Experiments, Model Human Processor, GOMS, Competitive Analysis

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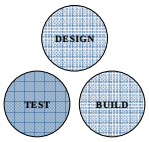
Overview

- Where we left off
- Experiments
- Model Human Processor
- **G**oals, **O**perators, **M**ethods & **S**election Rules
- Competitive Analysis



Where We Left Off

	Think Aloud Protocol	Heuristic Evaluation	Cognitive Walkthrough	Model Human Processor	GOMS	Experiment	Competitive Analysis
User	X					X	
Heuristic		X	X				
Hard-Data				X	X	X	
Market Defined							X
Speed	Fast	Medium	Medium/Slow	Slow	Slow	Slow	Fast
Cost	Cheap	Cheap	Cheap	Cheap	Cheap	Expensive	Cheap
# of users required	2-8	0	0	0	0	20+	0
# of evaluators required	1-2	2-8	2-8	1-2	1-2	1-4	1-2
Developed by	Newell & Simon from CMU	Jakob Nielsen (useit.com)	Based on Lewis & Polson's CE+ info processing model	Card, Moran & Newell	Card, Moran & Newell	Social Psychology as a field	Business & Marketing as an org structure

Experiments : An Overview

- A controlled experiment:
  - .. manipulates the world and then observes what happens
  - .. looks for **cause-effect relationships**
  - .. is a scientific procedure – a controlled, empirical test
- HCI is a science, usually found in the school of computer science at a university
- HCI produces an enormous written body of knowledge, usually in the form of experiment results.

You need to know how to read these.

Experiments : Goals

- A good experiment:
  - .. has a clear and testable **hypothesis**
  - .. has **quantitative** measurements
  - .. has a measure of **confidence** in the results (statistics)
  - .. has complete control of **variables** and conditions
  - .. can be **replicated**

Experiments : Experimental Method

- **Testable hypothesis**
  What do you want to know about your product, and what do you expect the result will be?
- **Independent variables**
  Variables you can manipulate (known as experimental treatments)
- **Dependent variables**
  Variables you can measure (the treatment effects)
- **Experimental design**
  The plan you will use to test your hypothesis

Experiments : An Example

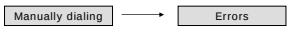
- A research question:
  How does manually-dialing a cell phone affect driving?

Experiments : An Example : Hypothesis

- Our hypothesis is about **causality** – what causes something else to occur
  - A **causes** C
    Manually dialing a cell phone causes driving errors.
  - A **has a bigger effect on** C than B
    Manually dialing a cell phone causes more driving errors than voice dialing.
  - A **has no effect on** C
    Manually dialing a cell phone has no effect on driving errors.

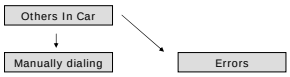
Experiments : An Example : Hypothesis

- **Causality**? Or **Association**?
  - Manually dialing a cell phone causes driving errors



.. or ..

  - There are three other people in the car, talking noisily, so the driver can't use voice dialing



Experiments : An Example : Variables

- Independent Variables: The things you manipulate to see how a participant's behavior changes
  - The **amount** of a variable
  - The **level** of a variable
  - **Presence** of a variable
    .. manually dialing a cell phone
  - **Absence** of a variable
    .. any other dialing method

Experiments : An Example : Variables

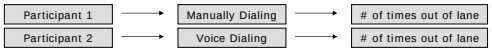
- Dependent Variables: The things you measure (and do not change)
  - Speed of the vehicle
  - Time taken to complete the task
  - # of accidents
  - Ability to keep the vehicle in a straight line (in their lane)

Experiments : An Example : Design

- Select your participants
  - Age
  - Experience
  - Education
  - Demographics
  - Skill levels

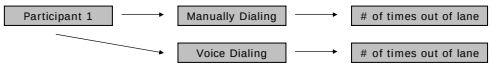
Experiments : An Example : Design

- Between-subjects



  - Individual differences
  - More participants needed

- Within-subjects



  - Learning (counterbalancing)
  - Maturation (fatigue, boredom)

Experiments : Being Skeptical

Basis: Measurements from a weather satellite, taken at the altitude of the satellite, show a decrease in the temperature of Earth's upper atmosphere over a 20-year period.

Conclusion: Not only is the Earth's atmosphere not warming due to the greenhouse effect, it's actually cooling.

What's wrong with this conclusion?

Experiments : Being Skeptical

- Over a 20-year period, atmospheric drag had significantly lowered the satellite's orbit.
- The temperature readings, over time, were taken at progressively lower levels.
- At this level of the atmosphere, temperature decreases with lower altitudes.

This is an example of **hidden variables**.

Experiments : Being Skeptical

Basis: After advertising for an "Eating Disorder Study" on campus, results showed a comparison between gender, age and eating disorder.

Conclusion: Almost 96% of college aged woman have an eating disorder!

What's wrong with this conclusion?

Experiments : Being Skeptical

- In order to accurately determine who has eating disorders, it is necessary to study people both with and without the disorder.
- By advertising for an "eating disorder study", you will likely get more people with eating disorders than in the regular population.

This is an example of **selection bias**.

Experiments : What You Need To Know

- You will rarely be running experiments
- You will frequently be reading about experiments
  - The newspaper
  - Magazines/Internet
  - CHI journals
- Be able to be **skeptical**

Model Human Processor

Model Human Processor : An Overview

- Intended to approximate human behavior at a gross (large, not ugly ☺) scale
- Gives you more heuristics for design
- Gives you a very rational, scientific means to defend design ideas
- Made up of several "laws", each backed by scientific experiment

Model Human Processor : Basics

When I clap, you knock on the table.

Model Human Processor : Basics

Clap .. Pause .. Knock

There are three interacting subsystems:

1. **Perceptual**
   (hear clap)
2. **Cognitive**
   (process clap)
3. **Motor**
   (knock)

Each subsystem has a processor & associated memories.

Model Human Processor : Basics

- We annotate the various processors & memories like this:

Greek Letter	Pronounced	Meaning
μ	mew	Storage capacity of a system
δ	delta	Decay time of an item
κ	kappa	Type of processor (physical, acoustic, visual or semantic)
τ	tau	Cycle time of a processor

- We use three times to encompass individual differences: fastman, middleman & slowman

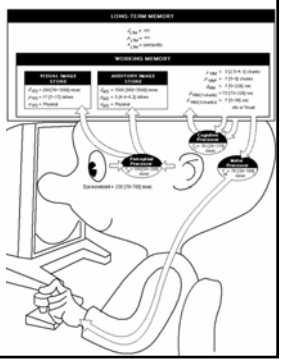
  written like this: middleman [fastman ~ slowman]

Model Human Processor : Bubblehead

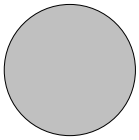
- Perceptual Processor
- Motor Processor
- Cognitive Processor

On each cognitive processor cycle, the contents of working memory initiate actions linked to them in long term memory.

These actions then modify working memory.

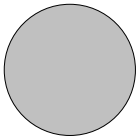


Model Human Processor : Explains Animation



Model Human Processor : Explains Animation

By flashing images quickly, the dot seems to "grow" - animation.



The perceptual processor speed is Tp = 100 [50 ~ 200].

Assuming middleman, animation frame speed should be greater than 1 frame every 100 ms, or **10 frames/sec**.

But, to make sure everyone sees the animation, assume fastman; greater than 1 frame every 50 ms, or **20 frames/sec**.

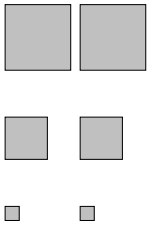
Model Human Processor : Explains Animation

- Animation in older films falls apart when the film is bright. But darker scenes hold together.

  Variable Perceptual Processor Rate Principle:
  The Perceptual Processor cycle time Tp varies inversely with stimulus intensity.

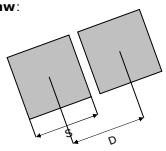
  What does this tell us about palm pilots, watches, cell phones, hand-held video games?

Model Human Processor : Targets



Model Human Processor : Targets

- **Fitt's Law**:

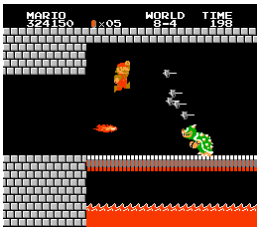


The time Tpos to move the hand to a target size S which lies a distance D away is given by:

Tpos = I_M log2 (D/ S + .5), where I_M = 100[70~ 120] ms1

What does this tell us about button sizes in interfaces?

Model Human Processor : Practice



Model Human Processor : Practice

- Users get faster at their tasks with practice

  The Power Law of Practice
  The time Tn to perform a task on the nth trial follows a power law:

  $T_n = T_1 n^{-\alpha}$, where α = .4[.2~.6].

  What does this tell us about our assumptions in creating our personas & scenarios?

Model Human Processor : Uncertainty

17 button phone

68 button phone

Model Human Processor : Uncertainty

- **Decision time T increases with uncertainty about the judgment or decision to be made**:

  $T = I_C H$, where H is the information- theoretic entropy of the decision and I_C = 150 [0~ 157] msec/ bit.

  For n equally probable alternatives (called Hick's Law) $H = \log_2 (n + 1)$. For n alternatives with different probabilities, p_i, of occurrence $H = S_i p_i \log_2 (1/ p_i + 1)$

  This applied to uncertainty in the environment, not uncertainty in memory (ie, not for icons).

Model Human Processor : Rationality

- This one's easy – no math

  a person acts so as to attain his goals through **rational action**, given the structure of the task and his inputs of information and bounded by limitations on his knowledge and processing ability.

  Goals + Tasks + Operators + Inputs + Knowledge = Behavior

  Goal: To increase company profits

  Task: Book a flight

  Operators: Mouse movements, clicking, typing

  Inputs: A combo box, an OK button

  Knowledge: A combo box is a way to make a selection; an OK button applies the new selection

Model Human Processor : Summary

- You will probably not use the MHP **equations** while you design
- You will definitely use the MHP **principles** while you design
- **You now have a scientific way to prove design decisions to engineers, marketing, etc**

GOMS

GOMS : An Overview

- **G**oals, **O**perators, **M**ethods & **S**election Rules
- GOMS attempts to predict human performance on tasks involving **routine cognitive skill**:
  - assembly workers
  - telephone operators
- Uses MHP formulas and principles to determine an approximate total task time
- Once you have created a full GOMS model of a task, you can very easily determine how design decisions will impact time on task

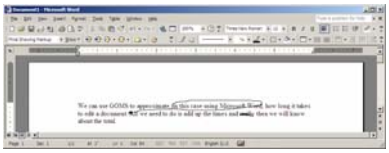
GOMS : What It Will Tell Us

- **Operator sequence**
  Which actions must come in a sequence; which actions can occur at once (in parallel)
- **Execution time**
  How long does a task take, at the millisecond level
- **Learning time**
  How long does it take to learn a task
- **Error recovery support**
  Are users about to regain control after an error occurs

GOMS : What It Won't Tell Us

- **User's goals**
- **Any ergonomic issues:**
  - Readability
  - Icon recognition
  - Command memorization
- **Any emotional qualities:**
  - Is the user bored?
  - Is the interface ugly?
  - Is the system so frustrating to use that people leave crying?
- **Social or Organizational impact of the system:**
  - Did the system replace 300 people's jobs and morale is low at the company?

GOMS : An Example : Goals



A **goal** is an end towards which effort is directed. Our goal is to make the necessary edits in this document.

- Edit Manuscript (high level goal)
  - Move text
  - Erase text

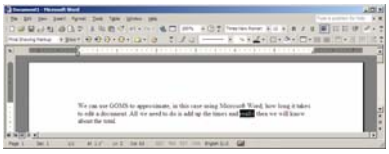
GOMS : An Example : Operators

An operator is an action performed to complete a goal.

- Move the mouse
- Click the mouse button
- Shift-Click the mouse button
- Press the delete key
- Press Ctrl-X
- Press Ctrl-V

- Operators are independent of historical background, including learning time or execution time

GOMS : An Example : Methods



A **method** is a sequence of operators that accomplish a goal.

If our goal is to delete a phrase, our method may be to use the "mark beginning & end delete method":

- Move mouse to the beginning of the phrase
- Click mouse button
- Move mouse to the end of the phrase
- Shift-click mouse button
- Press the delete key

GOMS : An Example : Selection Rules

A **selection rule** is the knowledge of how to choose one method over another.

To delete a phrase, we can use:

- mark beginning & end delete method
- mark beginning and press delete many times method
- mark end and press backspace many times method
- mark beginning & end and press ctrl-x (cut)

We pick our method based on the task situation – our selection rules.

GOMS : How To Do It

1. List the overt actions necessary to complete the task
   - Keystrokes & Button presses
   - Mouse movements
   - Hand movements from mouse to keyboard
   - System response times
2. Insert mental operators for cognitive processes
3. Assign execution times based on previous experiments
4. Add up the execution time

GOMS : Summary

- You will probably never build a GOMS model.
- You will frequently hear about GOMS models and the terminology presented
- GOMS works, and is worth the time, when:
  - You are studying a very repetitive task
  - You are concerned with time on task
  - You are concerned with fraction-of-a-second specificity

… bringing us to …

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Competitive Analysis : Overview

- A way to compare feature sets across a market
- Often used by marketing in determining requirements for a product release – see what the competition is doing, and match it
- Careful: competitive analysis makes an implicit assumption that:
  - Features are important (instead of goals)
  - The features competitors choose are good ones

Competitive Analysis : The Basics

- Using tasks (or scenarios), walk through competitors products and record:
  - The features included in the product
  - Any new and insightful innovations
  - Any problems you immediately see with competitors basic frameworks
- Using a grid (excel, HTML table, etc) record a visual representation of each step or key point through the interface
- As you look at more and more products, go back and fill in the missing information from previous products

Competitive Analysis : An Example

- News, online. What seems to be important to a news site?

	CNN	msNBC	News.com	Savannahnow
				
Search mechanism	Simple search located on the top/left of the main page	Simple search located on the right/center of the main page	Directly on top/right of the main page; offers search of news, cnet or all of the internet	None on the main page; forces user to the left nav, and then offers "power search"
Advertising	Banner on the top; integrated push content from partners (Time, Business 2.0, Sports Illustrated)	Banner in the center; huge take-over ads prevent reading of content; ads for NBC everywhere	Banner on the top	Ads everywhere; border on the top, right and left of ads limits content to a small area

Summary

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