Human Factors and Usability Interaction on Fingerprint Quality

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What is Usability?

Usability is part of a successful product

**Usability**
The effectiveness and efficiency of a system to meet the user’s needs, resulting in user satisfaction and productivity

**Usability Engineering**
tools, techniques and user centered processes applied to achieve usability
Usability means that the people who use the product can do so quickly and easily to accomplish their own tasks.

Usability is a combination of factors that affect the user's experience including:

- **Effectiveness** — a measure of user productivity, how well a user can perform his job accurately and completely.
- **Efficiency** — a measure of how quickly a user can perform work, the resources expended to accomplish the task.
- **Satisfaction** — The degree to which users like the product: a subjective response in terms of ease of use, frustration, and usefulness.
Usability Problems are Uncontrolled Overhead

A large, invisible source of **uncontrolled overhead** results when **end-users** find their tools:

- confusing to comprehend
- time-consuming
- error prone
- inconsistent
- require excessive training, & frequent informal retraining

This undermines business benefits and expected ROI.
The Value of Usability

Examples of savings include

- **Maximizing throughput**
  - Standardizing the counter height of the scanner
  - Saves an average of 1.1 seconds per scan (4.6% in time savings)
  - Increases operational throughput capacity from 40,000 to 41,800 captures/day

- **Improved biometric system accuracy**
  - recognize the affects of age and gender
  - recognize the affects of feedback

- **Minimize training and errors**
  - 10 print capture is computationally more complex
  - early observational data indicates that subjects tend to remove their hands too quickly
  - recovery will add at least 10% to the total capture time
Goals of the effort:

The development and testing of a set of usability guidelines for biometric systems that:

- enhance performance
- improve user satisfaction/acceptance
- provide consistency across biometric system user interfaces
Guidelines must address

- Users
  - Subjects, operators, examiners, users with special needs

- Context
  - Environment, motivation, cognitive load

- Tasks
  - Acquisition/capture, training, tools

- Usability metrics
  - Throughput, accuracy, satisfaction
Consider for example 3 questions:

- Does habituation affect user’s performance and the acquisition of quality prints?

- How does feedback affect habituation and image quality?

- Does the height of the scanner affect user’s performance?
Younger subjects submit higher quality prints than older subjects.
Women’s fingerprints, on average, are of poorer quality than men’s
Without feedback, habituation has no affect on image quality

Quality of finger prints over time
Daily Variability was observed, but no overlap of 2 groups

Quality of finger prints over time for 18-25 and 55-65 age groups
When feedback was introduced older participants tried more times.

Attempts by age group:

- **18**: Attempt count
- **25**: Attempt count
- **35**: Attempt count
- **45**: Attempt count
- **55**: Attempt count
- **65**: Attempt count
With feedback older subjects produced prints that were of higher quality over time.

Quality of finger prints over time for 18-25 and 55-65 age groups.

Phase 1 (no feedback)  Phase 2 (with feedback)
Younger subjects still submit higher quality prints

But older subjects did improve

Quality of fingerprints by age group

Phase 1 (no feedback)

Phase 2 (with feedback)
Height does affect acquisition times

![Average Acquisition Time Graph]

- Slap-Left-Avg
- Slap-Right-Avg
- Thumb-Both-Avg
- Thumb-Left-Avg
- Thumb-Right-Avg
Users prefer

Most Comfortable Height

- 26 Inches
- 32 Inches (highest)
- 36 Inches
- 42 Inches
Recommended guidelines from these studies would include:

- Habituation without feedback cannot be expected to significantly affect print quality.

- Habituation with feedback can translate into improvement of quality—subjects can produce higher quality prints with fewer attempts.

- The nature of the feedback provided needs more investigation; determining the optimal feedback remains an open problem.

- Users are both most comfortable and are fastest when using fingerprint scanners at standard counter height.
Future Work

- Complete analysis of height study
- Design a study to examine approaches to feedback
- 10-print user timing study
- 10-print user instruction study
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