Current Topics in Human–Computer Interaction

Research Approaches in HCI

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https://hci.rwth-aachen.de/cthci
Three Approaches to HCI Research

Test
Empirical science

Observe
Ethnography

Make
Engineering & Design
CHAPTER 4

Empirical Approach
Empirical Approach

Research Question

Hypothesis

Observation
Initial Observation

• Begin with casual or informal observation

• Usually comes from personal experience that catches your attention or raises questions in your mind

• Example: “Cloth has an affordance of pinching. Could this be useful for interaction design?”
Research Question

• Identify variables and research question for your observation

• **Variables**: characteristics or conditions that change or have different values for different individuals

• **Research question**: a statement that describes or explains a relationship between or among variables
  
  • A proposal to be tested

• Example: “When pinching cloth, different **areas** of the body would differ in **preference** and the **way** people pinch”
Hypothesis

• **Concrete and testable** statements derived from the research question

• **Operational definition:** a specific set of operations for measuring external, observable behavior

• In-class exercise: try giving an operational definition for the variables highlighted below
  
  • “There would be a difference in **user’s preference** for pinching cloth among different **areas** on the body.”
Example: Pinstripe

- Karrer et al., CHI ’11

- Recall the prediction:
  - “There would be a difference in user’s preference for pinching cloth among different areas on the body.”

- Method (operationalization):
  - Identify 16 different body areas
  - Ask the participants to perform the pinching gesture in these areas
  - Collect convenience rating in 5-point Likert scale

We performed the study asking people on the campus of our university and around the city to participate. Of the 90 participants, 15 were female, 75 were male. We also asked users for their preferred body area the user had named. This information was only collected for the orientation of the control gesture, i.e. mapping an inwards motion of the thumb to an increase in the controlled value or a decrease. This information was only collected for the dominant or non-dominant hand. After the trial, participants were asked to name the one single body area they would most prefer to use Pinstripe at. We also asked users for their preferred body area from the list of 16 areas that would be colored green. The participants were rated according to the average grade given to the respective area. The two ‘pocket’ areas were added after the study to account for textile UI elements that could be placed in these areas. Some areas were left out deliberately. The ‘blobs’ outline observations we made during the experiment. The ‘blobs’ show several modes, typically two, which correspond to different ways in which users held their hands when performing the pinch-and-roll gesture (Figures 5, 6). The regions received a grade of 5. The standard deviation of the grade was 0.5, six regions received a median grade of 3 and six regions received a median grade of 4 or 5. The standard deviation of the angle of the control gesture (Figures 5, 6) was 0.5. The standard deviation of the angle of the control gesture was 0.5. The standard deviation of the angle of the control gesture was 0.5. The standard deviation of the angle of the control gesture was 0.5.
Conducting the Study

• Goal: Collect data to support, refute, or refine the original hypothesis

• Three strategies
  • **Descriptive research:** X happens
    • Focus on the current state of each *individual* variable
  • **Relational research:** X and Y happen together
    • Measure **two or more variables** that *exist naturally* from each participant
  • **Experimental research:** X causes Y
    • **Manipulate** one or more variables and observe their **effects** on other variables
EMPIRICAL

Descriptive Research
Descriptive Research

- Describe a naturally-occurring phenomenon
- Measure and report individual variables *without claiming relationships*
- Natural phenomena can occur when using a new technology as well
- Methods: observation, survey, case study
EMPIRICAL

Relational Research
Relational Research

- Measure a set of variables for each participant
- Examine the data to identify **patterns** and relationships
  - Goal: Finding **correlations** (changes in one variable are consistently and predictably accompanied by changes in another variable)
- Measure the **strength** of the relationships
Example: Social Network Activity and Social Well-Being

• Burke (CMU), Marlow, and Lento (Facebook), Best paper CHI ’10

  “An empirical analysis of the relationship between direct and passive communication on Facebook and social well-being, including loneliness, bridging, and bonding social capital.”

• Survey using Likert scales (N = 1193)

• Analyzed the past two months of users’ Facebook activity data, e.g.,
  • Friend count
  • Directed communication: comments, likes
  • Passive consumption of broadcast items such as status updates
Patterns in the Relationship between Variables

Simulated data for instructional purposes, based on results from [Burke et al., CHI '10]

General relationship

Positive relationship

Negative relationship
Strength of the Relationship between Variables

Simulated data for instructional purposes
Limitations of Relational Research

- Correlation does not imply causation

- E.g., here we do not know:
  - Loneliness $\Rightarrow$ less direct communication?
  - Less direct communication $\Rightarrow$ loneliness?
  - Third variable $\Rightarrow$ direct communication and loneliness?

- Third variable problem: unidentified variable controls the correlated variables
Limitations of Relational Research

- **Shallow** data from large number of people instead of **deep** data
  - Can be improved by follow-up interviews, follow-up surveys
- Participant sampling method limits the conclusion
  - Method: advertisement on Facebook
  - Participants: only English-speaking users (but compensated by many countries of origin)
EMPIRICAL

Experimental Research
Experimental Research

• Purpose: To infer cause-and-effect relationship

• Controlling independent variable

• Observe the change in the dependent variables

• In-class exercise: recall the following experimental designs from DIS1
  • Between-groups vs. within-groups
  • Benefits and drawbacks

• More details in next lecture
Exercise: Mobile Phone Text Input Example

• Research question: On a mobile phone, is typing faster using physical keys compared to using a touchscreen and your fingers or a stylus?

• IV: keyboard types: {physical, stylus, touch}

• DV: time in seconds for typing a specified sentence.
  • Begin: when the user presses the first key
  • End: when the user presses Enter

• Design: between-groups
  • Each keyboard is tested by 20 participants
  • Each participant types the sentence only once (one trial)
Limitations of Experimental Research

- Ideal world: variance caused by IV only ("IV has an effect on DV")
Limitations of Experimental Research

- Ideal world: variance caused by IV only ("IV has an effect on DV")

- Real world: Data from experiments is noisy (here: differences between people or trials)

  - => Variance caused by IV and/or by those uncontrolled factors ("confounding variables")?

- Statistics help resolve this
Example: Mid-air Pan-and-Zoom on Wall-sized Displays

- Nancel et al. (Paris), Best paper CHI ’11

- Contributions & Benefits:
  - “Design and evaluation of multiscale navigation techniques for very large displays based on **three key factors**: number of hands involved, type of movement, type of feedback.”
1D path
- linear
- circular

2D surface
- linear
- circular

3D free
- linear
- circular

Uni-manual
- zoom gesture
- focus of zoom, pointing

Bi-manual
- screen projected zoom gesture

Figure 2. Matrix of the 12 techniques organized according to key characteristics: uni- vs. bimanual, degree of guidance, linear vs. circular gestures.

Guidance through Passive Haptic Feedback
Two main categories of techniques have been studied for mid-air interaction on wall-sized displays: freehand techniques based on motion tracking; and techniques that require the user to hold an input device.

Input devices provide some guidance to the user in terms of what gesture to execute, as all of them provide some sort of passive haptic feedback: A finger operating a knob or a mouse wheel follows a specific path; gestures on touch-enabled devices are made on planar surfaces. Freehand techniques, on the contrary, provide essentially no feedback to the user who can only rely on proprioception to execute the gesture. We call this dimension the degree of guidance.

Gestures can be guided to follow a particular path in space (1D path); they can be guided on a touch-sensitive surface (2D surface); or they can be totally free (3D free). These three values correspond to decreasing amounts of passive haptic feedback for the performance of input gestures.

DESIGN CHOICES
Panning.
For all techniques, controlling the cursor's position is achieved naturally by ray-casting from the dominant hand to the wall display (dashed arrows in Figure 2). As mentioned earlier, first order of control was discarded for both pan and zoom operations. Panning is achieved by dragging, as in applications such as Adobe Illustrator or Google Maps with their typical hand-shaped cursor.

Zooming.
As in desktop applications such as Google Maps or NASA's WorldWind, linear techniques zoom in by moving forward towards the display and zoom out by moving backwards; circular techniques zoom in by turning clockwise and zoom out by turning counter-clockwise (solid arrows in Figure 2). Pointing plays an important role when zooming, as it specifies the focus of expansion (zoom in)/contraction (zoom out). Letting users specify this focus point is very important on displays of that physical size, as they will typically not be standing right in the center. A focus of expansion implicitly located at the center of the screen would make zooming operations tedious and hard to control as every zoom operation would require multiple panning actions to compensate drifts induced by the offset focus.

Bi-manual interaction.
All bimanual techniques (Figure 2, bottom row) are grounded in Guiard's study of asymmetric division of labor in bimanual actions that led to the Kinematic chain model. Following the observation that motion of the dominant hand typically finds its spatial reference in the results of motion of the non-dominant hand, we assign...
Correlation Does Not Imply Causation

Adapted from a tweet of @altonncf with data from FBI and W3Schools
Three Approaches to HCI Research

Test  Observe  Make
Empirical science  Ethnography  Engineering & Design
CHAPTER 5

Ethnography
Three Approaches to HCI Research

- Test: Empirical science
- Observe: Ethnography
- Make: Engineering & Design
Ethnography

• Collect data with different methods, e.g.:
  • Observation
  • Interview

• Code data and find patterns in it

• Create theories that explain the data

• Try to attack the theories by gathering more data
  • Leads to stronger theories
Data Collection

• Methods: Observation, interview, participation, logging
  • Format: Field notes, video, audio, log files

• Triangulation: use multiple data sources to support an interpretation that increases the confidence of your conclusion
  • From different participants
  • From different types of data, e.g., observations, interviews, logs
Example 1: The Normal Natural Troubles of Driving with GPS

• Brown (Sweden) and Laurier (Edinburgh), Best paper CHI ’12

• Goal: To understand users’ interaction with GPS navigation system in non-controlled setting

• 14 drivers, 2 video cameras, field notes
  • 9 hours of video ⇒ 75 clips ⇒ 37 detailed transcriptions
  • Analyzed the data to find common patterns/themes and construct theories that explain them
Figure 1: Following GPS instructions

While the driver 'follows' what the GPS recommends the driver still needs skill to read what the GPS says and even to ignore GPS instructions.
Example 1: The Normal Natural Troubles of Driving with GPS

• Contribution & benefits:
  • “Presents a video analysis study of driving using GPS navigation systems in natural settings. The paper argues for [understanding] driving with [a] GPS as an active process and not as ‘docile driving’.”

• Conclusion
  • GPSs are used in ways that the designers had not foreseen: Drivers must match instructions and the map to the actual situation
  • Designer should take “driver intelligence” into account
    • E.g., less persistent instructions when user decided to deviate from them
Example 2: Video Blogging System in Dental Hygiene Clinical Instruction

- Becvar and Hollan (UCSD), ACM GROUP ’07
- Field site: Dental hygiene training program in San Diego, CA, USA
- Goals
  - Gain understanding of teaching and learning practices, media and representations
  - Implement & evaluate a design prototype based on those findings
- Method
  1. Ethnographic study of current practice
  2. Implementing and deploying prototype, then second ethnographic study
Example 2: Video Blogging System in Dental Hygiene Clinical Instruction

- Method for the first part (ethnographic study, 2004, one year in the field)
  - Observation
  - Video recording
  - Contextual interview
- 18 students, 4 instructors participated
- Sample finding: strategies used by clinical instructors
  - Molding: laying their hands over students’ hands as they work with instruments
  - Directing: verbally talking a student through a new procedure ("Do this")
  - Demonstration: using hand gestures to show correct/incorrect ways to handle instruments
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What’s next?

• Introduction to the Mini HCI Project in **tomorrow’s lab**

• Official project start next week

• Form groups of 3 in Moodle until next week, **April 30, 18:00**

• You will not be able to participate in the project and pass the course if you do not join a group in time

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