User Evaluation: Usability Testing

Human Computer Interaction

Fulvio Corno, Luigi De Russis

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Evaluation Goal (recap)

- «Evaluation tests the usability, functionality, and acceptability of an interactive system»
  - According to the design stage (sketch, prototype, … final)
  - According to the initial goals
  - Alongside different dimensions
  - Using a range of different techniques
- Very wide (and a little bit vague) definition
- The idea is to identify and correct problems as soon as possible

Evaluation Approaches (recap)

- Evaluation may take place:
  - In the laboratory
  - In the field
- Involving users:
  - Experimental methods
  - Observational methods
  - Query methods
  - Formal or semi-formal or informal
- Based on expert evaluation:
  - Analytic methods
  - Review methods
  - Model-based methods
  - Heuristics
- Automated:
  - Simulation and software measures
  - Formal evaluation with models and formulas
  - Especially for low-level issues

Lab vs. Field

Evaluation in Lab

- Advantages
  - specialist equipment available
  - uninterrupted environment
- Disadvantages
  - lack of context
  - difficult to observe several users cooperating
- Appropriate
  - if system location is dangerous or impractical
  - for constrained single user systems to allow controlled manipulation of use

Evaluation in the Field

- Advantages
  - natural environment
  - context retained (although observation may alter it)
  - longitudinal studies possible
- Disadvantages
  - distractions
  - noise
- Appropriate
  - where context is crucial
  - for longitudinal studies

Involving Users: Experimental Methods

Usability/User Testing

- "Let's find someone to use our app, so that we will get some feedback on how to improve it."
- anecdotal, mostly
- observation-driven

Controlled Experiments

- "We want to verify if users of our app perform task X faster/…/with fewer errors than our competitor's app."
- scientific
- hypothesis-driven

Involving Users: Experimental Methods

Usability/User Testing

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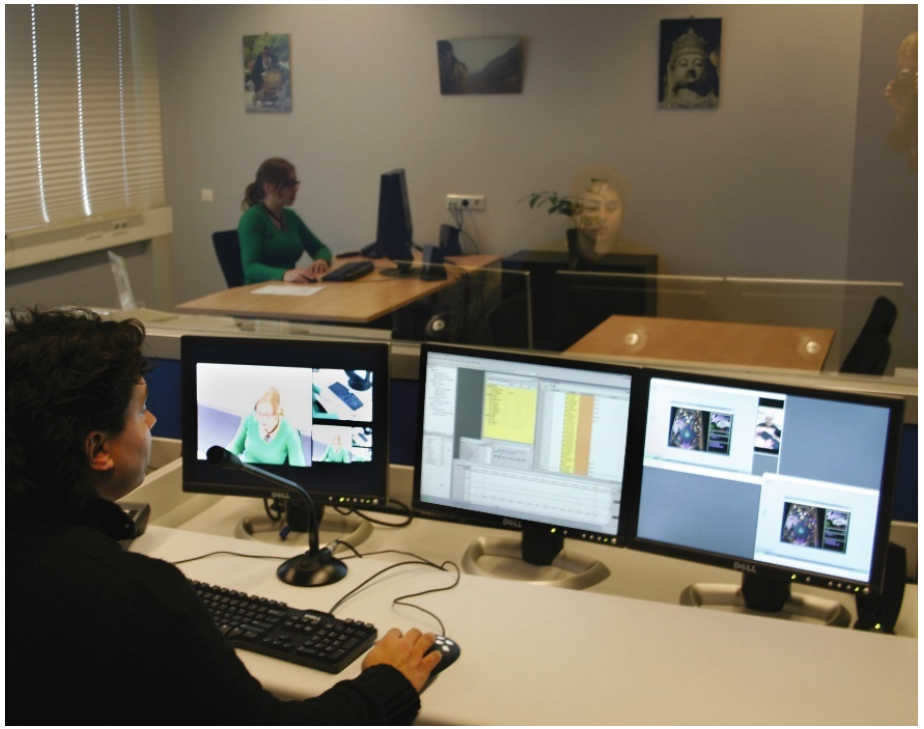
Controlled Experiments

In January

Usability Testing

- Usability testing speeds up many projects and produces cost savings in a system development
- Participants should represent the intended user communities, with attention to:
  - background in computing and experience with the task
  - motivation, education, and ability with the natural language used in the interface
- The movement towards usability testing stimulated the building of ad-hoc usability labs

Usability Testing Labs



- The usability lab usually consists of two areas
  - the testing room
  - the observation room
- The testing room is typically smaller and accommodates a small number of people
- The observation room can see into the testing room typically via a one-way mirror
  - it is larger and can hold the facilitators with ample room to bring in others, such as the developers of the product being tested

Usability Testing: 3 Steps

1. **Plan**
   - who are your participants? what are you going to test, where, and how?
2. **Run**
   - one participant at time, multiple sessions
   - collect data about the interactive system/interface
3. **Analyze**
   - extract information from the collected data, both qualitative and quantitative

Plan

Usability Testing

Usability Testing: Plan

- Choose **who** you will involve in the test
  - who are your (target) users?
- **How many** participants do you need?
  - 5!
  - https://www.nngroup.com/articles/how-many-test-users/
- Decide who and which **roles** you are going to "play"
  - you need at least a facilitator of the session
  - other 1-2 people may serve as note-takers and observers
  - **N.B.** developers, designers, creators, … of the interactive system in evaluation must not serve as facilitators!

Usability Testing: Plan

- Choose **which task(s)** you are going to ask your participants to perform
  - tasks may be introduced with a scenario
  - they must be *concrete* and with a *clear goal*
  - between *5-10* tasks

- Choose any **methodology** you are willing to apply
  - think-aloud, cooperative evaluation, …, none
    - more details in a few slides
  - and for which tasks you are going to use it

- Define detailed success/failure **criteria** for each task

Usability Testing: Plan

- Decide whether you need or want to ask any **additional information**
  - before and/or after the test
  - before and/or after each task
  - before and/or after a meaningful group of tasks

- Select which **equipment** you will need
  - also with respect to the criteria and methodology you define

- Prepare an **informed consent form** for participants to fill

Usability Testing: Plan

- Decide whether to have a **debriefing** session at the end of the test
  - for each participant
  - observers and note-takers can ask general and specific questions, to better understand some pathways or comments
- Develop a **written test protocol** ("script") for consistency among sessions
  - step-by step instructions with all the needed questions and forms
  - often down to the exact words that the facilitator will say
  - the appendix may contain a table with all tasks and their metrics
- *Practice* your script with friends or colleagues
  - to fix obvious bugs so that you do not waste (yours and users') time

Informed Consent Form

- Professional ethics practice is to ask all participants to read, understand, and sign a statement which says:
  - I have freely volunteered to participate in this experiment
  - I have been informed in advance what my task(s) will be and what procedures will be followed
  - I have been given the opportunity to ask questions and have had my questions answered to my satisfaction
  - I am aware that I have the right to withdraw consent and to discontinue participation at any time, without prejudice to my future treatment
  - My signature below may be taken as affirmation of all the above statements; it was given prior to my participation in this study

Metrics

- For success/failure criteria and additional information
- *Subjective* metrics, i.e., questions you ask participants:
  - prior to the session, e.g., background info
  - after each task scenario is completed, such as ease and satisfaction questions about the task
  - overall ease of use, satisfaction, and likelihood to use/recommend at the end
- *Quantitative* metrics
  - what you will be measuring in your test, e.g., successful completion rates, error rates, time on task

Metrics

Successful Task Completion	A task is successfully completed when the participant indicates they have found the answer or completed the task goal.	Boolean value, 0-100 scale, …
Critical Errors	Deviations at completion from the targets of the task, so that the participant cannot finish the task. Participant may or may not be aware that the task goal is incorrect or incomplete.	Absolute or relative number
Non-Critical Errors	Errors that are recovered by the participant and do not result in the participant's ability to successfully complete the task. These errors result in the task being completed less efficiently.	Absolute or relative number, or they may affect the "successful task completion"
Error-Free Rate	The percentage of participants who complete the task without any errors.	Relative number

Metrics

Time On Task	The amount of time it takes the participant to complete the task.	Time
Subjective Measures	Self-reported participant ratings for satisfaction, ease of use, ease of finding information, etc.	Likert Scale
Likes, Dislikes and Recommendations	What participants liked the most about the system, what they liked least, any recommendations for improving it, etc. Typically at the end of the session or a meaningful part of it.	Free text

Reliable and validated questionnaires exist for subjective measures and open questions

Methodology: Think-Aloud

- While the participant performs a task, she is asked to describe what she is doing and why, what she thinks is happening, etc.
- Advantages
  - simple, it requires little expertise
  - can provide useful insight
  - can show how the system is actually used
- Disadvantages
  - subjective
  - selective
  - the act of describing may alter task performance (e.g., time-on-task metric)

Methodology: Cooperative Evaluation

- Variation of the think-aloud
- The participant and the facilitator collaborate during the evaluation
  - both can ask each other questions throughout

- Additional advantages
  - less constrained and easier to use
  - user is encouraged to criticize system
  - clarification possible

Equipment

- Any of these can work for an effective usability testing:
  - Laboratory with two or three connected rooms outfitted with audio-visual equipment
  - Room with portable recording equipment
  - Room with no recording equipment, as long as someone is observing the participant and taking notes
  - Remotely, with the participant in a different location (either moderated or unmoderated)

Equipment: Some Material

- Paper and pencil
  - cheap, limited to writing speed
- Audio
  - good for think-aloud
- Video
  - accurate and realistic
  - needs special equipment
  - may be obtrusive
- Computer logging
  - automatic and unobtrusive
  - large amounts of data may be difficult to analyze
- Eye-tracking
  - to track and record eye movements

Mixed use in practice

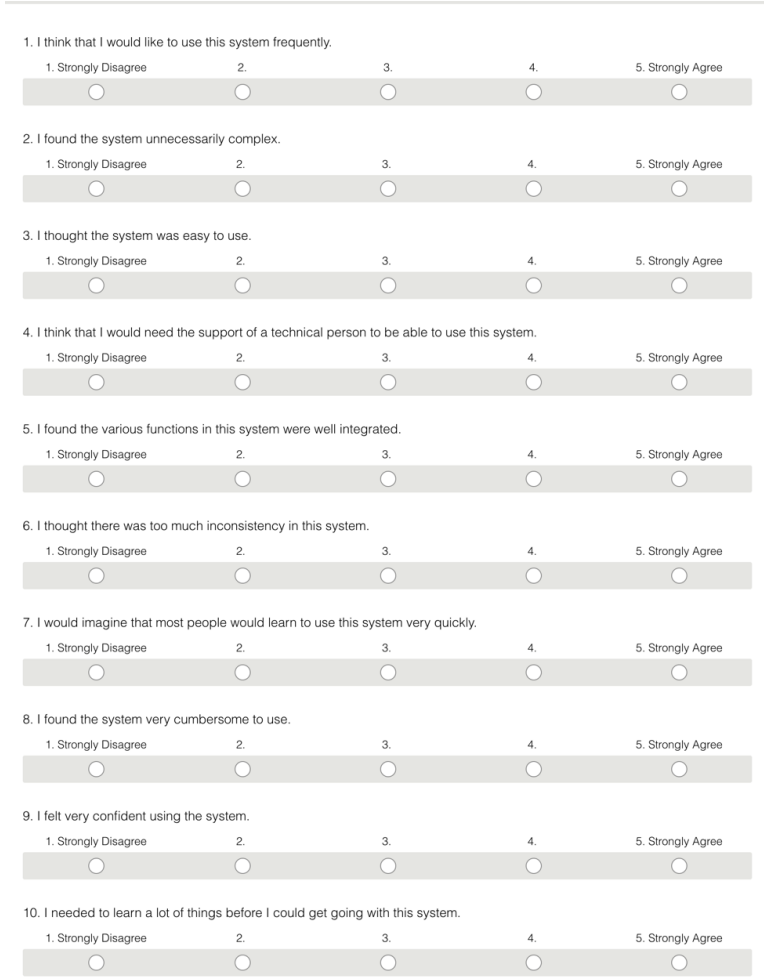
- audio/video transcription difficult and requires skill
- some automatic support tools available

Post-Task Questionnaire: SEQ

- *Single Ease Question (SEQ)*
- Post-task questionnaires need to be short (1–3 questions) to interfere as little as possible with the flow of using the system in a session
- SEQ exemplifies this concept in a useful and simple manner
  - experimentally validated
  - reliable, valid, and sensitive
- It asks the user to rate the difficulty of the activity they just completed, from Very Easy to Very Difficult on a 7-point Likert scale

Post-Test Questionnaire: SUS

- *System Usability Scale (SUS)*
  - a "quick and dirt" (but trustable) usability scale
  - invented by John Brooke in 1986
- It measures the **perceived usability** of a system
- A 10-item Likert-scale questionnaire
  - each question has 5 response options
- It produces a score from 0-100
  - not equivalent to a percentage score!
- A SUS score above 68 is considered **above average**



SUS: Questions

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

SUS: Scoring

To **calculate** the SUS score of your system:

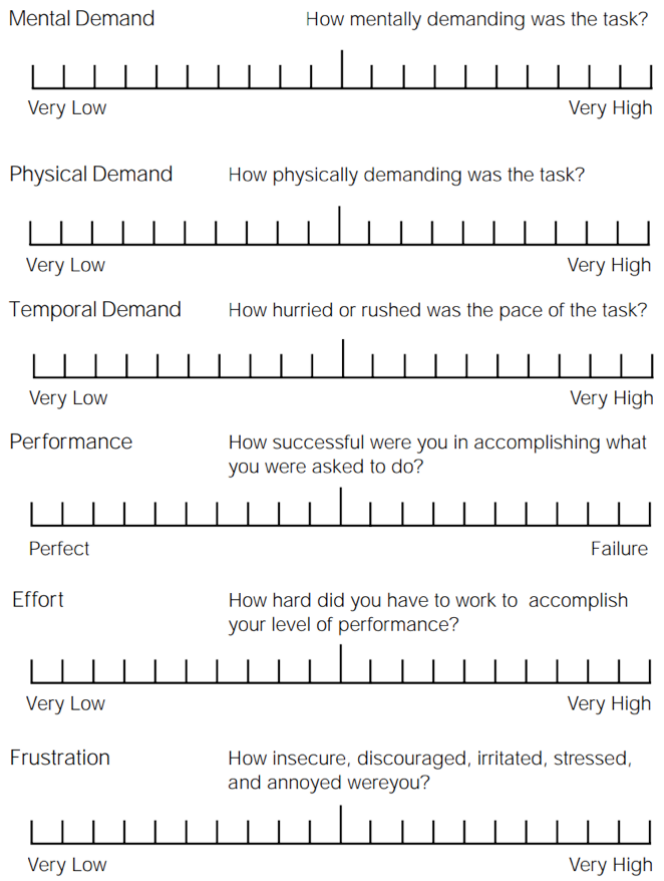
1. Each answer is 1-5 (X)
2. For every odd-numbered question, subtract 1 from the score (X-1)
   - e.g., the answer for question 1 is 4, so its score is 4-1 = 3
3. For every even-numbered question, subtract the score from 5 (5-X)
   - e.g., the answer for question 2 is 4, so its score is 5-4 = 1
4. Sum the scores from even and odd-numbered questions
5. Multiply the total by 2.5

SUS: Advantages and Disadvantages

- Advantages
  - Score reliability has been evaluated over the decades and it is on par with more complex and costly methods
  - Free, quick, and simple
  - Quite used in industry
  - Applicable to a wide range of technologies, systems, and products
- Disadvantages
  - It is a subjective measure of perceived usability
    - it should not be your only method
  - It gives no clues about how to improve the score
    - it is not diagnostic
  - It is not possible to make systematic comparisons between two system and their functionality using SUS

Post-Test Questionnaire: NASA-TLX

- *NASA Task Load indeX (NASA-TLX)*
  - emerged in the 1980s
  - the result of NASA efforts to develop an instrument for measuring the **perceived workload** required by the complex, highly technical tasks of aerospace crew members
- Useful for studying complex products and tasks in high-consequence environments
  - e.g., healthcare, aerospace, military, etc.



NASA-TLX: Questions

- 6 questions on an unlabeled 21-point scale
  - ranging from *Very Low* to *Very High*
- Each question addresses one dimension of the perceived workload:
  - mental demand
  - physical demand
  - time pressure
  - perceived success with the task
  - overall effort level
  - frustration level
- Respondents weigh each one of the questions pertaining to the six categories, to indicate which mattered most to what they were doing

NASA-TLX: Score

- A **complex** instrument to score
- NASA shares a paper and pencil version
  - with instructions
  - https://humansystems.arc.nasa.gov/groups/tlx/tlxpaperpencil.php
- and a free iOS app to compute the score
  - https://itunes.apple.com/us/app/nasa-tlx/id1168110608

Sample Scripts and Some Tips

- Sample Usability Testing scripts, with no task described in them, mainly:
  - https://www.sensible.com/downloads/test-script.pdf
  - http://www.lse.ac.uk/intranet/staff/webSupport/guides/archivedWebeditorsHandbook/pdf/script.pdf
- How to create good tasks?
  - https://www.nngroup.com/articles/task-scenarios-usability-testing/

Run and Analyze

Usability Testing

Usability Testing: Run

- Get informed consent
  - better in written format
- One person acts as the facilitator and rest of team are observers
  - at least one of the observers must take notes
- Tell each participant:
  - "we are testing our app, not you! Any mistakes are app's fault, not yours."
  - **IMPORTANT!**

Usability Testing: Run

- The facilitator should always follow the script, remain neutral, not help the participants, and provide clear instructions
  - tasks can be given in a written form, one at time, … or vocally
- The facilitator must encourage participants to adopt (and explain) the chosen methodologies, at the right moment
  - e.g., how the think-aloud work and for which tasks to use it
- Note-takers take notes of the participant's behavior, comments, errors and completion (success or failure) of each task
- The system is ready to measure **all** the defined criteria

Usability Testing: Analyze

- Analyze collected data to find UI failures and ways to improve
  - e.g., written notes, audio, video, usage logs, …
- Do not forget to consider the collected metrics
  - per task and overall
- Quantitative data can be summarized in, e.g., success rates, task time, error rates, satisfaction questionnaire ratings
- Look for trends and keep a count of problems that occurred across participants
  - e.g., observations about pathways participants took, comments/recommendations, answers to open-ended questions

References

- Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, Human Computer Interaction, 3rd Edition
  - Chapter 9: Evaluation Techniques
- Ben Shneiderman, Catherine Plaisant, Maxine S. Cohen, Steven M. Jacobs, and Niklas Elmqvist, Designing the User Interface: Strategies for Effective Human-Computer Interaction
  - Chapter 5: Evaluating Interface Design
- usability.gov - Improving the User Experience
  - https://www.usability.gov

References

- Beyond the NPS: Measuring Perceived Usability with the SUS, NASA-TLX, and the Single Ease Question After Tasks and Usability Tests
  - https://www.nngroup.com/articles/measuring-perceived-usability/
- John Brooke, SUS - A quick and dirty usability scale, 1986
  - https://hell.meiert.org/core/pdf/sus.pdf
- The Pros and Cons of the System Usability Scale (SUS)
  - https://research-collective.com/blog/sus/

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