Characteristics of Novices

- Novices Users
  - Don't want to remain this way for long
  - Need help that goes away once redundant eg. guided tour
  - Need system features that rely on recognition and support learning eg. menus, prompts, help screens
  - Need simple tasks with small no of options & informative feedback

# Characteristics of Experts

- Expert Users
  - Want fast access to regular tools -> short cuts
  - Want powerful features, not bothered by increased complexity
  - Expect rapid performance
  - Rely of free recall
  - Need less informative feedback
  - Seek efficiency by reducing keystrokes, summarising  
-> eg. short cuts
  - Their perceptions of a product will feed down to less experienced users, so important to keep satisfied

# Characteristics of Intermediates

- Intermediate Users
  - Want access to tools, but don't need scope and purpose explained to them
  - Tooltips are useful -> focus on function
  - On-line help useful -> can access when needed
  - Want regularly used functions easily available  
-> easy to find and remember
  - Find it reassuring to know advanced features exist, but rarely use them (something to aspire to)

# Design

- Why design for both?

# Practical applications of expert/ novice differences

- Software can be designed with different modes or versions for novices and experts
  - Expert version would have more options, features and short-cuts, but may not be as easy to learn to use
  - Novice version would have limited options, but be easier to learn to use
  - See ‘Training Wheel’ example (Preece et al., 1994, p311)

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Gmail Images

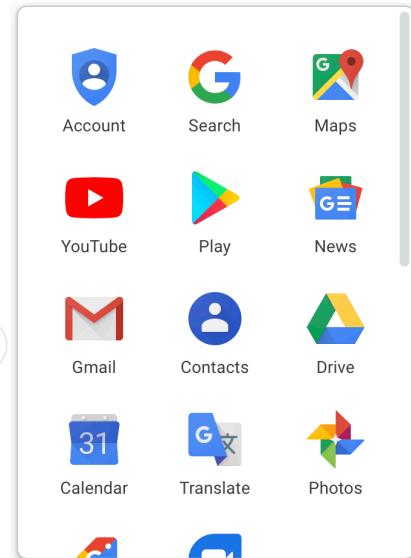


S

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- Marketplace 0
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- Users 615

**Languages**

Language	Count
Python	818
Java	738
JavaScript	711
C++	568
C#	281
C	233
HTML	185
CSS	78
PHP	57
Processing	57

**4,964 repository results** Sort: Best match

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- hkociemba/RubiksCube-TwophaseSolver** Solve Rubik's Cube in less than 20 moves on average with Python cube python rubikcube-twophasesolver rubik kociemba two-phase-algorithm ★ 199 • Python GPL-3.0 license Updated on 28 Sep 2019
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Solve Rubik's Cube in less than 20 moves on average with Python rubik cube python rubikcube-twophasesolver kociemba two-phase-algorithm

74 commits 1 branch 0 packages 0 releases 2 contributors GPL-3.0

Branch: master New pull request Find file Clone or download

hkociemba Merge pull request #8 from Tazeg/master ... Latest commit 0e77bf8 on 28 Sep 2019

.idea	Do some code cleanup	11 months ago
.gitignore	Initial commit	3 years ago
LICENSE	Initial commit	3 years ago
README.md	Update README.md	10 months ago
client_gui.py	Improve comments	7 months ago



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# Practical applications of expert/ novice differences

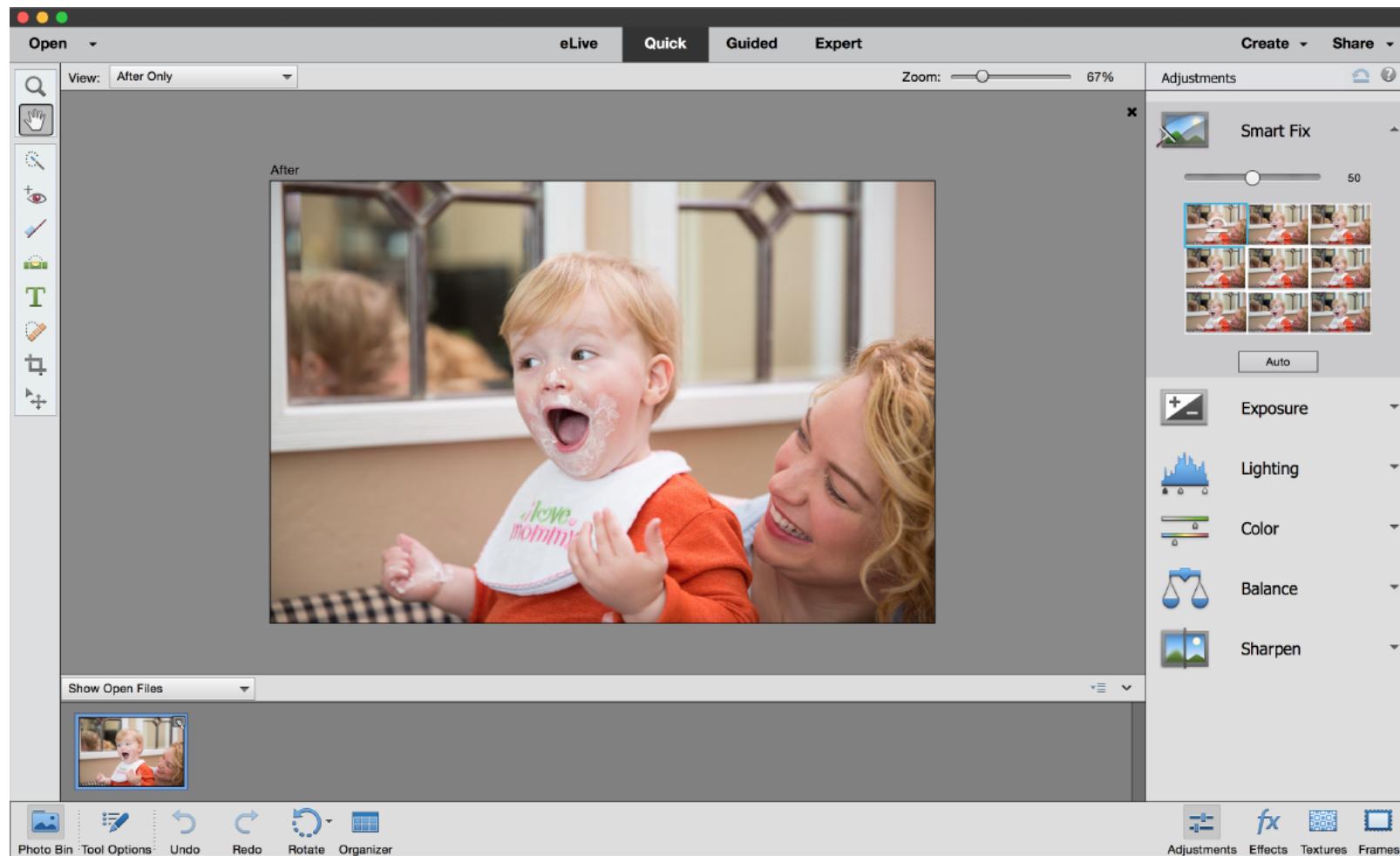
- Game software often takes level of expertise into account
  - As level of expertise increases, things speed up, there may be less cues and there is often more information to deal with
- Sometimes two different applications are created, one for novices and another for experts eg. movie software, photoshop



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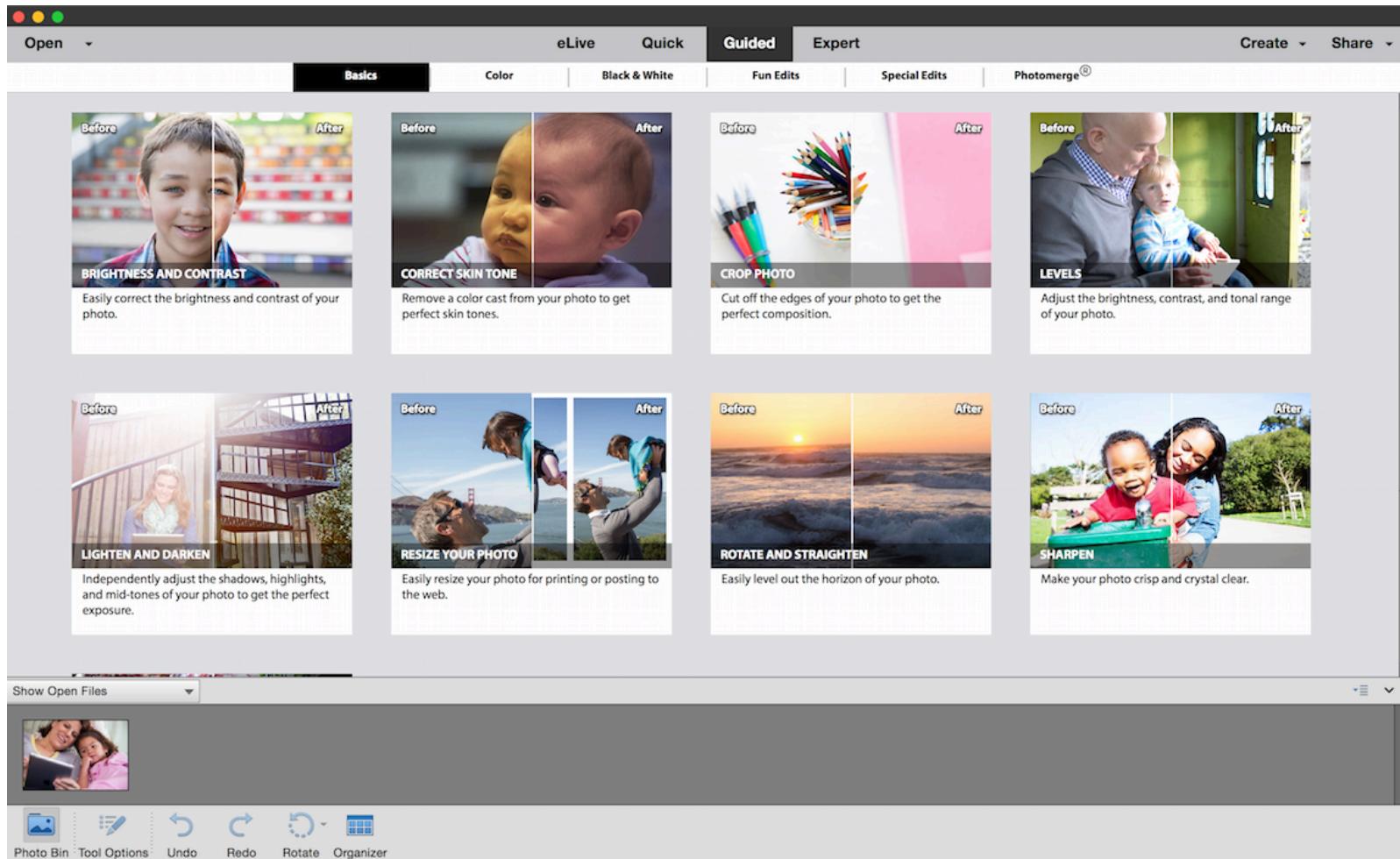


# Photoshop Elements



[https://helpx.adobe.com/photoshop-elements/getting-started/editor\\_workspace.html](https://helpx.adobe.com/photoshop-elements/getting-started/editor_workspace.html)

# Photoshop Elements



[https://helpx.adobe.com/photoshop-elements/getting-started/editor\\_workspace.html](https://helpx.adobe.com/photoshop-elements/getting-started/editor_workspace.html)

# Photoshop Elements



[https://helpx.adobe.com/photoshop-elements/getting-started/editor\\_workspace.html](https://helpx.adobe.com/photoshop-elements/getting-started/editor_workspace.html)

# Practical applications of expert/ novice differences

- Expert/novice web users
  - Expert web users are skilled at using search engines and locating information on the web.  
There tends to be no difference in skills when navigating a particular site (see Lazonder, Biemans & Wopereis, 2000).
  - We thus need to be teaching novices basic web search skills.

# Practical applications of expert/ novice differences

- Expert/novice web users
  - Kuo, Chu, Hsu, and Hsieh (2004) showed that people with high self-efficacy in online search found relevant information more quickly than those with low self-efficacy.
    - experts' pre-existing mental models of the usefulness of websites



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SYDNEY

# Library

## Research

Library services for researching

## Teaching

Library services for teaching

## Study

Student and general services

Search all things Library



Library collection

Databases

eJournals

Course resources

UNSWWorks

Digitised collections

Exhibitions

Postgraduate  
Study Space  
Main Library, Level 4



Help



myLibrary



Room bookings



ELISE



Copyright



Pay



About



Q Library chat



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The screenshot shows the UNSW Library homepage. At the top left is the UNSW Sydney logo. To its right is the word "Library". Below the logo is a navigation bar with links: "Library collection", "eJournals", "Databases", "Interlibrary Loan Service", "UNSWworks", and "Citation Search". To the right of the navigation bar are icons for a user profile, "myLibrary", and "Sign in". Below the navigation bar is a search bar containing the placeholder "Search the Library collection" and an orange magnifying glass icon. To the right of the search bar is a link "ADVANCED SEARCH". On the left side of the main content area is a box titled "Sign in to *myLibrary*" with a bulleted list: "Discover online resources", "Save search queries and results to *My Favourites*", and "View loans, requests, messages in *myLibrary*". To the right of this is another box titled "Highlights" with a bulleted list: "Quickly identify peer-reviewed or open access items", "Easy access to search history", and "See a summary of all your loans, requests, fines, fees and messages in *myLibrary*". At the bottom of this section is a link "Learn more about discovering Library resources.". A vertical yellow sidebar on the right is labeled "Library chat".

The screenshot shows the UNSW Library homepage with the "ADVANCED SEARCH" option selected. The search interface is displayed in a large white box. It includes fields for "Title" (with dropdown menus for "contains" and "AND"), a "Resource Type" dropdown set to "All types", and a "Publication Date" dropdown set to "Any year". Below these fields is a button "+ ADD A NEW LINE". To the right of the search interface is a link "SIMPLE SEARCH". A vertical yellow sidebar on the right is labeled "Library chat".



# Exercise

- What are some ways in which you can cater for both experts and novice users in your Assignment 2 applications?

# Questions?



# Introduction to Cognitive Psychology: Problem Solving

Never Stand Still

COMP3511/9511 Human Computer Interaction  
Dr Sasha Vassar

# Overview

- Problem solving

# Overview of Problem Solving

- Relevance & definition of problem solving
- General problem solving strategies
- Importance of prior knowledge to problem solving
- Importance of appropriate problem representation
- Other reasons why problems may be difficult to solve
- **Goal/Learning objective:** To understand why some problems are difficult to solve and apply this to HCI design.

# Reading

- Smith, E. E., & Kosslyn, S. M. (2013).  
‘Chapter 10: Problem Solving and Reasoning’  
In Cognitive Psychology: Pearson New  
International Edition: Mind and Brain. Pearson  
Higher Ed
- Also Walker, 2nd edition, chapter 9 - Section  
on Problem solving (available electronically  
via COMP3511 in the library catalogue)

# Questions to be addressed

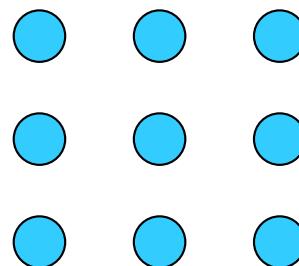
- What is problem solving?
- How do we tend to solve problems?
- Why are some problems difficult to solve?
- How can we improve our problem solving strategies?

# Relevance to HCI and Com Sci

- Within Computer Science programming, writing databases, debugging, creating websites, etc... are all instances of problem solving.
- Within Human Computer Interaction
  - New users of an application are solving the problem of how to interact with the interface and how to use the system.
  - Experienced users also encounter problems.
  - Designers need to solve the problem of designing a usable application.

# Nine dot problem

- Using 4 straight lines, and without lifting your pencil from the paper, draw a line through each dot

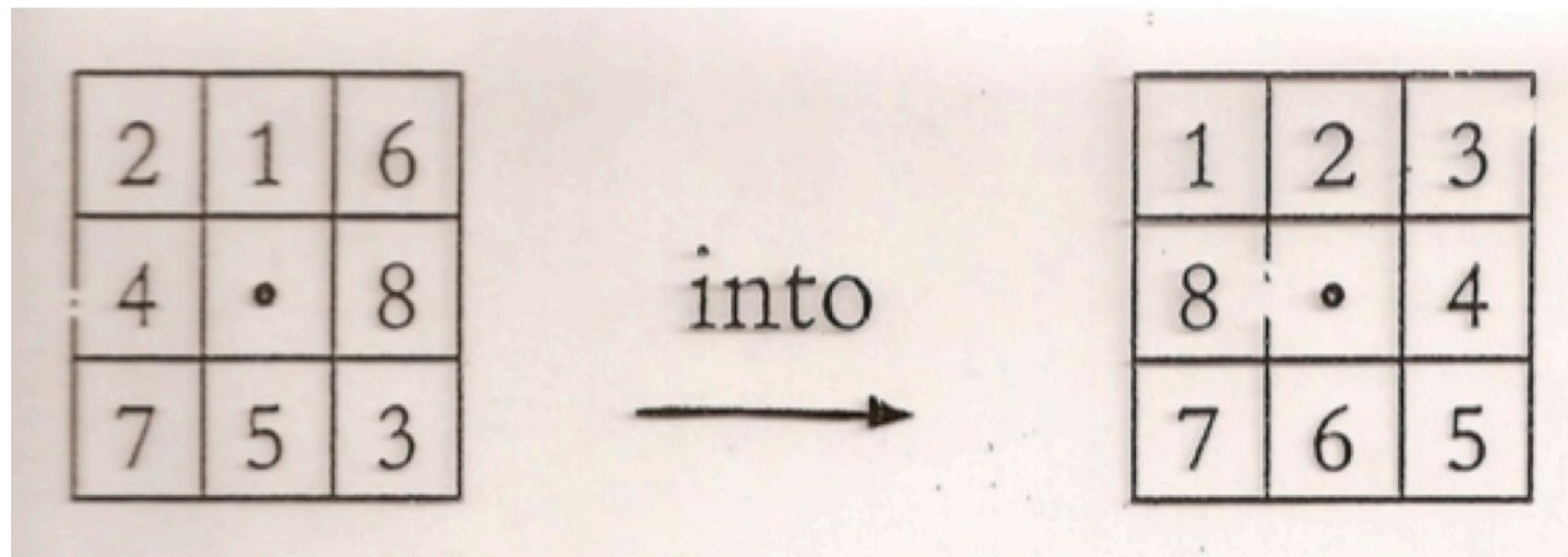


# Definition of problem solving

- **Problem solving** is finding a path (or solution) that overcomes some obstacle, permitting us to reach a desired goal state.
  - often want the BEST solution
- **Problem space** includes:
  - *initial state* - initial situation of the problem solver
  - *goal state* - the goal itself
  - *problem solving operators* - transform one problem state into another problem state

# Tile puzzle

- Transform the initial state into the goal
- Operator: move a tile into an empty space



# Typical problem:

- $\underbrace{2x + 3y = 5}_{\text{initial state}}$        $x = ?$        $\underbrace{x}_{\text{goal state}}$
- Problem solving operators ->  
rules of algebra
- Problem states:  
$$2x = 5 - 3y$$
$$x = \frac{5 - 3y}{2}$$
$$x = \frac{5}{2} - \frac{3}{2}y$$

# Typical problem.... $2x + 3y = 5$ , $x = ?$

- Problem states:

$$2x = 5 - 3y$$

$$x = \frac{5 - 3y}{2}$$

$$x = \frac{5}{2} - \frac{3}{2}y$$

- Problem space would also include:

$$\frac{2x + 3y}{2} = \frac{5}{2}$$

$$x + \frac{3y}{2} = \frac{5}{2}$$

$$x = \frac{5}{2} - \frac{3}{2}y$$

(includes any legal algebraic expression)



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# Some general problem solving strategies

- ***Diagrams***

- Help to make the relationship between problem elements more concrete and explicit.
- Act as an external memory and so help us to visualize the whole problem all at once
- Help to represent *complex* relations between elements of a problem in a less abstract format
- Help with the understanding of a problem i.e. problem representation

Eg. flowcharts.

# Problem solving strategies

- Creating ***subgoals***
  - involves decomposing a problem into smaller, more manageable components eg. subroutines.
  - Program to sum integers:
    - Input integers
    - Add
    - Output results

# Problem solving strategies

- ***Working backwards*** from the goal
  - look at what the goal is, and try to figure out how to get back to the start state
  - tend to use this strategy in unfamiliar domains

# Problem solving strategies

- ***Random search***
  - also known as generate and test
  - is essentially a trial and error procedure
  - fall back method when others don't work or are too cognitively overloading
- ***Hill climbing***
  - Problem solver looks one move ahead and chooses the move that most closely resembles the goal state
  - Often more reliable than random search but can lead you astray as sometimes have to move further away from the goal in the process of solving a problem

# Problem solving strategies

- **Means-ends strategy** – the problem solver compares the **current problem state** with the desired **goal state** and tries to find problem solving **operators** that will bring them closer to the goal state eg. Tower of Hanoi
- **Means-ends analysis** is a useful problem solving strategy for novices. However, it is not a very good learning strategy.

# Problem solving strategies

- ***Analogy*** - the problem solver uses the structure of the solution to one problem to guide the solution to another similar problem.
- Success in using an analogy depends on recognising the similarity between the two problems as well as recalling the solution of the analogous solution.
- People better at recognising analogies when surface features of the problems are similar; not as good when problems only share structural similarities.

# Problem solving strategies: Analogy

The amount of water in a bathtub is determined by the rates of water flowing into the tub and water flowing out through the drain. As long as the inflow of water into the tub exceeds the outflow, the bathtub will continue to fill.

Likewise, the amount of carbon dioxide ( $\text{CO}_2$ ) in the atmosphere is determined by the rates of  $\text{CO}_2$  emissions and  $\text{CO}_2$  removal.

# Problem

Suppose you are a doctor faced with a patient who has a malignant tumor in his stomach. It is impossible to operate on the patient, but unless the tumor is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumor. If the rays reach the tumor all at once at a sufficiently high intensity, the tumor will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumor will also be destroyed. At lower intensities the rays are harmless to healthy tissue, but they will not affect the tumor either. What type of procedure might be used to destroy the tumor with the rays, and at the same time avoid destroying the healthy tissue?



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# Importance of prior knowledge

- Most everyday problems that we solve rely on a large base of **domain specific knowledge**, which is stored in the form of schemas.
  - Eg.  $2x+3y=5$  ,  $x=?$
- **Schema** – cognitive structure in memory that allows people to classify information according to how it will be used (Sweller, 1994).

# Example:

Once there was a monk who lived in a monastery at the foot of a mountain. Every year the monk made a pilgrimage to the top of the mountain to fast and to pray. He would start out on the mountain path at 6 a.m., climbing and resting as the spirit struck him, but making sure that he reached the shrine at exactly 6 p.m. that evening. He then prayed and fasted all night. At exactly 6 a.m. the next morning, he began to descend the mountain path, resting here and there along the way, but making sure that he reached his monastery again by 6 p.m. of that day.

That evening as he was hastening to a much needed dinner, he was stopped by the monastery's visiting mathematician, who said to him, "Do you know, I suddenly realised a very curious thing. Every time you make your pilgrimage, there is always some point on the mountain path, perhaps different on each trip, that you pass at the same time when you are climbing up as when you are climbing down." "What!" snorted the monk, annoyed. "Why, that's ridiculous! I walk at all manner of different paces up and down the path. It would be a great coincidence if I should pass any spot at the same time of day going up as coming down. The idea that such a coincidence might happen time after time surpasses belief!" The mathematician, who had a touch of fiendishness in his soul, smiled sweetly and said, "Bless you, Brother, not only should you believe it, but if you will just think about it in the right way, it's obvious." He then locked himself in his cell, confident that he had spoiled the monk's dinner and probably his night's sleep as well.

# Importance of appropriate problem representation

- One of the reasons a problem may be difficult to solve is that the problem may be difficult to *represent* in a solvable form.
- Example: Monk problem

# Importance of appropriate problem representation

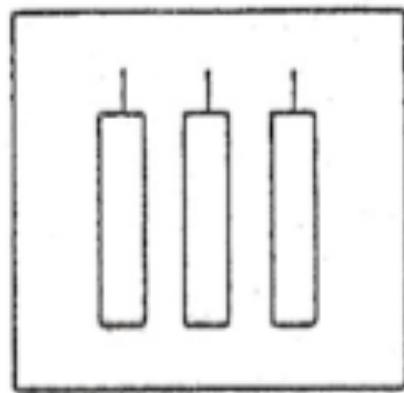
- Application to HCI
  - An interface may be difficult to use because one does not have the appropriate background knowledge, and so cannot adequately represent the problem.
  - Analogies and tutorials can be helpful.

# Functional fixedness

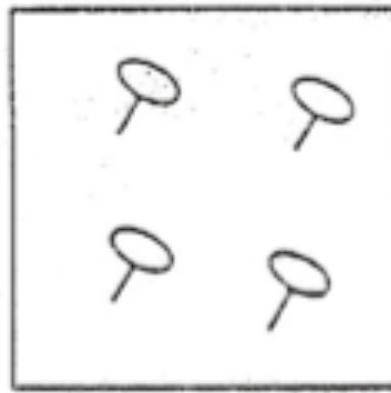
- **Functional fixedness** involves a mental block against using an object in a new or unconventional way in order to solve a particular problem.

# Duncker's candle problem

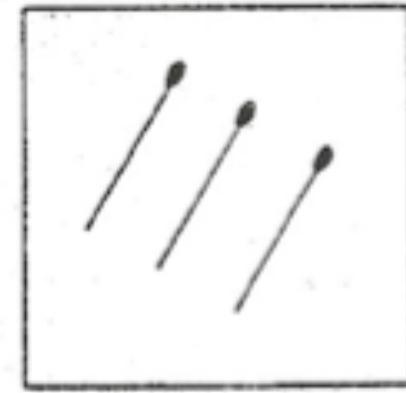
- Goal: Given the following, how would you mount the candle vertically on the nearby screen to serve as a lamp?



Candles  
in box



Tacks in  
box



Matches in  
box



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# Functional Fixedness

- Application to HCI:
  - Sometimes being an expert in an area can stop you from seeing things in a new or different way. The users of the software may discover new or unintended uses.

# The set effect

- The **set effect** occurs because of biases we have in solving a problem in a certain way as a result of previous experience.
- Example: Child's homework
- A certain procedure has worked successfully so many times in the past that it doesn't occur to us that a different procedure may be needed to solve this similar, but different problem.

# The Set Effect Example



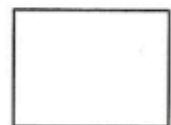
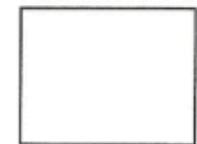
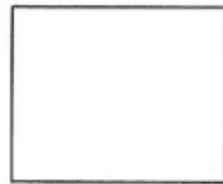
♦ or □



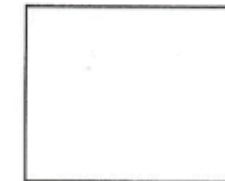
❖ or ✕



☎ or ✎



?



or



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# The set effect

- Application to HCI
  - A user of a system is unwilling to upgrade to a new, **more efficient** system as it is easier to continue doing things the way he/she is used to doing them.

# Other reasons why problems may be difficult to solve

- Goal state is inadequately defined
  - **Well-defined** problems have clear-cut goals and solutions

eg.  $2x + a = b$   
Solve for x
  - **Ill-defined** problems – do not have easily agreed upon solutions

eg. Discuss the implications of a limited working memory on problem solving?

# **Other reasons why problems may be difficult to solve**

- Problem solving space is too large
  - Too many options eg. choosing a career
  - Create subgoals to reduce search space size eg. want a career that involves helping others
- Lack of prior knowledge (specific to that domain)
  - Very common reason
- Memory limitations
  - Too much information that needs to be considered at once
  - Information not properly encoded into long-term memory

# Lecture Activity

- Think of some problems you recently had to solve?
- Were they easy or difficult? Why?
- Then think about Assignment 1 and how the complexity of the problem would be increased if you were asked to find your own website to analyze without any constraints
  - Define your *Problem Space*? Is it large or small?
  - What are the Problem states? What is your *initial state* and your *goal state*?
  - What are your *problem solving operators*?
    - The rules, constraints, what you can and cannot do
  - Why is it a difficult problem to solve?

# Summary

- Relevance & definition of problem solving
- General problem solving strategies
- Importance of prior knowledge to problem solving
- Importance of appropriate problem representation
- Other reasons why problems may be difficult to solve



**Internationalisation**  
COMP3511/9511 Human Computer Interaction

Never Stand Still

By Dr Sasha Vassar

Adapted from slides by Dr Daniel Woo

1

## Reading

- Ch 9 in Jacob Nielsen's book on Usability Engineering (1993).
  - Available to download via UNSW library



2

## Internationalisation / Localisation Overview

- Reasons why internationalisation is important
- Examples
- Internationalisation vs Localisation
- International Usability Engineering



3

## Internationalisation VS Localisation

- Internationalisation – making the user interface ready for translation
- Localisation – actually doing this translation for a particular language or culture



4

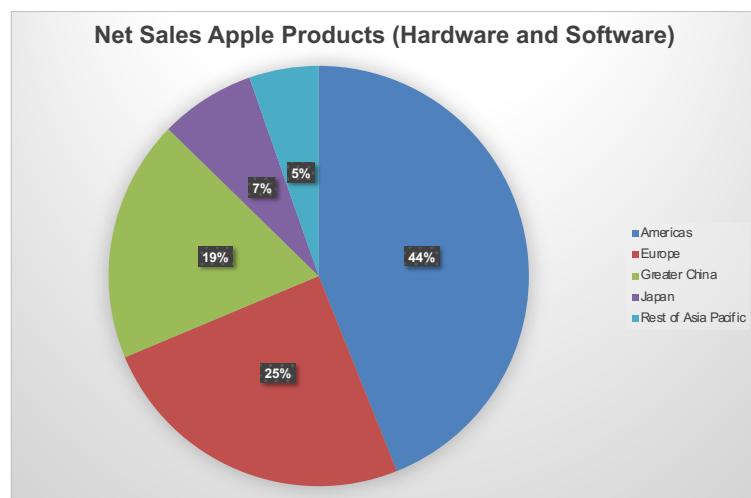
## Why do we need to consider international user interface design?

- International sales to other countries can be quite significant
  - In 1991 four of the five largest US computer companies derived >50% of their sales outside of the US
- The European Union (EU) creates a very large consumer market that has diverse needs in terms of language and culture
  - English, French, German, Italian, Swedish, Norwegian, ...



5

## Market Breakdown



Source: Apple Fourth Quarter Statement 2017  
<https://www.apple.com/newsroom/pdfs/fy17-q4/Q4FY17DataSummary.pdf>



6

## What is different?

- The character set / Keyboard
- Direction of text / alignment layout
- The language / words / phrases / spelling
- Size of words
- Unicode
- Metaphors
- Images / icons
- Date / time / currency
- Units of measurement
- Calendars
- Colours



7

## Why do we need to consider international user interface design?

- Not all languages are read from left to right and top to bottom. This will affect the layout of a user interface
  - Left to right (Australian)
  - Right to left (Arabic)
- Local customs may be quite different



8

# Text Direction

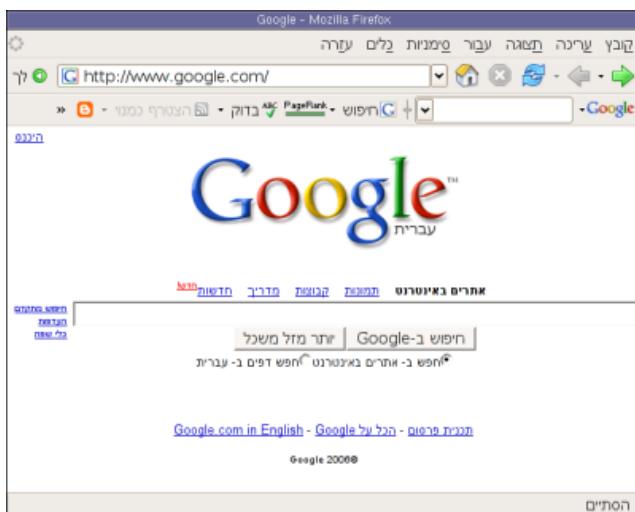


Image Credit: <http://web.mit.edu/6.813/www/sp16/classes/19-internationalization/>



9

## Can't we just do translation?

- Text is used in a variety of places in software
    - Labels / titles
    - Menu items
    - Error messages
    - Help
    - Manuals
  - Translation alone may not be enough



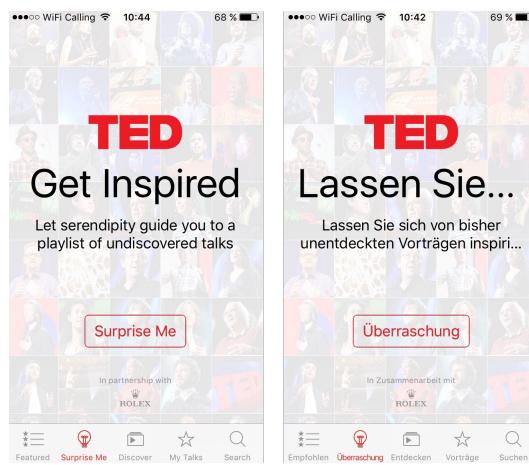
10

## Can't we just do translation?



11

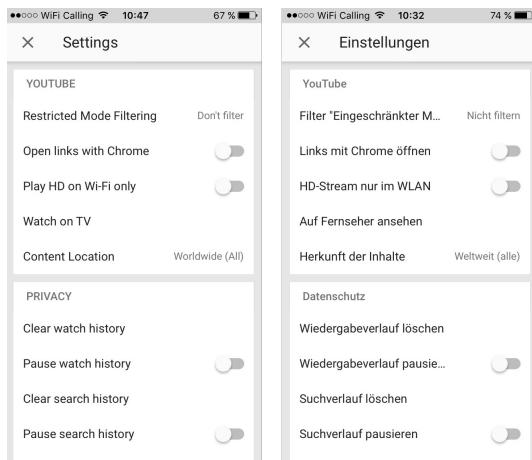
## Can't we just do translation?



12

<https://blog.prototypr.io/challenges-of-app-localisation-618add749450>

## Can't we just do translation?

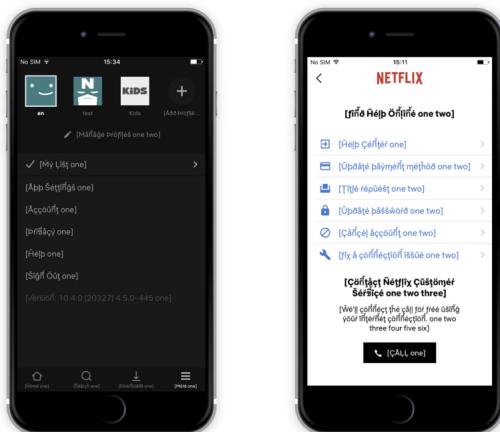


<https://blog.prototypy.io/challenges-of-app-localisation-618add749450>



13

## Pseudo Localisation



<https://www.ulatus.com/translation-blog/tech-brands-with-exceptional-localization-strategies/>



14

## Cultural localization: Slack example



  
**You look nice today.**  
- Your friends at Slack

<https://www.ulatus.com/translation-blog/tech-brands-with-exceptional-localization-strategies/>



15

## Can't we just do translation?

- You will require the expertise of a person who is familiar with the local customs and expressions
- They need to have been in the locale in recent times
- They should be briefed about the design rationale to give them background information



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## Translation gone wrong



Image Credit: [http://news.bbc.co.uk/2/hi/uk\\_news/wales/7702913.stm](http://news.bbc.co.uk/2/hi/uk_news/wales/7702913.stm)



17

## International Usability

- Avoid complicated language
- Avoid using examples overly dependant on local culture
- Involve international representatives in product design (from early stages)



18

## Example of localisation

The image shows two versions of a "Where and When?" shipping form side-by-side, demonstrating how form fields and validation rules differ between the United States and Germany.

**Left (United States):**

- Ship From:**
  - Country: United States
  - City: [Field circled]
  - ZIP Code: [Field circled]
- Ship To:**
  - Country: United Kingdom
  - Post Town: [Field circled]
  - Postcode: [Field circled]

**Right (Germany):**

- Ship From:**
  - Country: Germany
  - Postal Code: [Field circled]
  - City: [Field circled]
- Ship To:**
  - Country: England
  - City: [Field circled]
  - Postal Code: [Field circled]

Image Credit: <http://content.lionbridge.com/website-internationalization-how-to-boost-traffic-and-global-cx/>



19

## Graphics

- Do icons / graphics have worldwide recognition?
- International traffic signs *might* have worldwide recognition
  - In Au: Green man to cross street/Red to wait (Noise)
  - In US: White man to cross street/Red hand to wait (Silent)
- No guarantee. You need to test.
- 13% of Japanese did not know the Red Cross Symbol



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## Ticks and crosses

- We may consider ticks and crosses to be interchangeable
- In Japan the cross would indicate that the person was NOT a student

Student

Student



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## Icon Example

- Japanese and US symbols for an e-mail “mailbox” are different



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## Icon Examples

- Symbol of an owl
- Means wisdom and knowledge in the US
- Means witchcraft and black magic in Central America



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## Calendars

- Seasons are not the same between north and south hemispheres
- Gregorian calendar used in US, Australia, most of Europe
- Arabic, Jewish and Chinese calendars refer to lunar cycles
- Japanese calendars may reference the reign of specific Emperors



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## Dates

- Different date formats may be used
  - D/M/Y
  - D/M-Y
  - M/D/Y
  - Y.M.D
  - Y-M-D
- 12/11/2001 - does this mean the exam is on December 11 or November 11?



26

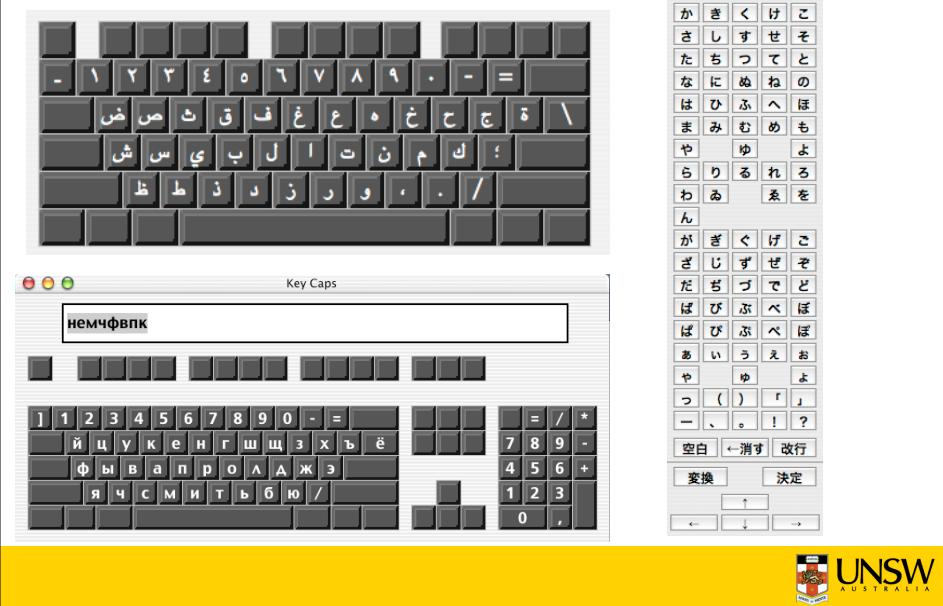
## Units

- US Imperial (inches, feet, miles)
- Rest of the world (metric)
- Celsius / Fahrenheit



27

## Keyboard Layout



28

## Internationalisation vs Localisation

- Internationalisation is the process of designing, preparing and developing your application for localisation
- Localisation is the processes of adapting an internationalised application to local and cultural conditions



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## Internationalisation vs Localisation

- Internationalisation relates to the development of the infrastructure that will enable the creation of localised versions
- Localisation involves the specific changes to the user interface
  - Text messages
  - Icons / Images
  - Sounds / media



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## Internationalisation vs. Localisation

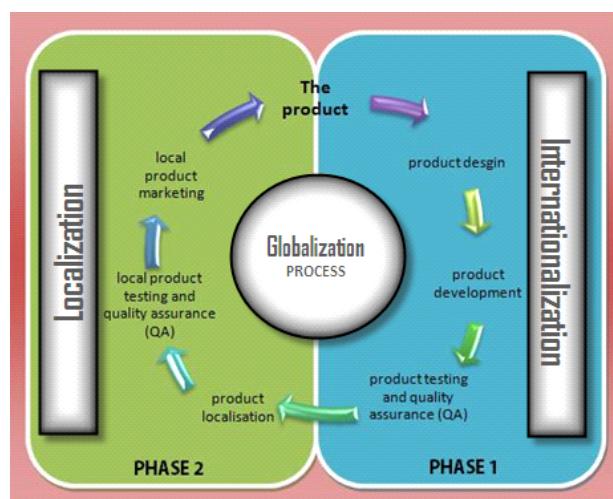


Image Credit: <http://www.belatrixsf.com/blog/globalized-software-a-brief-internationalization-and-localization-overview/>



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## Changing Infrastructure

- Previously the way of deploying an application for international markets was to develop one “executable” for each separate locale
- Storing localised information in separate resources means that one “executable” application can be shipped with many localisations included



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## Changing Infrastructure

- Requires that the application and user interface are designed with internationalisation in mind
- Design independently of localisation issues
- Apply individual localisations



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## International Usability Engineering

- Need to treat the localised versions as a new interface. It requires testing and evaluation like any other interface design effort
- Design from the beginning with internationalisation in mind rather than trying to add support at the end
- Early focus on international users' needs



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## International Usability Engineering

- Keep a design rationale explaining why translated phrases were adopted
- Maintain a glossary of translations - reusable design tool
- Work with specialists in the field for the specific locale
- Understand what the platform infrastructure (operating systems) will do for you



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## Summary

- Reasons why internationalisation is important
- What is different across countries
- Why we can't just translate
- Examples
- Graphics/Icons can have different meanings
- Internationalisation vs Localisation
- International Usability Engineering



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## Lecture Activity

- Consider how could you make your assignment 2 designs more International? What sorts of things would you need to change?



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## Some housekeeping

- myExperience Surveys
- Peer Review for Assn 2
- Exam Details
  - Fit to Sit and Special Considerations
  - Technical Issues



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## Online Surveys

- UNSW MyExperience survey
  - Available via Moodle for the course – see <https://moodle.telt.unsw.edu.au/mod/lti/view.php?id=3513676>
  - Should get an email via UNSW email address to complete this - please do this!
  - Course Evaluation: COMP3511 / COMP9511
  - Teacher Evaluation



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Complete your myExperience and shape the future of education at UNSW.

Click the Experience link in Moodle

or login to [myExperience.unsw.edu.au](https://myexperience.unsw.edu.au)

(use z1234567@ad.unsw.edu.au to login)

The survey is confidential, your identity will never be released  
Survey results are not released to teaching staff until after your results are published



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## Peer Review

- Please ensure everyone completes the Peer Review for Assignment 2 by the end of next week! (**Link will be open on Moodle Monday of Week 5**)
- If you do not complete the Peer Review by Friday, February 5<sup>th</sup> at midnight (Week 5), you will automatically have 10% deducted from your assignment.
  - I note that no input essentially translates to zero contribution for the group components of assignment 2, which could mean this could translate to a failed assignment.



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## Final exam

- Saturday 6<sup>th</sup> February at 10am
- Link will be available on MOODLE,  
please make sure that you are logged in  
on time and ready to start the exam



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## Final exam

- There are 50 multiple-choice questions (50 marks)
- There is one short essay style answer (20 marks)
- ALL questions are COMPULSORY.
- Please note that the exam uses a sequential order of questions – **once you answer a question you cannot go back!!!!** So please make sure that you are happy with your answer before moving on.
- Suggest about 1.2 minutes per question in MC
- Short answer about 30 minutes – you will also have the option to upload a file in this question, if you prefer to respond in a Word file.



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## Final exam

- You understand and can apply the user centred design methodology
- You understand when and how to apply the design techniques
- Provide examples to support your reasoning
- Define terms you reference, to show you understand what they mean
- Sketch examples
- We assume that you have read the prescribed text and assigned readings!!



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## Exam Approach

- Given a particular situation can you describe the specific steps in the user centred design process
- Can you critique a design and offer improved designs, supporting your design with a rationale (explanation) that is based on usability principles, heuristics etc. ?



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## Exam Approach

- Multiple choice section tests for understanding of concepts/principles and ideas as well as their application.
- The questions cover content from the whole course.



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## Sample Exam

- Sample exam available on Moodle
- Demonstrates the style of the exam questions – multiple choice
- Lets you practice with sequential order
- Given you unlimited attempts of the sample exam
- Sample exam will be made available this Sunday to allow you sufficient time to ask questions



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## Fit to sit rule

- Please ensure you get the date and time correct for the HCI exam (6<sup>th</sup> February at 10am) .
- If you are not feeling well on the day of the exam, please refer to the following link to find what you need to do:

<https://student.unsw.edu.au/special-consideration>



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## For Technical Issues

- Please pay particular attention to the special consideration policy for technical issues:
  - If you experience a technical issue that is beyond your control and impacts on your ability to complete an assessment, you should submit a special consideration application (either immediately, at the conclusion of your assessment or at the latest within 3 working days of the assessment) and upload relevant documentation that clearly demonstrates your circumstances and their impact.

<https://student.unsw.edu.au/special-consideration>



50

## For Technical Issues (2)

- In order to apply, you should:
  - Take screenshots of as many of the following as possible:
    - error messages
    - screen not loading
    - timestamped speed tests
    - power outage maps
    - messages or information from your internet provider regarding the issues experienced
- All screenshots *must* include the date and time the issue occurred.

<https://student.unsw.edu.au/special-consideration>



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## For Technical Issues (3)

- If the Course Coordinator or Tutor is present online during the assessment in chat, make contact *immediately* and advise them of the issue.
  - Please see next slide for details – I will be online and available during your exam
- Submit a Special Consideration application *immediately* at the conclusion of your assessment and upload your screenshots.
- Your special consideration application will be reviewed, and an outcome updated within 3-5 working days.

<https://student.unsw.edu.au/special-consideration>



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## Tech and support during exam

- A Teams channel has been set up:
  - FinalExam
- If any technical problems during the exam, please post on the wall and tag us:
  - @Alexandra Vassar
- If questions about content or personal, please message privately on Teams. DO NOT PUT SCREENSHOTS OF QUESTIONS ON THE CHANNEL.

