

Comp 341/441 - Human-Computer Interface Design

Spring Semester 2017 - Week 6

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Cognitive Load

intro

- 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

impact of interactions

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...*

Image - Xerox

big green button...

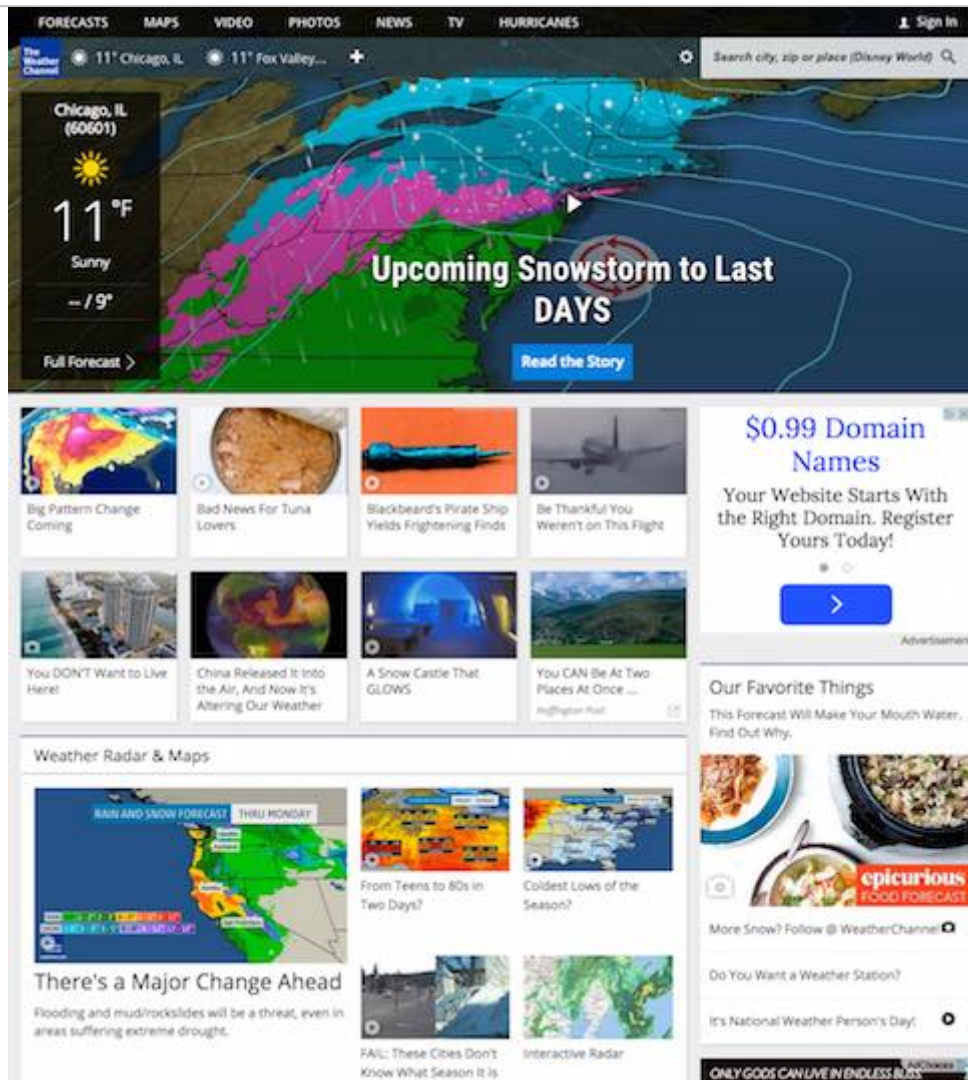


Xerox's Big Green Button

Source - Fuji Xerox Printers

Image - Cognitive Load

Weather.com

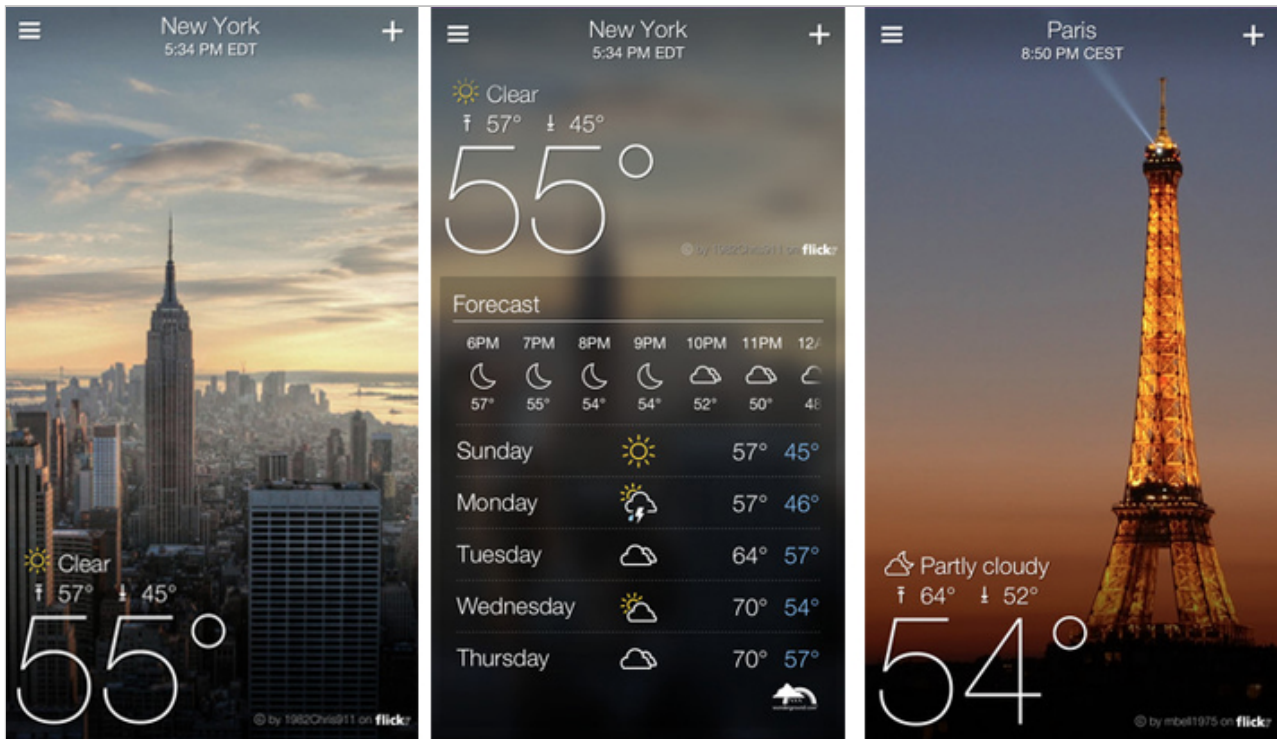


Weather.com

Source - Weather.com

Image - Cognitive Load

Yahoo Weather app



Yahoo Weather App

Source - Yahoo! Weather Mobile App

Cognitive Load

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...

Video - Cognitive Load

users and interaction - second try...

Filter photographs based on metadata

Source - Adobe Lightroom Tutorials

Cognitive Load

forced, unnecessary thinking

- 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 limit 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*

Image - Cognitive Load

distraction free



Kindle Paperwhite

Source - Amazon Kindle Paperwhite

Image - Cognitive Load

app's *Big Green Button*



Xerox's Big Green Button

Source - Fuji Xerox Printers

Cognitive Load

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

intro

- 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

usage

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

example

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

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*

References

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- Norman, D. *The Design of Everyday Things*. Basic Books. 2013.