Comp 388/441 - Human-Computer Interface Design

Week 6 - 19th February 2015

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Cognitive Load - 1

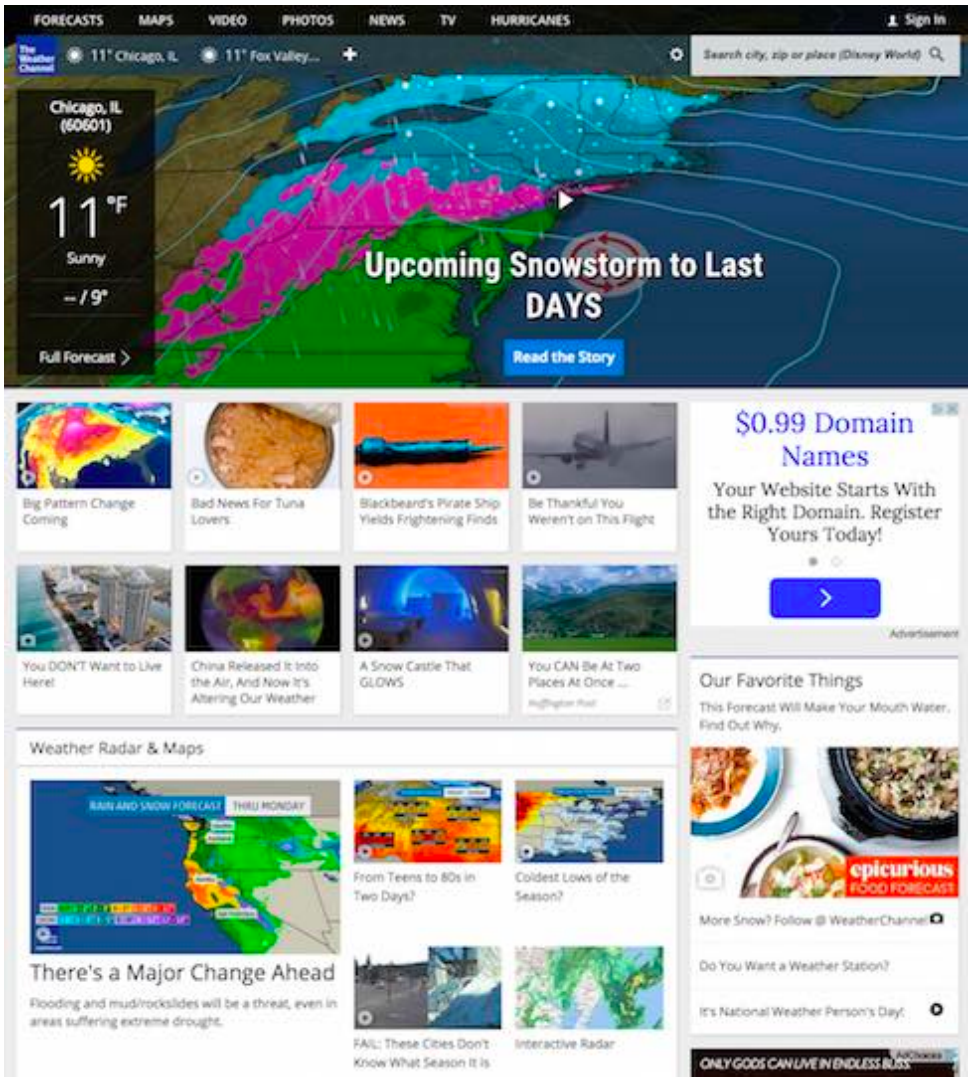
- consider the physical act of interacting with a computer
    - *using a mouse, keyboard, touchscreen...touching, swiping, shaking*
- physical actions incur a cost of time and effort
    - *varying degrees of effort, both physical and mental*
- cognitive load refers to the mental taxation exerted on a user
    - *whilst performing a given task*
    - *refers to amount of sustained attention and cognitive effort required per task*
- the more complex the task, the higher the level of focused attention
    - *cognitive load will be higher as a result*
- good design strategy to try to reduce a user's cognitive load
- try reducing the amount a user has to think about
    - *general concepts, points of interaction, basic navigation, interface elements...*
- "Don't make me think , revisited: A common sense approach to web usability."
    - *Steve Krug, 2014.*

Cognitive Load - 2

Cognitive load may be impacted by the following interactions:

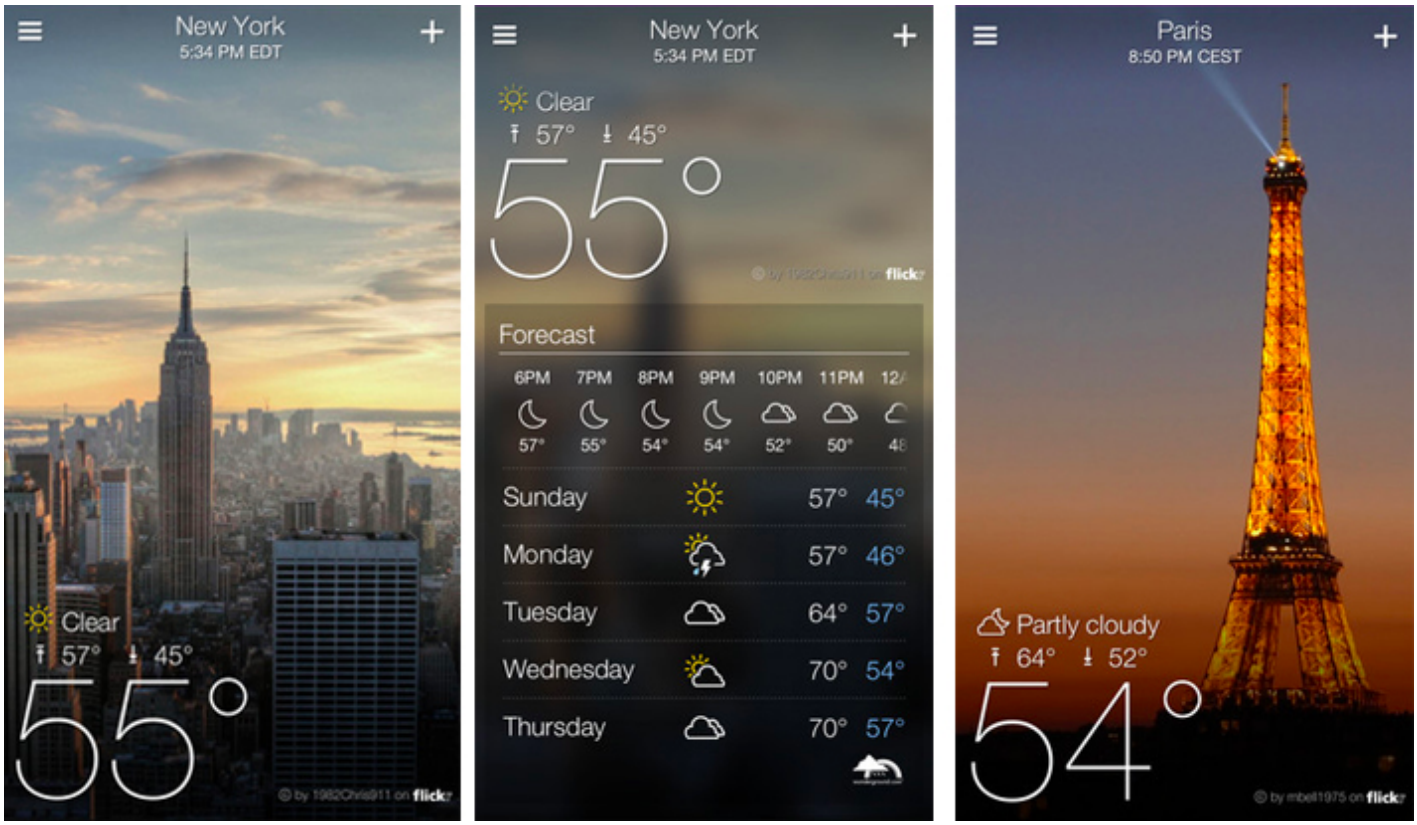
- scrolling, navigating, searching within an application
- choosing options such as menus, lists, forms...
- reading instructions, labels, titles...
- switching contexts (eg: switching between windows, tabs, pages...)
- switching visual attention
    - *reading text, then referring to an image, and then back to the text*
- memory recall for a specific ID, name, action, task sequence...
- simply waiting for the system or application to respond...
- recovering from a specific distraction
    - *such as an interruption not relevant to the current task at hand...*

Cognitive Load - Weather.com



Source - Weather.com

Cognitive Load - Yahoo Weather App



Source - Yahoo! Weather Mobile App

Cognitive Load - 3

Thinking

- reduce cognitive loads by awareness of types of user thinking an app requires
- for example:
    - *working out the next step in a procedure*
    - *using working memory to help complete an ongoing task*
    - *recall of commands, facts, procedures from long-term memory*
    - *memorising commands, facts, procedures etc for long-term memory*
    - *referencing information from another source*
    - *making decisions or considering judgements*
    - *mental integration of information from disparate sources*
    - *including research, reference, or simply general peripheral sources...*

Users & Interaction - Video Second Try...

Filter photographs based on metadata

Source: Adobe Lightroom Tutorials

Cognitive Load - 4

- our goal is not to reduce thinking relative to our application
    - *intellectual thinking different from forced, unnecessary thinking due to poor design...*
- our app should promote and facilitate thinking, and record results where applicable
- our app should try to limite extraneous cognitive load for activities such as
    - *active research activities*
    - *creative development and output*
    - *general problem solving and issue resolution*
    - *reading, note taking, and other general tasks...*
- cognitive load reduced by an app's focus upon
    - *the task in hand, relevancy of UI information and implementation, reduction in extraneous content...*
- reduce interface induced thinking additional to the primary task
    - *better contextual support and research*

Cognitive Load - 5

Distraction-free

Source - Amazon Kindle Paperwhite

Cognitive Load - 6

Consider your app's big green button...

Source - Fuji Xerox Printers

Quantify Cognitive Load

- interested in how we can quantify the cognitive load
    - *required by a user for performing a given task*
- better understanding of load issues within our application and interface
    - *helps guide us in apportioning emphasis and control in design*
- for a particular task we can compile a list of actions, steps...
    - *estimate a score (% etc) which represents our understanding of required effort*
    - *total all of the action scores to assign an overall score for the effort required*
    - *evaluate different design options by comparing overall scores...*
- KLM-GOMS model
    - ***Keystroke-Level Model for the Goals, Operators, Methods, and Selection Rules***
    - *Card et al. "The Psychology of Human-Computer Interaction." 1983.*

KLM-GOMS Model - 1

- users divide goals into a series of tasks
    - *each task requiring some initial thought and preparation*
- preparation known as **task acquisition time**
    - *can be very short for simple, routine tasks*
    - *may be much longer, perhaps a few minutes, for more creative, original tasks*
- user will then continue with their chosen task
    - *using a sequence of actions or operations*
- total required time to complete the actions is known as **task execution time**
- total time required to complete task is the sum of
    - ***task acquisition time*** + ***task execution time***
- modified models for mobile devices, such as phones...
    - *eg: Keystroke-level model for advanced mobile phone interaction*

KLM-GOMS Model - 2

Code	Operation	Time (in seconds)
K	Key press & release (keyboard)	Best Typist (135 wpm) = 0.08
		Good Typist (90 wpm) = 0.12
		Avg. Skilled Typist (55 wpm) = 0.20
		Poor Typist (40 wpm) = 0.28
		Typing Random Letters = 0.50
		Typing Complex Codes = 0.75
		Worst Typist = 1.20
P	Point mouse to an object on screen	1.10
B	Button press or release (mouse)	0.10
H	Hand from keyboard to mouse & vice-versa	0.40
M	Mental preparation (operation)	1.20
T(n)	Type string of characters	n x K seconds

wpm = words per minute

Source: Kieras, D. 1993. Wikipedia

KLM-GOMS Model - 3

Example implementation - text search including mental operators

Action	KLM-GOMS Code	Time (in seconds)
move mouse to **search** menu	H (hand to mouse)	0.40
	M + P (search menu)	1.20 + 1.10
select **search** menu...	BB (select search menu)	2 * 0.10
click on ***find text*** link...	M + P (find text menu item)	1.20 + 1.10
	BB (select menu item)	2 * 0.10
	H (hand from mouse to keyboard)	0.40
enter search term ***et***	KK (type ***et*** characters)	2 * 0.20 (avg. typist)
click the ***OK*** button	H (hand from keyboard to mouse)	0.40
	M + P (***OK*** button)	1.20 + 1.10
	BB (click button)	2 * 0.10
Total		9.10

BB = double button press to simulate mouse click and release (0.20 seconds)

Reducing Cognitive Load - 1

A few tips and tricks

- consistent use of icons, labels, names, and general visual presentation
    - *consistency should include design for multiple tasks as well*
- clear navigation for process steps...wizards, paged results etc
- include visual cues and clues...saves users having to remember functionality
- avoid popups except for explicit intervention reasons...warnings, errors etc
- avoid redundancy in content and rendering
- relational material should be organised in close proximity to one another
- identify and remove unnecessary steps
- automate processes, steps where possible
- reduce delays and latency as much as possible...use progress updates, bars
- option for templates, tutorials for new documents in productivity apps etc
- video and audio tutorials often easier to follow and understand than text only
- repetitive user data entry can be avoided
    - *app should not force a user to continually remember such data and information*

Reducing Cognitive Load - 2

Concept of **Flow** by **Mihaly Csikszentmihalyi**

- user's creativity and productivity are high
    - *performance of activity occurs naturally and unconsciously*
- user experiences deep concentration and immersion in their current activity
    - *user is effectively both alert and relatively relaxed*
- living in the moment
    - *sensation of being so engrossed in an activity a user is unaware of the passage of time*
- balancing interest and challenge
- user is confident and exhibits a sense of control over their current situation
- user is working progressively towards achieving a specific goal
    - *eg: in games this might be as simple as getting to the next level*

TED 2004 - Flow, the secret to happiness

Working Memory and the Concept of Flow

TED 2013 - Peter Doolittle: How your "working memory" makes sense of the world

Reducing Cognitive Load - 3

Flow states and software

- unusual for beginners to be able to gain a sense of **flow**
    - *normally requires some level of comfort or familiarity*
    - *ease with the general operation and control of the application*
- acquiring a state of **flow** is quite difficult
    - *focused concentration is often not enough*
    - *reducing cognitive load in apps can aid in the process*
- interruptions in the real world can break a user's sense of **flow**
    - *visual clutter and noise in interfaces can have the same effect*
    - *interface distractions can also break a user's sense of **flow***

Reducing Cognitive Load - 4

Interface suggestions for **flow**

- reduce interruptions in the interface unless intentional for warnings, errors...
    - *non-important modal popups, notifications should be avoided*
- keep visual presentation simple
    - *bright, loud colours and images are jarring to the user's eye*
    - *unnecessary, prolonged or repetitive animations are distracting*
- sequential navigation should be obvious
    - *do not require the user to search the interface for **next**...*
- avoid switching between tabs, windows, pages for related information
- saving a document, work etc should be easy and intuitive for a user
- output and display progress reports for ongoing activities
    - *progress bars, spinning wheels, timers...*
- offer feedback in a prompt and consistent manner within the interface
- multi-tasking for users is difficult
    - *don't ask your users to perform too many interface tasks at once...*

References

- Card, S.K., Moran, T.P. and Newell, A. *The psychology of human-computer interaction*. Lawrence Erlbaum Associates. 1983.
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- Kieras, D. *Using the Keystroke-Level Model to Estimate Execution Times." 1993. http://courses.wccnet.edu/~jwithrow/docs/klm.pdf
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