

The Science of Human Factors and Organizational Psychology: Usability Analysis and Training Evaluation



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What is Human Factors?

- A science – the study of humans and their capabilities and limitations.
- The practice of applying the understanding thereof to the design and deployment of systems and tasks.
 - n Fitting the system to the user.
- Example: Designing a user interface so that it can be effectively and efficiently used.

What is Organizational Psychology?

- A science-study of people and groups at work.
- **Scientific approach to making organizations effective.**
- Example: The design of a selection system



Human Factors & Organizational Psychology in high-impact fields

- Human Factors & Org Psych have a long history working with fields where errors have drastic implications:
 - n Military
 - n Medical
 - n Aerospace
 - n Nuclear
- Intelligence community faces similar high-impact decisions!





The Military Influence...

- Military applications have driven the evolution of HF + OP.
- In the two World Wars, technology was introduced **without being empirically validated** for use by humans.
- Growing need for systems to be usable **regardless** of who they were paired with.
- Today, military funds much of the applied and basic research in the field.



The Products...

- o What HF + OP produce
 - n Principles – e.g., Fitts' Law
 - n Methods – e.g., Heuristic Evaluation
 - n Tools – e.g., NASA TLX
 - n Strategies – e.g., Cross-Training
 - n Devices – e.g., iPhone
 - n Guidelines – e.g., Intelligent Tutoring Guidelines
 - n Theories – e.g., Motivation Theory



How do we evaluate products?

- Two primary means to ensure effectiveness:
 - 1) Usability Analysis
 - 2) Training Evaluation Typology (TET)
- Usability Analysis uses HF principles to evaluate a system and **tailor** it to the user.
- TET uses OP & HF principles to ensure the user is **able to use** the task or system and has acquired **needed competencies**.



Usability Analysis: Overview

- Usability Analysis is part of an **iterative cycle** – the usability engineering life cycle.
- Effectively, analysis should be performed **before, during, and after** design and implementation.
- Usability Analysis focuses on the **system and how the user interacts with it.**



Usability Analysis Examples

- Particular model of car keeps rear-ending other automobiles.
 - n What is causing this? Visibility issues? Control issues? Bad brakes?
 - n Test with different users, different tasks.
 - n Discovery: Gas and brake are too close together, getting pushed at the same time.
- Data is getting deleted from a data entry system.
 - n Poorly trained users? Software bug?
 - n Discovery: Dialog for saving is misleading, users think they have saved but have not.



Existing Usability Analyses Relevant to Intelligence

- Data visualization (Plaisant, 2004)
- Mobile devices (Duh, Tan, & Chen, 2006)
- Wearable systems (Siegel & Bauer, 1997)
- Informatics (Kushniruk et al., 1997)
- Automated decision aids (Beverly et al., 1999)
- Virtual environments for military intelligence (van den Bosch, Janssen, 2002)

Usability Analysis Techniques

In order of increasing complexity:

- Heuristic evaluation
- Cognitive walkthrough
- Interviews
- Think-aloud verbal protocol
- Field testing





Heuristic Evaluation

- Heuristic evaluation is the most **informal method** of analysis, but can be very effective (Jeffries & Desurvire, 1992). Usability experts judge whether the system fits established heuristics (Nielsen, 1984)

- Heuristics:

Speak the user's language	Design minimalist systems
Be consistent	Use chunking
Minimize memory load	Provide progressive levels of detail
Be flexible and efficient	Don't lie to the user

- Pro: Quick, low-cost
- Con: No user insight



Cognitive Walkthrough

- Bench-testing of the system by an expert analyst or group of analysts/designers (pluralistic walkthrough).
 - n Analyst takes on the role of a user, and methodically steps through using the system.
 - n Identifies goals, problems, actions of the user (Rieman, Franzke, & Redmiles, 1995).
 - n Best used early on in the usability lifecycle, with rapid prototypes (Jeffries & Desurvire, 1992).
- Pro: Virtual view of user without logistical hassle of actual users
- Con: Not based on actual users



Interviews

- **Formal or informal meetings with end users and experts.**
 - n Determine user **needs and goals**.
 - n With an existing product, can also determine common problems and issues.
 - n Can function as a needs analysis or as a way to identify problems from the **user perspective**.
- **Pro: Direct user contact.**
- **Con: Logistically complicated, may not be appropriate for community.**



Think-aloud Verbal Protocol

- Similar to the cognitive walkthrough, but performed by an **actual user** engaging in an **actual task**.
- User is asked to narrate their stream of consciousness out loud while performing a task.
 - n Example: “I need to copy this file, so I’m going to look for a clipboard function... maybe it’s under “Edit” like on Windows... oh, here’s a button”
- Problems, goals, and actions are identified as in cognitive walkthrough.
- Pro: High degree of user interaction
- Con: High time investment



Field Testing

- Observation of field deployment of a system.
 - n Similar issues as lab vs. quasi experiments: less control, potential influence on task, but can reveal **in situ information** (Baber & Stanton, 1996).
- Pro: Unique information
- Con: Potentially expensive or difficult
- Applicability to community is variable.



Laboratory Testing

- Simulate tasks in **laboratory**.
- With mobile devices or systems with specific contexts, can try to replicate usage context (Kjeldskov & Stage, 2004)
- More **control**, less ecological validity.
- Can be aided by measurement systems such as eye trackers.
- Pro: Control, measurement
- Con: Expense

Usability Implications

- Most evaluations are lab-based, but field testing reveals information that is unique, especially for mobile devices (Duh, Tan, & Chen, 2006).
- Best to do discount usability evaluation (e.g., heuristic evaluation, cognitive walkthrough) early



Kirkpatrick's Model of Training Evaluation

Level 5 – Return on Investment
Was the training worth the cost?

Level 4 – Results
Did the change in behavior positively affect the organization?

Level 3 – Behavior / Training Transfer
Did the participants change their behavior on-the-job based on what they learned?

Level 2 – Learning
What skills, knowledge, or attitudes changed after training? By how much?

Level 1 – Reaction
Did the participants like the training?
What do they plan to do with what they learned?



Training Evaluation: Overview

- Learning outcomes may be classified as:
 - n Cognitive
 - Knowledge, KO, Cognitive strategies
 - n Skill-Based
 - Behaviors
 - n Affective
 - Attitudinal Outcomes
- Methods:
 - n Survey
 - n Tests
 - n Observation

Training Effectiveness in the Field

- Crew Resource Management (CRM) Training
 - n Aviation, flight deck, & beyond
- Medical Teams
 - n Healthcare
- Command & Control
 - n Military





Training Evaluation: Pros and Cons

- Pros

- n Robust approach
- n Diagnostic
- n Helps with accountability

- Cons

- n Labor-intensive
- n Typical vs. maximum performance
- n Pushback from organizations
- n Difficulty in obtaining level 4 data



What do HF & Org Psych offer?

- Better Design
 - n Focused on user needs
 - n Fit to task
 - n Easier to use
 - n Fewer mistakes
- Effective Training
 - n Increased knowledge
 - n Enhanced skills
 - n Better Situation Awareness