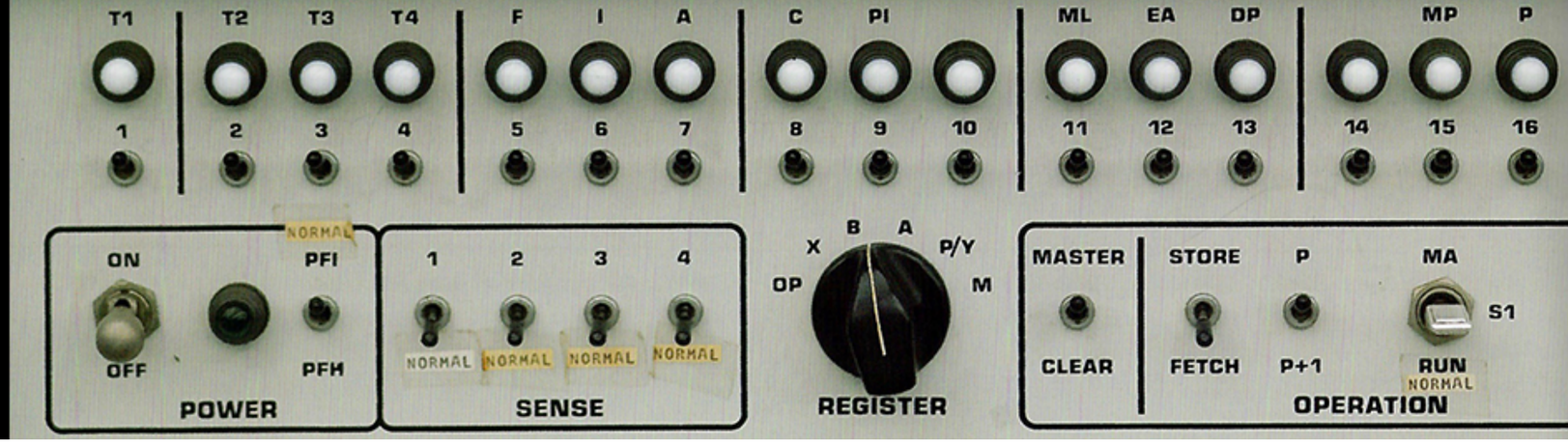
CS160

USER INTERFACE DESIGN

FALL 2018



USABILITY TESTING

8 OCT 2018

ERIC PAULOS
www.paulos.net

UNIVERSITY OF CALIFORNIA Berkeley

berkeley certificate in design innovation

bcdi.berkeley.edu

College of Engineering • College of Environmental Design • Haas School of Business
• College of Letters and Science – Arts and Humanities Division

The Berkeley Certificate in Design Innovation introduces design as the creative and critical means to innovate — to define, to imagine, and to advance a globally just future.

APPROVED COURSES FOR THE BERKELEY CERTIFICATE IN DESIGN INNOVATION

BERKELEY CERTIFICATE IN DESIGN INNOVATION		
1 lower division course	**DESIGN FOUNDATIONS**	
must be taken outside of home College or School	ART 8- Intro to Visual Thinking ART W23AC- Data Arts DES INV 10- Discovering Design DES INV 15- Design Methodology	ENV DES 1- People & Environmental Design ENV DES 4A- Design & Activism ENV DES 104- Design Frameworks THEATER 60- Intro to Technical Theater & Production UGBA 190T- Needfinding in the Wild
choose 2 (2+ units)	**DESIGN SKILLS**	
	ARCH 11A- Intro to Visual Representation & Drawing ARCH 150- Introduction to Structures ARCH 160- Introduction to Construction BCNM 185- Interdisciplinary Drawing Design DES INV 21- Visual Communications & Sketching DES INV 22- Prototyping & Fabrication DES INV 190-001- Methods, Skills & Mindsets DES INV 190-002- User Experience Design ENGIN 25- Visualization for Design ENGIN 26- 3D Modeling for Design ENGIN 27- Intro to Manufacturing & Tolerancing	LD ARCH 1- Drawing a Green Future LD ARCH 189- Contemporary Approaches to Visualization and Communication in Landscape Architecture MUSIC 158A- Musical Applications of Computers and Related Technologies THEATER 173- Scenic Design for the Theatre THEATER 174- Costume Design for the Theatre THEATER 175- Lighting Design for the Theatre THEATER 177- Sound Design & Media Theater THEATER 178- Video Production for Performance UGBA 190T- Innovation and Design Thinking in Business
1 upper division (3+ unit course)	**ADVANCED DESIGN**	
	ART 178– Game Design CIV ENG 186- Design of Cyber-physical Systems COMPSCI 160- User Interface Design & Development COMPSCI 194/ DES Inv 190-001— Interactive Device Design COMPSCI 194/NWMEDIA 203– Critical Making CY PLAN 140- Urban Design- City Building & Place Making DES INV 190/NWMEDIA 19- Critical Practices DES INV 190-3- Reimagining Mobility	IEOR 170- Industrial Design and Human Factors INTEGBI C32- Bioinspired Design LD ARCH 111- Plants in Design ME 150A- Solar Powered Vehicles ME 178- Designing the Human Body MUSIC 158B- Situated Instrument Design for Musical Expression THEATER 175B- Advanced Lighting Design UGBA 190T/ ME 110- Intro to Product Development UGBA 190T/TDPS 100/ ART 100- Collaborative Innovation

HCI AND DESIGN COURSES

DES INV 10	DISCOVERING DESIGN
DES INV 15	DESIGN METHODOLOGY
DES INV 21	SKETCHING & VISUAL COMMUNICATION
DES INV 22	PROTOTYPING & FABRICATION
CS 294	INTERACTIVE DEVICE DESIGN
NWMEDIA 190	CRITICAL PRACTICES: PEOPLE PLACES PARTICIPATION
NWMEDIA 203	CRITICAL MAKING
IEOR 191	TECHNOLOGY ENTREPRENEURSHIP
IEOR 115	INDUSTRIAL & COMMERCIAL DATA SYSTEMS
IEOR 185	CHALLENGE LABS
CS 160	USER INTERFACE DESIGN
IEOR 186	PRODUCT MANAGEMENT
CS 260	RESEARCH TOPICS IN HCI

DES INV 23: CREATIVE PROGRAMMING & ELECTRONICS

DES INV 24: USER EXPERIENCE DESIGN

DES INV 95: DESIGN FIELD NOTES LECTURE SERIES

DES INV 97: MANUFACTURING FIELD TRIPS

DES INV 190-1 REIMAGINING MOBILITY: DESIGN DEVELOPMENT AND DELIVERY

DES INV 190-2: GLOBAL PRODUCT DEVELOPMENT

DES INV 190-3: DIGITAL PRODUCT DESIGN STUDIO

DES INV 190-4: Reimagining AR: Beyond the Headset

DES INV 190-9: Thinking Like a Good Ancestor

COMPUTER GRAPHICS AND ANIMATION

COMPSCI 194: Advanced Digital Animation

COMPSCI 98 /198: UCBUGG: 3D Modeling & Animation

NWMEDIA 190: Advanced Digital Animation

DIGITAL PRODUCT DESIGN

COMPSCI 160: User Interface Design and Development

COMPSCI 294: Interactive Device Design

COMPSCI 98 / 198: Web Design Decal

INFO C262: Theory and Practice of Tangible User Interfaces

NWMEDIA 203: Critical Making: Materials, Protocols, and Culture

ENGINEERING DESIGN

BIO ENG 192: Capstone Senior Design

EL ENG 192: Mechatronic Design Laboratory

ENGIN 25: Visualization for Design

ENGIN 26: Three-Dimensional Modeling for Design

ENGIN 128: Advanced Engineering design Graphics

MEC ENG 128: Computer Aided Mechanical Design

MEC ENG 102B: Mechatronic Design Laboratory

ENVIRONMENTAL DESIGN

ARCH 24: Design Thinking and the Design Professions

ARCH 105: Deep Green Design

ARCH 110AC: The Social and Cultural Basis of Design

CIV ENG 209: Design for Sustainable Communities

ENV DES 1: People and Environmental design

ENV DES 11A: Introduction to Visual Representation and Drawing

ENV DES 11B: Introduction to Design

HISTART 185A: Art, Architecture, and Design in the U.S.

LD ARCH 101: Fundamentals of Landscape Design

LD ARCH C250: Theories of Urban Form and Design

GAME DESIGN

ART 178: Game design Methods

ART 98 / 198: Video Games and You: The Player's Perspective

COMPSCI 198: iOS Game Development

FILM 178: Game design Methods

HUMAN CENTERED DESIGN

COMPSCI 160: User Interface Design and Development

COMPSCI 294: Interactive Device Design

COMPSCI 298-48: HCI Design Clinic

DES INV 10: Discovering Design

DES INV 15: Design Methodology

IND ENG 170: Industrial Design and Human Factors

INFO 214: Needs and Usability Assessment

INFO 262: Tangible User Interfaces

INFO 263: Technologies for Creativity and Learning

INFO 265: Interface Aesthetics

HUMAN CENTERED DESIGN

NWMEDIA 190: Critical Practices: People, Places, Participation

NWMEDIA 203: Critical Making: Materials, Protocols, and Culture

NWMEDIA C262: Theory and Practice of Tangible User Interfaces

NWMEDIA C263: Technologies for Creativity and Learning

UGBA 190T: Introduction to New Product Development

UGBA 190T-2A: Understanding Customers: Conducting Interviews

UGBA 190T-2C: Understanding Customers: Creating Customer Experiences

UGBA 190T-2D: Understanding Customers: Integrated Customer Understanding Project

INTERDISCIPLINARY

AFRICAM C134: Information Technology and Society

ANTHRO 150: Utopia: Art and Power in Modern Times

COG SCI 165: Psychology of Creativity

HISTORY C182C: Science, Technology, and Society

INFO 290: Re-imagining the Body: Design, Data, Values and Intersectionality

PSYCH C103: Psychology of Creativity

SOCIOL 166: Society and Technology

SOCIOL 167: Virtual Communities / Social Media

THEATER 177: Sound Design & Media Theater

THEATER 174B: Scenography: Costume Design for the Theater

COMPUTER GRAPHICS AND ANIMATION

COMPSCI 194: Advanced Digital Animation

COMPSCI 98 /198: UCBUGG: 3D Modeling & Animation

NWMEDIA 190: Advanced Digital Animation

COMPUTER GRAPHICS AND ANIMATION

COMPSCI 194: Advanced Digital Animation

COMPSCI 98 /198: UCBUGG: 3D Modeling & Animation

NWMEDIA 190: Advanced Digital Animation

STUDENT ORGANIZATIONS

Berkeley Innovation: Get hands-on experience with the design process, from conducting user research to building and marketing prototypes.

Design Engineering Collaborative: A student hub for hands-on engineering design. Interdisciplinary projects launch here, every day.

Design for America: Use human-centered design and creative problem solving to tackle big community problems.

Engineers Without Borders: We design and implement sustainable engineering solutions in communities that lack access to basic needs.

Hackers@Berkeley: Build it, break it, and build it again in workshops on web development, product design and other topics.

Innovative Design: Need a website, video, photo shoot or flyer? Teams of awesome Cal student designers can create it for you.

STUDENT ORGANIZATIONS

3-D Modeling Club: Interested in 3-D printing? Take a workshop, join a team project, enter a competition.

berkeleyByte: Join Berkeley's leading design, innovation, culture and technology blog.

Berkeley Engineers and Mentors: Create hands-on lesson plans and teach them at local K-12 schools.

Center for Entrepreneurship & Technology Student Association: Find tools and networks to start your own company. We've actually started businesses.

Code the Change: Use your computer science skills for social good through nonprofit projects.

Pioneers in Engineering: Every spring, Bay Area high school teams face off in a robotics competition that we craft. We build our own robotics kit for each team, we mentor the teams, we design and build the competition field.

DeCal: Learn graphic design, web design and just about anything else in a student-led class.

DE CAL

Intro to Photoshop & Illustrator

Principles of Graphic Design

Working with Typography

{design}.

Web Design Workshop

COMPETITION TEAMS

Cal Concrete Canoe: We design, build and race canoes made of concrete. We've won the national title a record five times.

Cal Construction: We tackle a project management challenge in a two-day national competition.

Cal Seismic Design: We design, analyze and fabricate models to withstand simulated earthquake ground motions.

CalSMV – Super Mileage Vehicle: Think you can get to 1,200 miles per gallon? We design and build hyper-efficient vehicles.

CalSol – UC Berkeley solar vehicle: We design, build and test fully solar powered vehicles and compete in races worldwide.

UC Berkeley Formula SAE Team: We design and fabricate small formula-style racecars and compete against other colleges from around the world.

UC Berkeley Human Powered Vehicle: We build aerodynamic recumbent bicycles as an engineering project for the ASME Human Powered Vehicle Competition.

UC Berkeley iGEM Team: In this international synthetic biology competition, we build a genetically engineered machine.

UC Berkeley Steel Bridge Competition Team: We've won three national trophies, so far, in this contest to design and fabricate the most structurally efficient and cost-effective steel bridge.

LABS AND STUDIOS

Airport Design Studio, McLaughlin Hall

Biomolecular Nanotechnology Center, Stanley Hall

Cal Design Lab, Wurster Hall

CITRIS Invention Lab, Sutardja Dai Hall

Civil & Environmental Engineering Lab, Davis Hall

iLab, Memorial Stadium

Marvell Nanofabrication Laboratory, Sutardja Dai Hall

Materials Lab, Hearst Memorial Mining Building

Mechanical Engineering Student Machine Shop, Etcheverry Hall

Rapid Prototyping Lab, Hesse Hall

SanDisk Computing Laboratory, Cory Hall

Supernode EECS student makerspace, Cory Hall

Swarm Lab, Cory Hall

TI Electronics Design Lab, Cory Hall

DESIGNATBERKELEY.COM

ANNOUNCEMENTS

Midterm 15 Oct in Sibley Auditorium – 80 min exam / closed notes & books

Midterm review on Fri in section

All DSP Info has been sent out

17 Oct — Team Worksession (required)

FEED 02: Team Checkin and Project Feedback — Section 19 Oct (required)

DESIGN 04: 22 Oct — Project Idea

FEED 04: 24 Oct — Project Slide

MIDTERM ON 15 OCT

In class – Actually in Sibley Auditorium

Watch Piazza for details

80 minutes

Closed book & notes

If you are registered with the DSP office, you should have received email from us about exam accommodations. All accommodations finalized today please.

MIDTERM

HKN has previous midterm for practice

come early so we can start on time

all you need is a pen or pencil to write with

The midterm will cover all aspects of the course through Wednesday's lecture. This includes, readings, lectures, assignments, section, etc. We may ask design questions, code questions, etc.

There will be a midterm Review in sections this Friday

If you find a question ambiguous, document the ambiguity. Indicate the way you interpreted the question in a set of separate sentences next to the question. The questions on the exam are not intended to be ambiguous, but sometimes another meaning is interpreted by the examinee that we did not take into consideration.

If you are registered with the DSP office and have special needs, you should have received email from me about exam accommodations via bCourses. You must contact me by TODAY if there is a problem in any accommodations details or accommodations made (or not made) to you.

MIDTERM ATTENDANCE

I know this won't happen but I'm putting it here so it is clear there is policy:

You must attend the midterm

There is not a makeup midterm exam date

If you have any reason to believe you may miss the midterm (i.e. you have a court appearance, you have difficult travel plans, you have a planned doctors appointment before class that may run over, you have a job interview, you have been called to testify before Congress, etc), you must let me know by class Wed 10 Oct. **We will not grant excuses for issues that come up after Wednesday** and you will be given a zero for the exam if you do not attend.

I will not read or respond to any requests concerning issues of why you cannot attend or will not be able to attend the midterm after end of class Wed 10 Oct.

MIDTERM ATTENDANCE

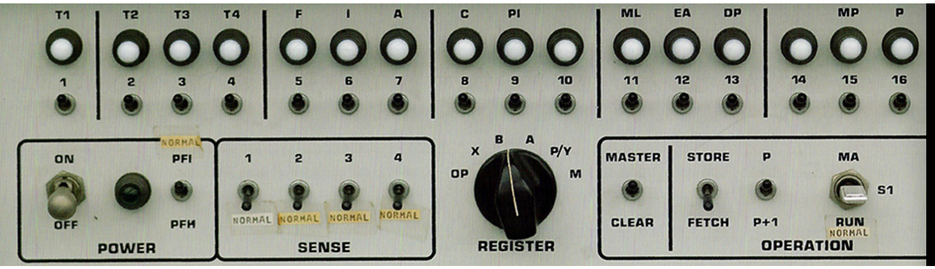
If you have a health or medical emergency and unable to make the midterm or decide not to come:

- You must tell us immediately via Piazza post to all instructors
- You must meet with me (Professor Paulos) as soon as possible to discuss your circumstances
- You will be given, at the complete discretion of the instructor, either a zero for the midterm, an oral exam of up to 3 hours (on a date set by the instructor that is not negotiable), or a 3 hour final exam during our scheduled final exam time covering the material from the entire semester. The grade on this exam will take the place of your midterm.
- Legitimate health related emergencies (as determined by the instructor) will not be given a zero but will be subject to the other two options at the discretion of the instructor.

MIDTERM ATTENDANCE

Should I come to the midterm (cheat sheet):

- I’m exhausted and need to sleep — ATTEND
- I think I’m starting to get a cold — ATTEND
- I am profusely sick and vomiting all over my bed — Goto Tang / DO NOT ATTEND
- I broke my leg — Call 911 / DO NOT ATTEND
- I am bleeding profusely. Help! — Call 911 / DO NOT ATTEND
- I’m not sure, I’ll email Professor Paulos — ATTEND as I will not be able to respond to any emails that arrive concerning the midterm attendance after 10 Oct



USABILITY TESTING METHODS

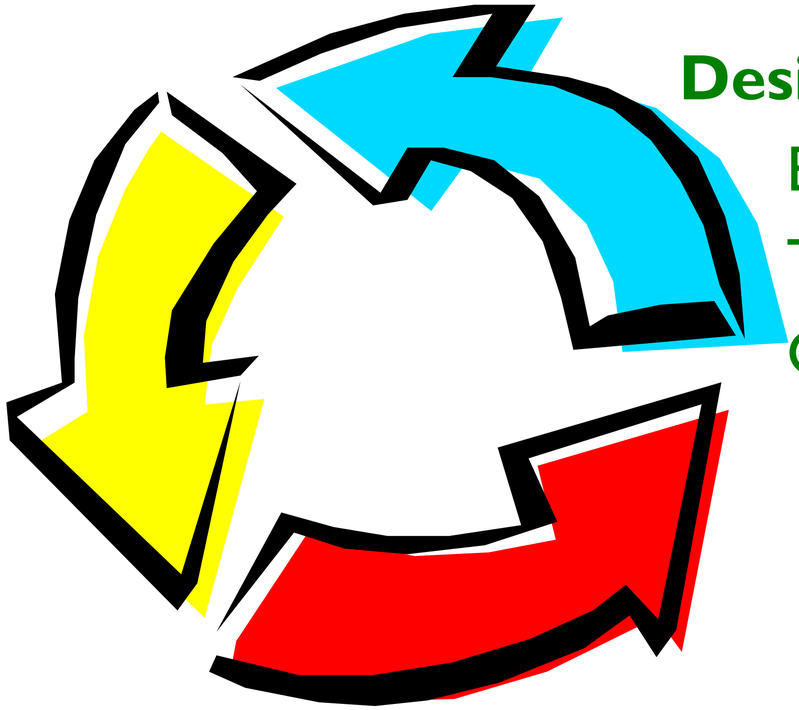
ITERATIVE DESIGN

Design

Brainstorming

Task analysis

Contextual inquiry



Prototype

Low-fi, paper

Evaluate

Low-fi testing,

Qualitative eval

Quantitative eval

GENRES OF ASSESSMENT

Automated	*Usability measures computed by software*
Inspection	*Based on skills, and experience of evaluators*
Formal	*Models and formulas to calculate measures*
Empirical	*Usability assessed by testing with real users*

EMPIRICAL TESTING IS COSTLY

User studies are very expensive – you need to schedule (and normally pay) many subjects.

User studies may take many hours of the evaluation team's time.

A user test can easily cost $10k's

“DISCOUNT USABILITY” TECHNIQUES

Cheap

No special labs or equipment needed

The more careful you are, the better it gets

Fast

On order of 1 day to apply

(Standard usability testing may take a week)

Easy to use

Can be taught in 2–4 hours

“DISCOUNT USABILITY” TECHNIQUES

Heuristic Evaluation

Assess interface based on a predetermined list of criteria

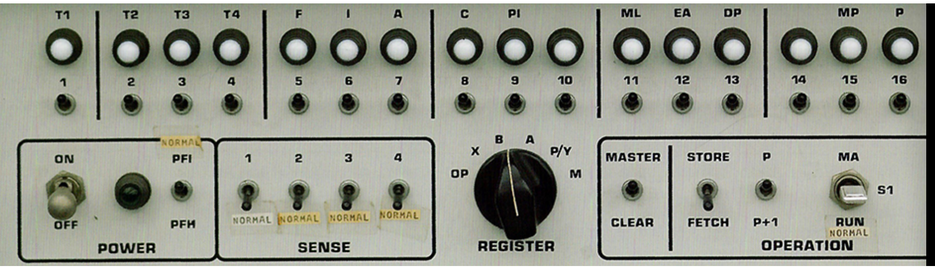
Cognitive Walkthroughs

Put yourself in the shoes of a user

Like a code walkthrough

Other, non-inspection techniques are on the rise

e.g., online remote experiments with Mechanical Turk



COGNITIVE WALKTHROUGH

COGNITIVE WALKTHROUGH

Formalized technique for imagining user's thoughts and actions when using an interface:

"*Cognitive walkthroughs involve simulating a user's problem-solving process at each step in the human-computer dialog, checking to see if the user's goals and memory for actions can be assumed to lead to the next correct action*." (Nielsen, 1992)

COGNITIVE WALKTHROUGH

Given an interface prototype or specification, need:

- A detailed task with a concrete goal, ideally motivated by a scenario
- Action sequences for user to complete the task

Ask the following questions for each step:

- Will the users know what to do?
- Will the user notice that the correct action is available?
- Will the user interpret the application feedback correctly?

Record: What would cause problems, and why?

COGNITIVE WALKTHROUGH EXAMPLE

Task: Find the call number and location of the latest edition of the book “Interaction Design” by Preece, Rogers & Sharp in the Berkeley library

Typical users: Students who are familiar with the web, but not necessarily with the library or its website

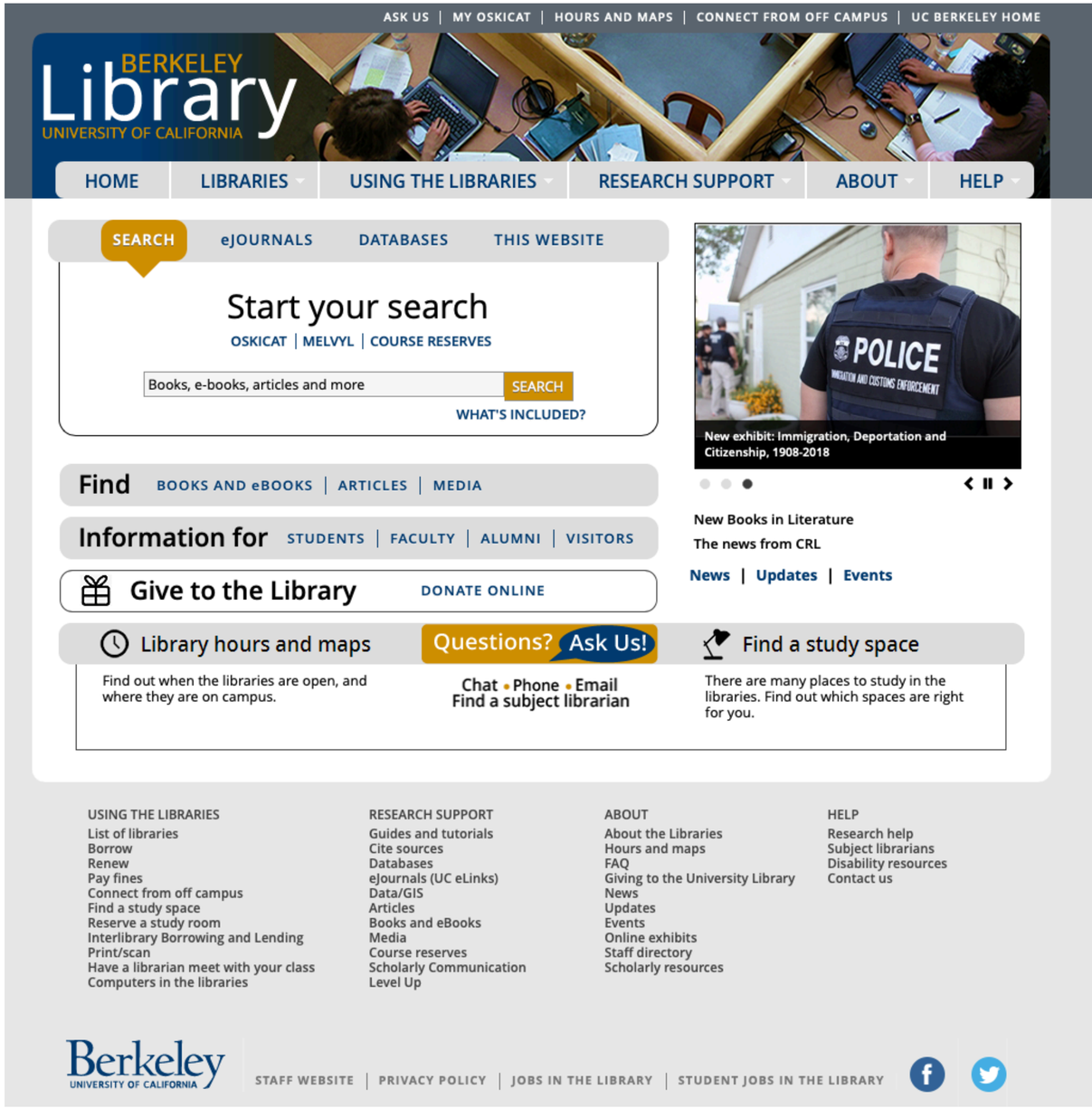
COGNITIVE WALKTHROUGH EXAMPLE

Step1: Select library catalog.

Will the user know what to do?

Will user notice that action is available?

Will user interpret feedback correctly?



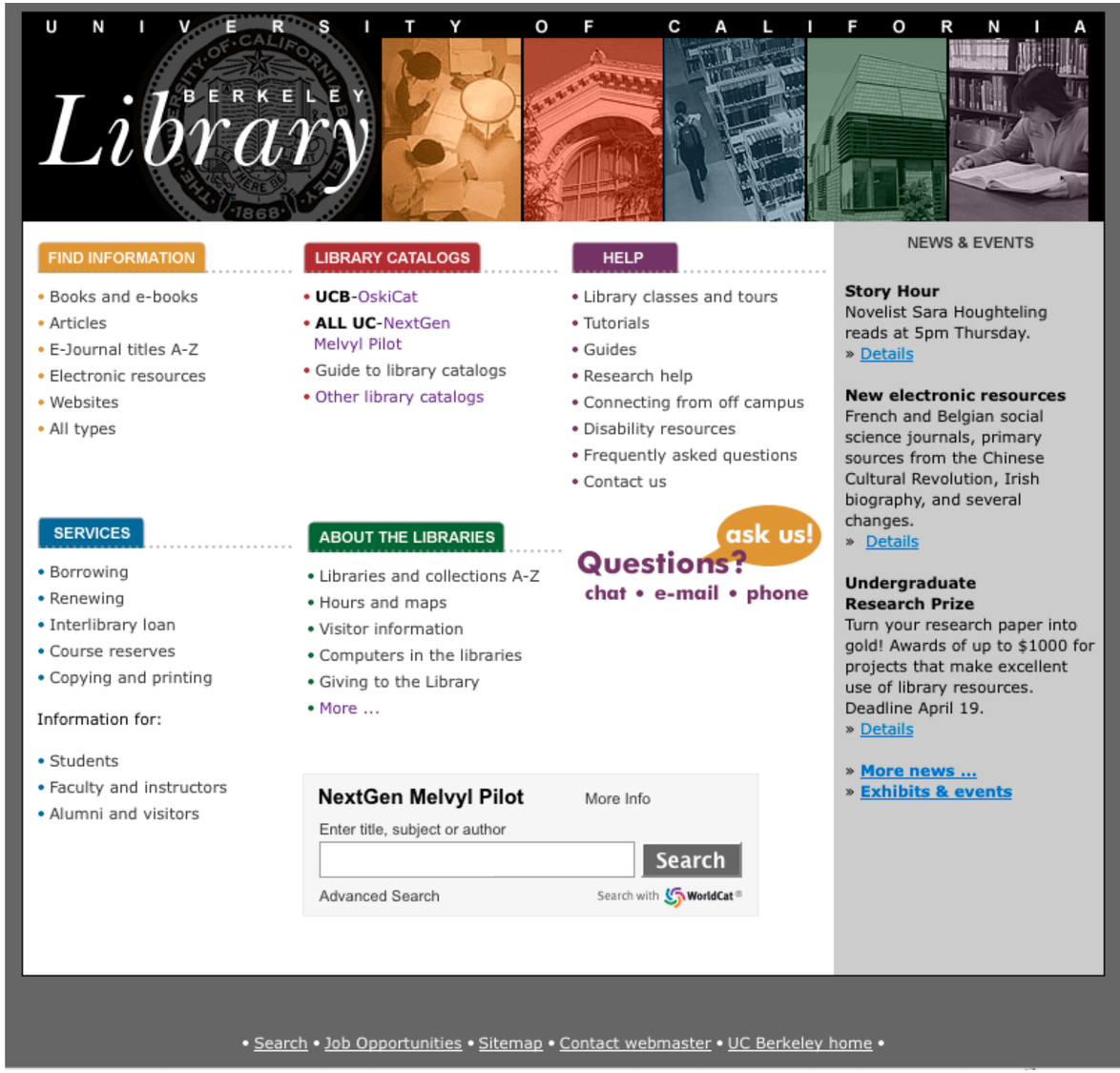
COGNITIVE WALKTHROUGH EXAMPLE

Step1: Select library catalog.

Will the user know what to do?

Will user notice that action is available?

Will user interpret feedback correctly?



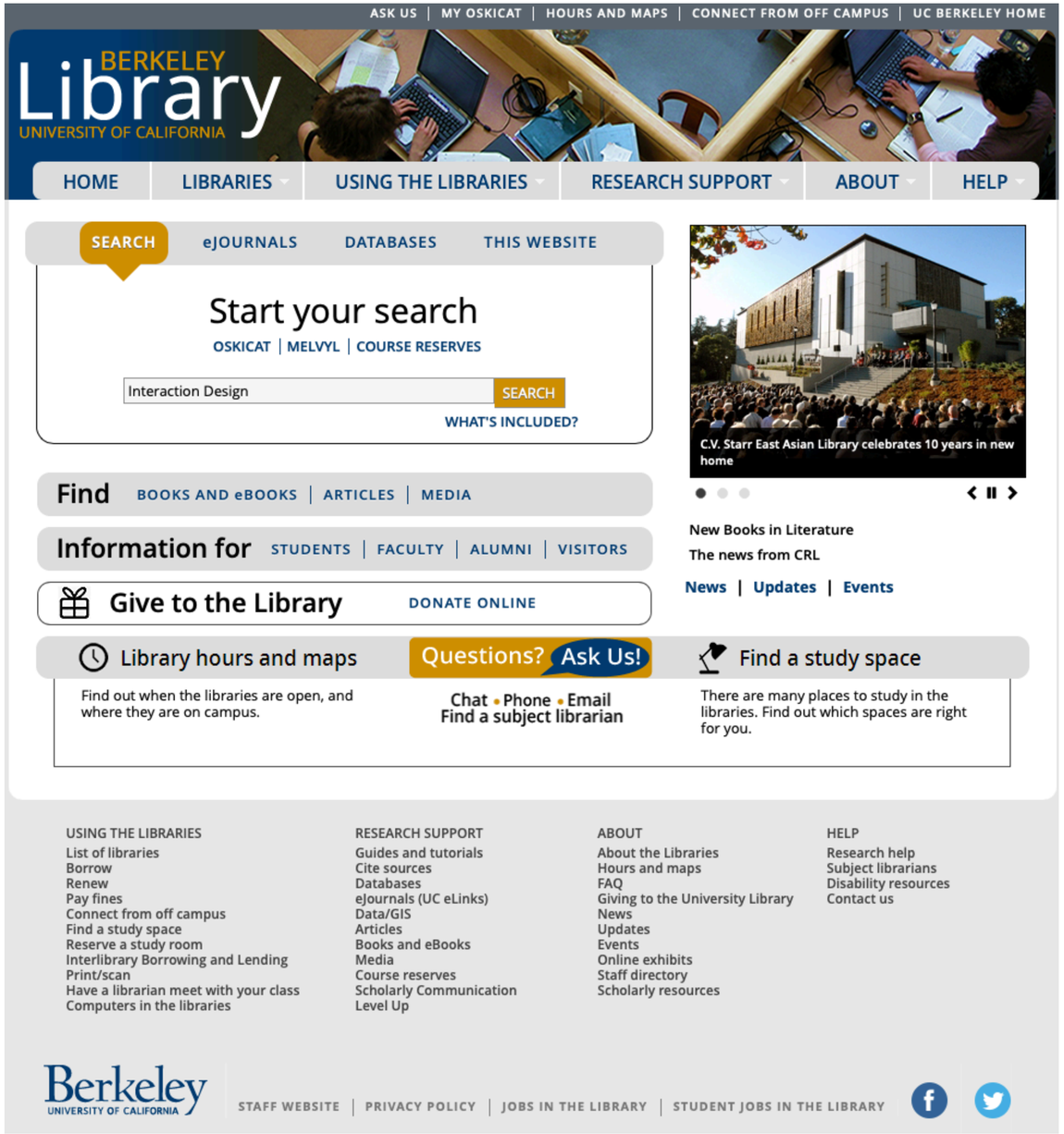
COGNITIVE WALKTHROUGH EXAMPLE

Step 2: Complete the search form

Will the user know what to do?

Will user notice that action is available?

Will user interpret feedback correctly?



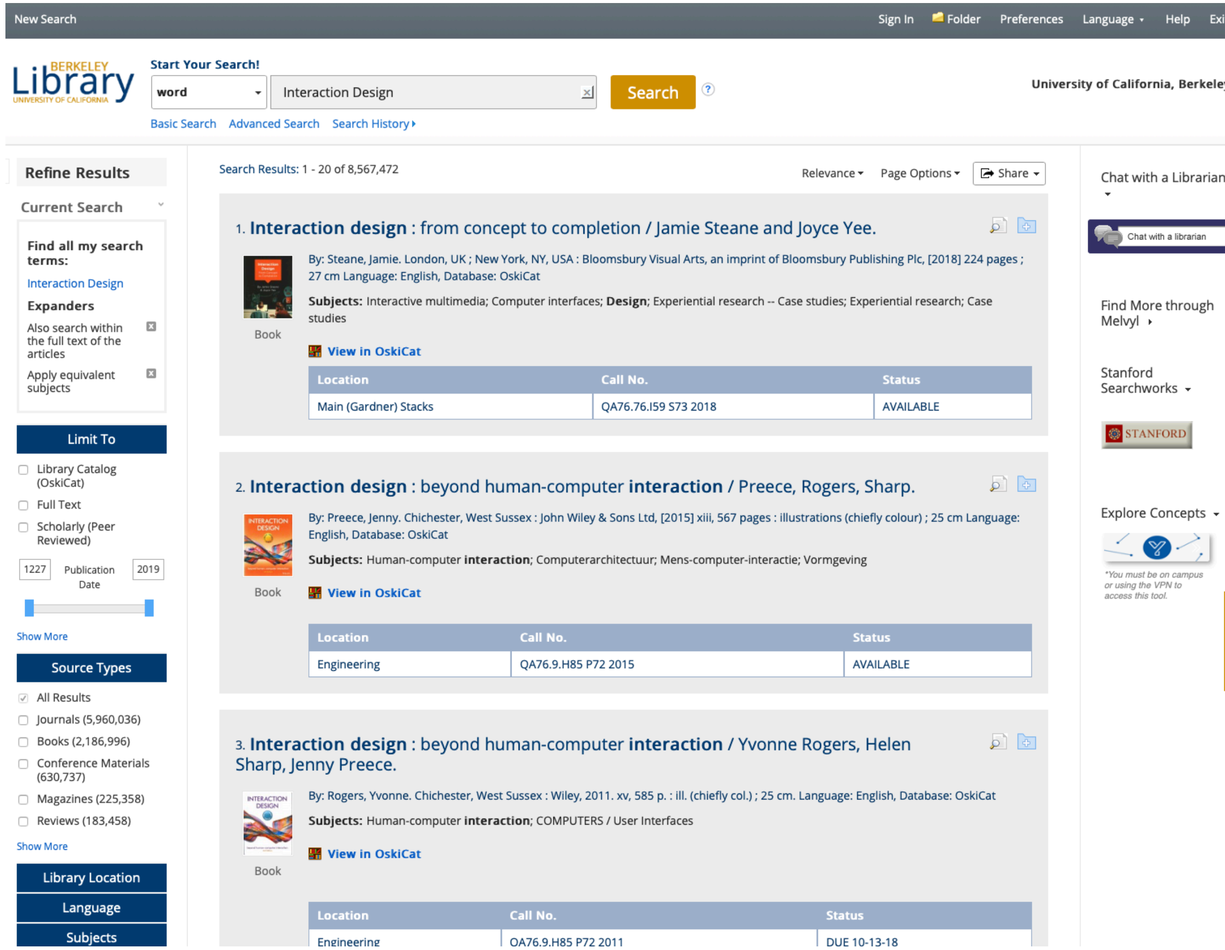
COGNITIVE WALKTHROUGH EXAMPLE

Step 3: Locate the right edition, click to detail screen

Will the user know what to do?

Will user notice that action is available?

Will user interpret feedback correctly?



COGNITIVE WALKTHROUGH EXAMPLE

Step 4: Locate call number and library location

Will the user know what to do?

Will user notice that action is available?

Will user interpret feedback correctly?

2. **Interaction design** : beyond human-computer **interaction** / Preece, Rogers, Sharp.

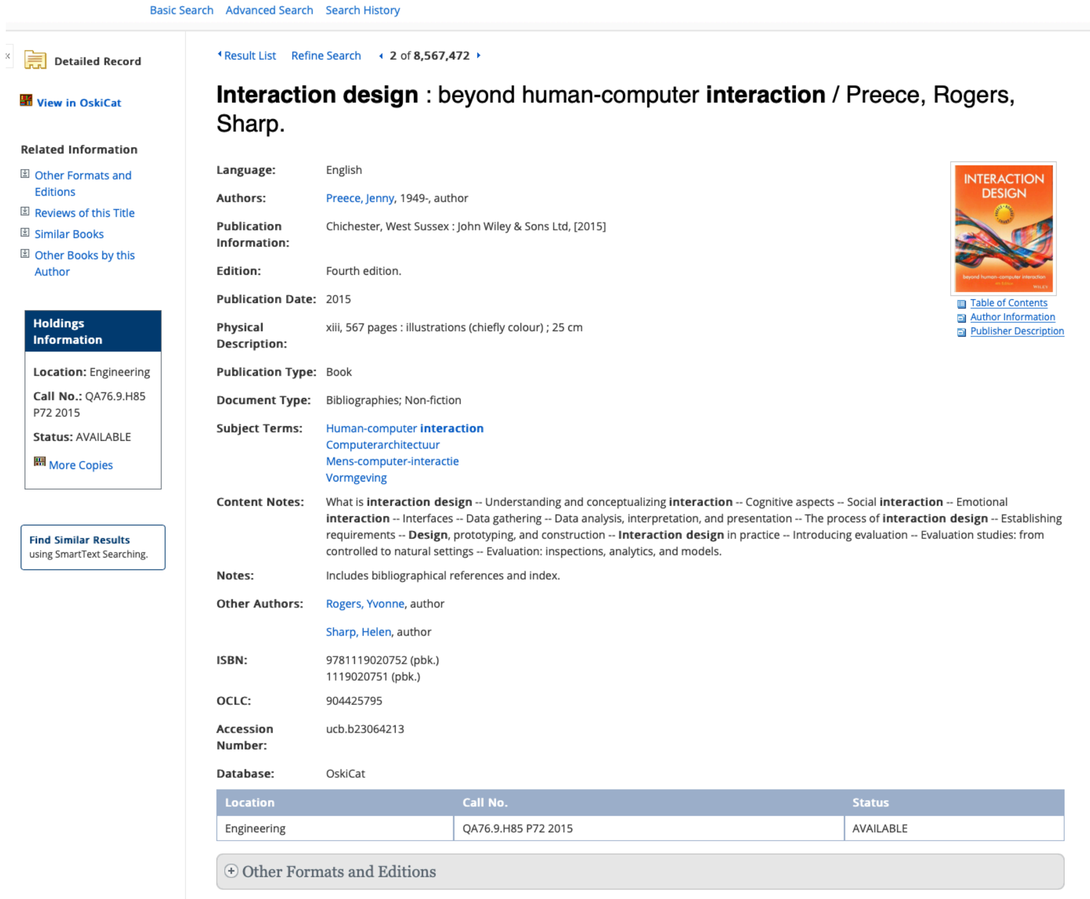
By: Preece, Jenny. Chichester, West Sussex : John Wiley & Sons Ltd, [2015] xiii, 567 pages : illustrations (chiefly colour) ; 25 cm Language: English, Database: OskiCat

Subjects: Human-computer **interaction**; Computerarchitectuur; Mens-computer-interactie; Vormgeving

Book

View in OskiCat

Location	Call No.	Status
Engineering	QA76.9.H85 P72 2015	AVAILABLE



EMPIRICAL ASSESSMENT: QUALITATIVE

Qualitative: What we've been doing so far

Contextual Inquiry: try to understand user's tasks and conceptual model

Usability Studies: look for critical incidents in interface

Qualitative methods help us:

Understand what is going on

Look for problems

Roughly evaluate usability of interface

EMPIRICAL: QUANTITATIVE STUDIES

Quantitative

Use to reliably measure some aspect of an interface

Compare two or more designs on a measurable aspect

Contribute to theory of Human-Computer Interaction

Approaches

Collect and analyze user events that occur in natural use

Controlled experiments

Examples of measures

Time to complete a task, Average number of errors on a task, Users' ratings of an interface*

** You could argue that users' perception of speed, error rates etc is more important than their actual values*

COMPARISON

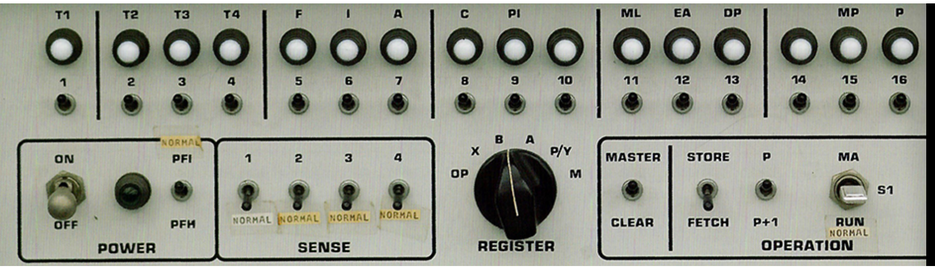
Qualitative studies

Faster, less expensive → especially useful in early stages of design cycle

Quantitative studies

Reliable, repeatable result → scientific method

Best studies produce generalizable results



DESIGNING CONTROLLED EXPERIMENTS

STEPS IN DESIGNING AN EXPERIMENT

1. State a lucid, testable hypothesis
2. Identify variables
   (independent, dependent, control, random)
3. Design the experimental protocol
4. Choose user population
5. Apply for human subjects protocol review
6. Run pilot studies
7. Run the experiment
8. Perform statistical analysis
9. Draw conclusions

EXPERIMENT DESIGN

Testable hypothesis

Precise statement of expected outcome

Independent variables (factors)

Attributes we manipulate/vary in each condition

Levels – values for independent variables

Dependent variables (response variables)

Outcome of experiment (measurements)

Usually measure user performance

EXPERIMENT DESIGN

Control variables

Attributes that will be fixed throughout experiment

Confound – attribute that varied and was not accounted for

Problem: Confound rather than independent variables could have caused change in dependent variables

Confounds make it difficult/impossible to draw conclusions

Random variables

Attributes that are randomly sampled

Increases generalizability

VARIABLE TYPES

Nominal: categories with labels, no order

Ordinal: categories with rank order

Continuous: interval (w/o zero point), ratio (w/ zero point)

COMMON METRICS IN HCI

Performance metrics:

- Task success (binary or multi-level)
- Task completion time
- Errors (slips, mistakes) per task
- Efficiency (cognitive & physical effort)
- Learnability

Satisfaction metrics:

- Self-report on ease of use, frustration, etc.

SLIPS VS MISTAKES

Mistake — when a person plans to do the wrong thing and is successful (conscious)

Example: Sitting at a table when you have to order from a bar or trying to use an old Xbox game controller like a motion-sensitive Wiimote and gesturing with it in the air when you need to press the buttons , misreading low oil-pressure light as low tire pressure

Slip — when a person plans to do one thing, but then inadvertently does something else (unconscious)

Example: Leaving your change in a vending machine or forgetting to replace the gas cap after filling up your car with fuel. Or even accidentally typing a wrong word when you're writing a text, even though you know how to spell it, sometimes you'll still type it wrnogly, or putting liquid hand-soap on toothbrush

SLIPS VS MISTAKES

The difference between **slips** and **mistakes** is important.

If someone makes a **mistake** because they don't know what to do, we can train them to improve their performance (informing a person that they have to order at the bar). They have the **wrong mental model.**

But training doesn't make us any less likely to slip up.

A **slip** is when the user has the **correct mental model** of the interaction **yet makes an error** on accident.

PERFORMANCE METRIC: LOSTNESS

Calculated using the ratio of visited and optimal node counts as shown below:

N = total number of different pages visited (including revisits)

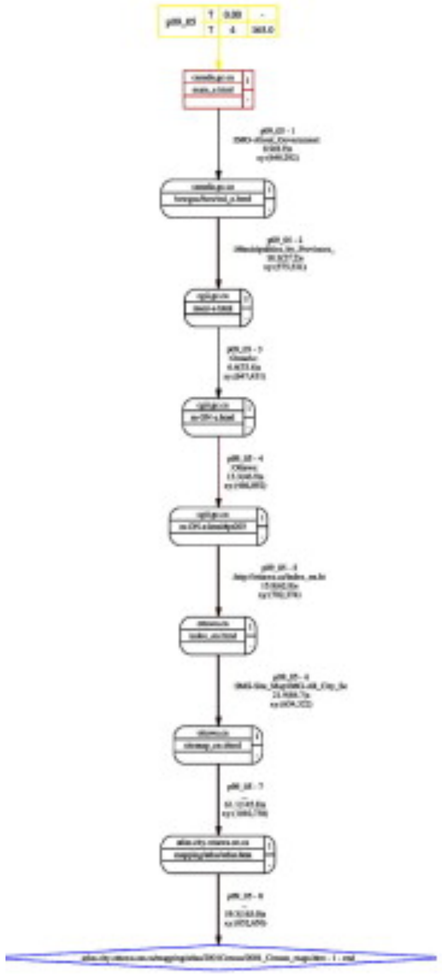
U = total number of unique pages visited

O = minimum (optimal) number of pages to accomplish task

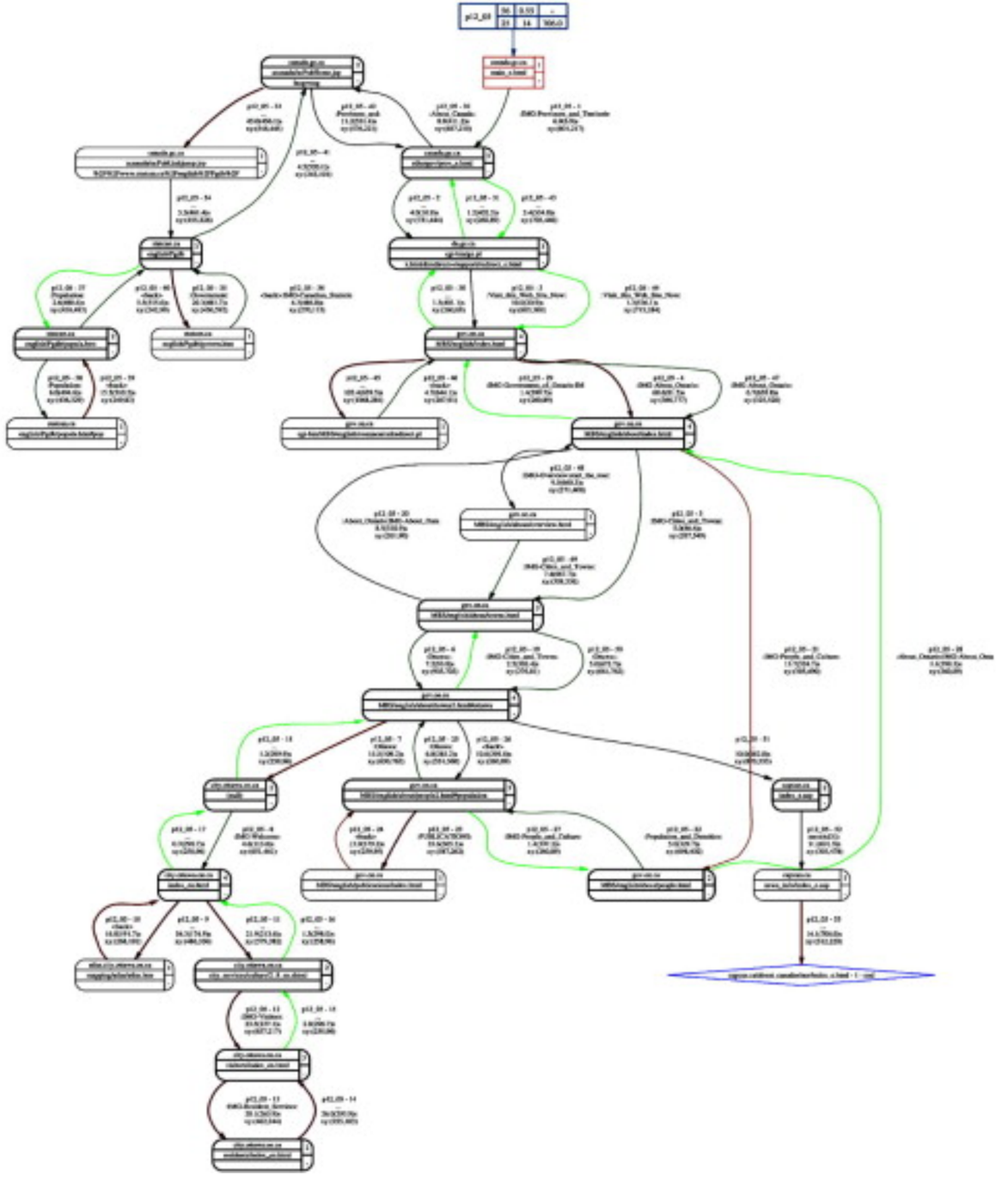
$$\texttt{Revisits} = 1 - \texttt{U}/\texttt{N},$$

$$\texttt{Lostness} = \sqrt{(\texttt{U}/\texttt{N} - 1)^2 + (\texttt{O}/\texttt{U} - 1)^2}.$$

Lostness_R = 1.3



Lostness_R = 2.8



SATISFACTION METRIC: LIKERT SCALES

Respondents rate their level of agreement to a statement

Likert data is ordinal, not continuous (matters for analysis)!

"Overall, I am satisfied with the ease of completing the tasks in this scenario"

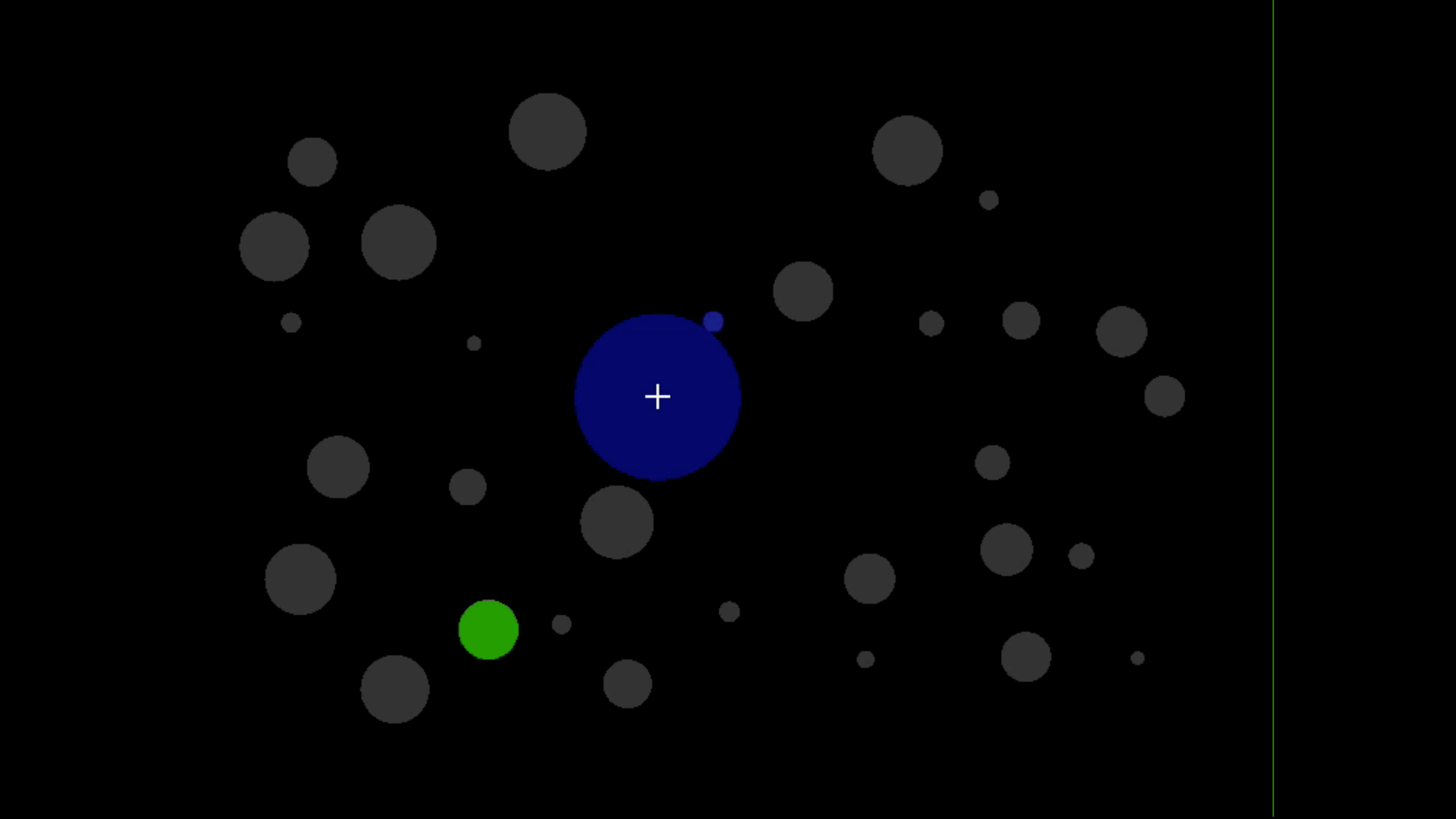
1: Strongly Disagree

2: Disagree

3: Neither agree nor disagree

4: Agree

5: Strongly agree



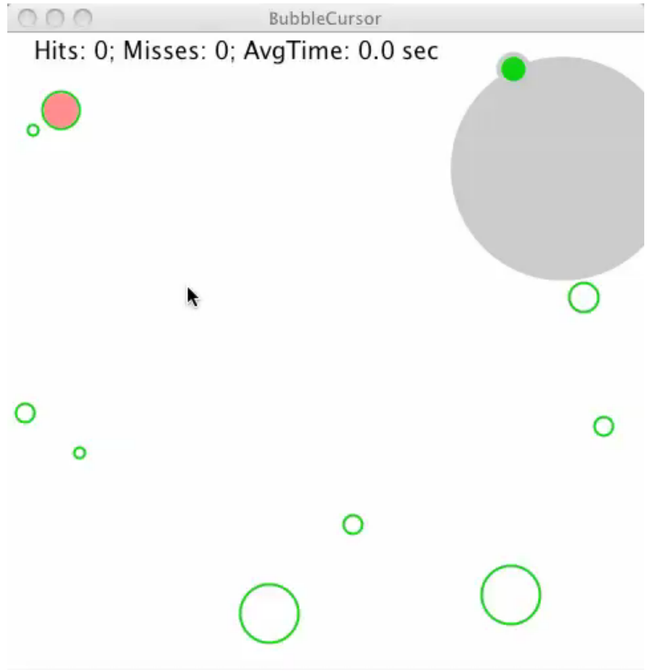
VARIABLES FOR THE BUBBLE CURSOR

Independent variables

Dependent variables

Control variables

Random variables



VARIABLES

Independent variables

Cursor type (bubble, normal, area?)
Target Distance
Target Width

Dependent variables

Movement Time
Error Rate
User Satisfaction

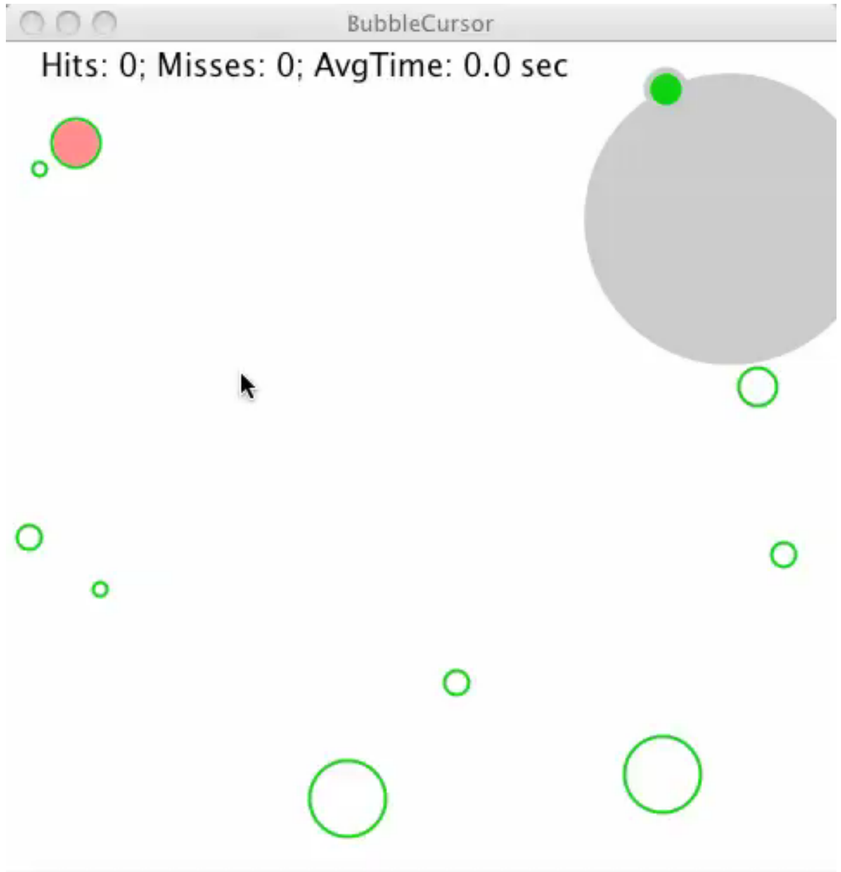
Control variables

Color scheme, input device, screen size

Random variables

Location, environment,
Attributes of subjects
Age, gender, handedness, ...

Conducting studies online
vs. in person strongly influences
which variables are controlled
and which are random



GOALS

Internal validity

Manipulation of **Independent Variable** is cause of change in **Dependent Variable**

Requires eliminating confounding variables (turn them into IVs or RVs)

Requires that experiment is replicable

External validity

Results are generalizable to other experimental settings

Ecological validity – results generalizable to real-world settings

Confidence in results

Statistics

EXPERIMENTAL PROTOCOL

What is the task? (must reflect hypothesis!)

What are all the combinations of conditions?

How often to repeat each combination of conditions?

Between subjects or within subjects

Avoid bias (instructions, ordering, …)

NUMBER OF CONDITIONS

Consider all combinations to isolate effects of each Independent Variable (factorial design)

(3 cursor types) * (3 distances) * (3 widths) = 27 combinations

Adding levels or factors can yield lots of combinations!

REDUCING NUMBER OF CONDITIONS

Vary only one independent variable
leaving others fixed

Problem: ?

REDUCING NUMBER OF CONDITIONS

Vary only one independent variable
leaving others fixed

Problem: Will miss effects of interactions

OTHER REDUCTION STRATEGIES

Run a few independent variables at a time

If strong effect, include variable in future studies

Otherwise pick fixed control value for it

Fractional factorial design

Procedures for choosing subset of independent variables to vary in each experiment

CHOOSING SUBJECTS

Pick balanced sample reflecting intended user population

Novices verses experts

Age group

Gender

....

Example

12 non-colorblind right-handed adults (male & female)

Population group can also be an Independent Variable or a controlled variable

What is the disadvantage of making population a controlled variable?

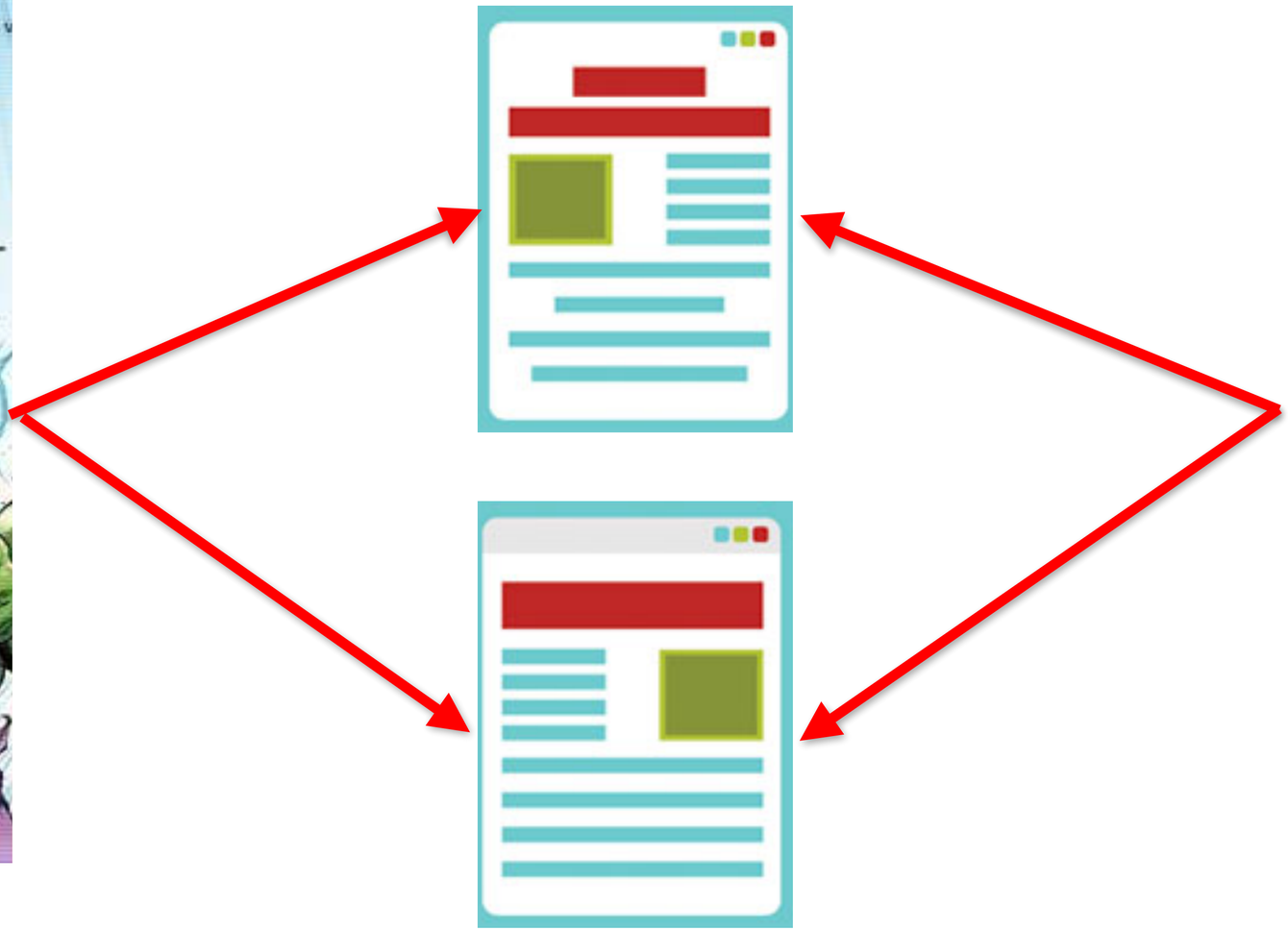
BETWEEN SUBJECTS DESIGN

Marvel Super Heroes use one interface

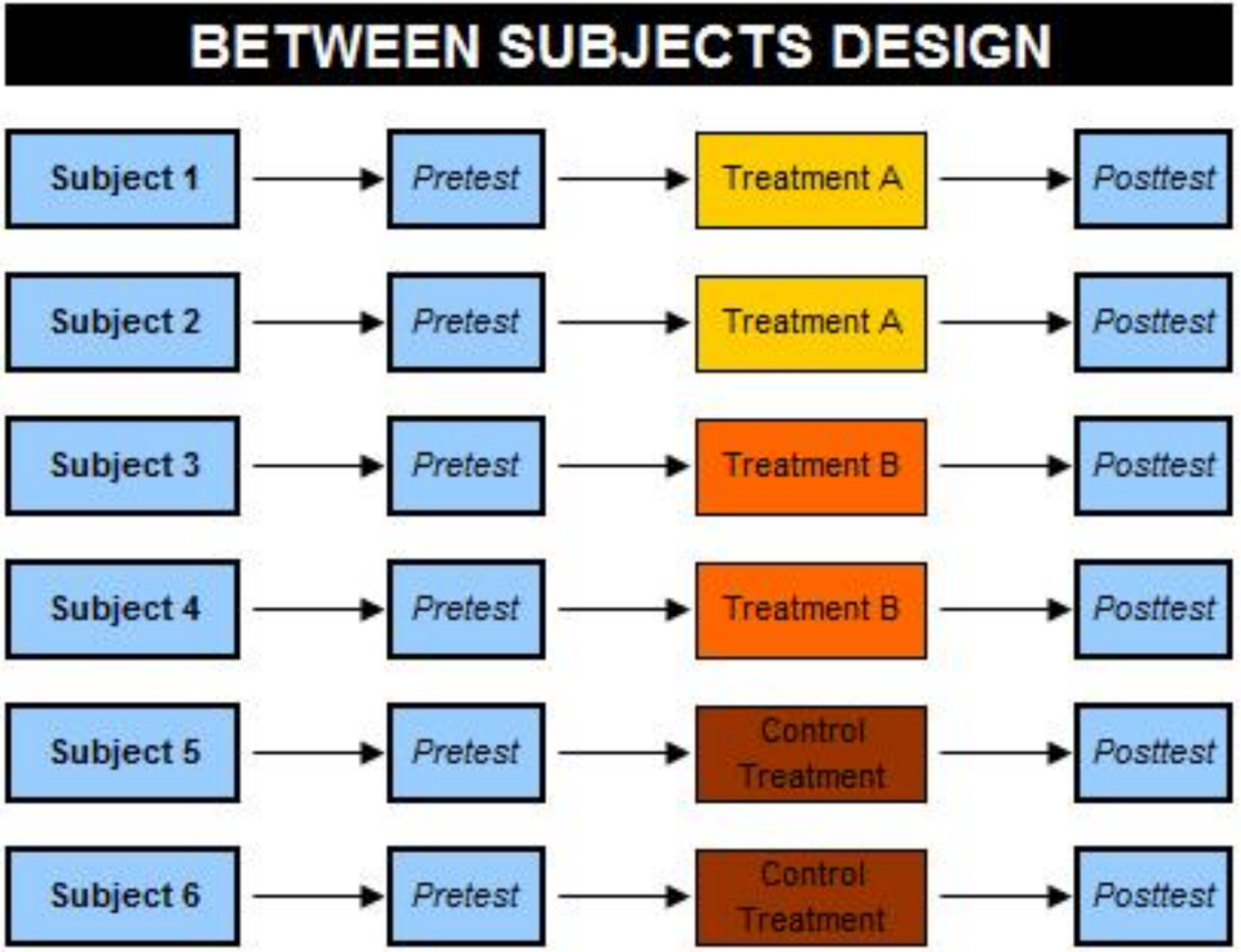
DC Heroes use one interface

WITHIN SUBJECTS DESIGN

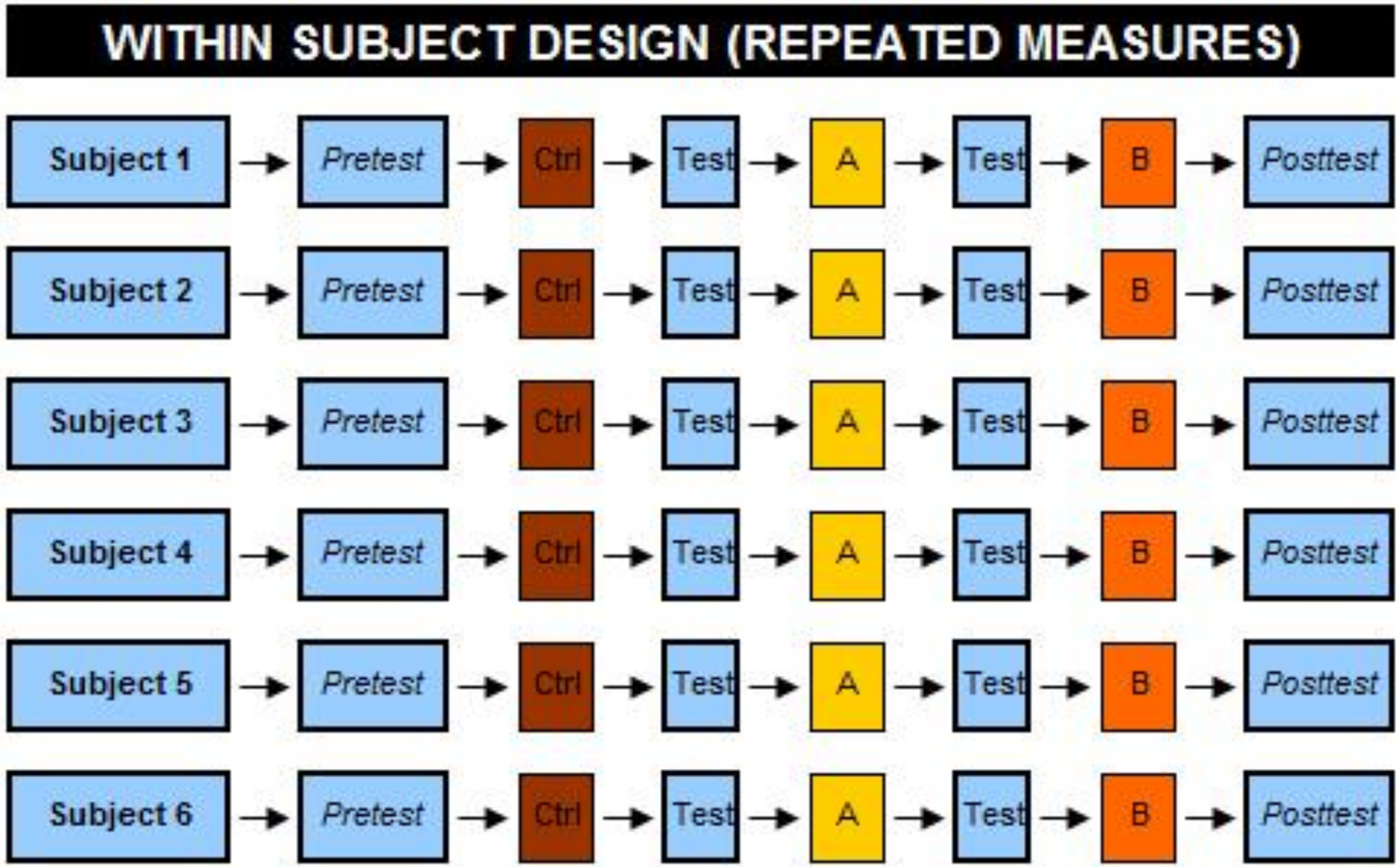
Everyone uses both interfaces



BETWEEN SUBJECTS DESIGN



WITHIN SUBJECTS DESIGN



Within Subjects

A group of people sees the test signs.

Between Subjects

One group of people sees one set of the test signs, and a different group sees another set.

BETWEEN VS. WITHIN SUBJECTS

Between subjects

Each participant uses one condition

+/- Participants cannot compare conditions

+ Can collect more data for a given condition

- Need more participants

Within subjects

All participants try all conditions

+ Compare one person across conditions to isolate effects of individual diffs

+ Requires fewer participants

- Fatigue effects

- Bias due to ordering/learning effects

WITHIN SUBJECTS: ORDERING EFFECTS

In within-subjects designs ordering of conditions is a variable that can confound results

Why?

Turn it into a random variable

Randomize order of conditions across subjects

Counterbalancing (ensure all orderings are covered)

Latin square (partial counterbalancing)

...

RUN THE EXPERIMENT

Always pilot it first!

Reveals unexpected problems

Can’t change experiment design after starting it

Always follow same steps – use a checklist

Get consent from subjects

Debrief subjects afterwards