Human Factors and Usability Interaction on Fingerprint Quality

Mary Theofanos

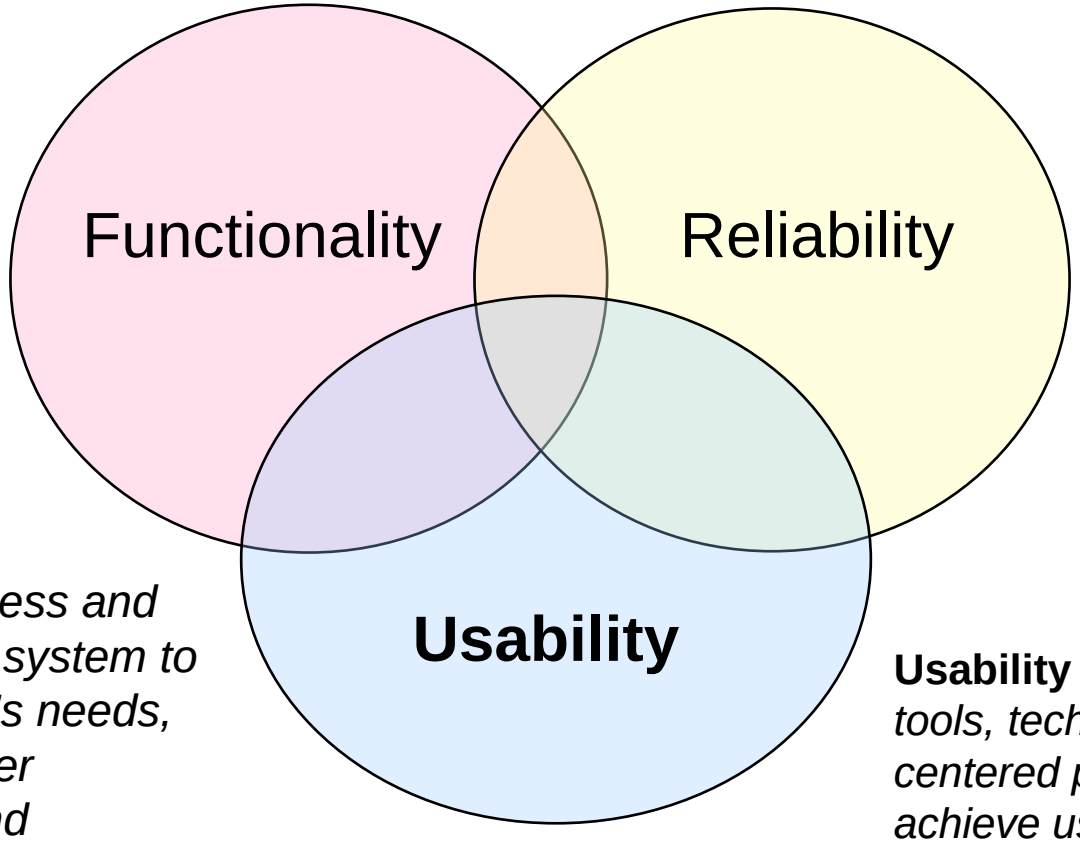
Ross Micheals

March 8, 2006

National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

What is Usability?

Usability is part of a successful product



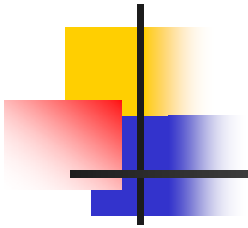
Usability
The effectiveness and efficiency of a system to meet the user's needs, resulting in user satisfaction and productivity

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

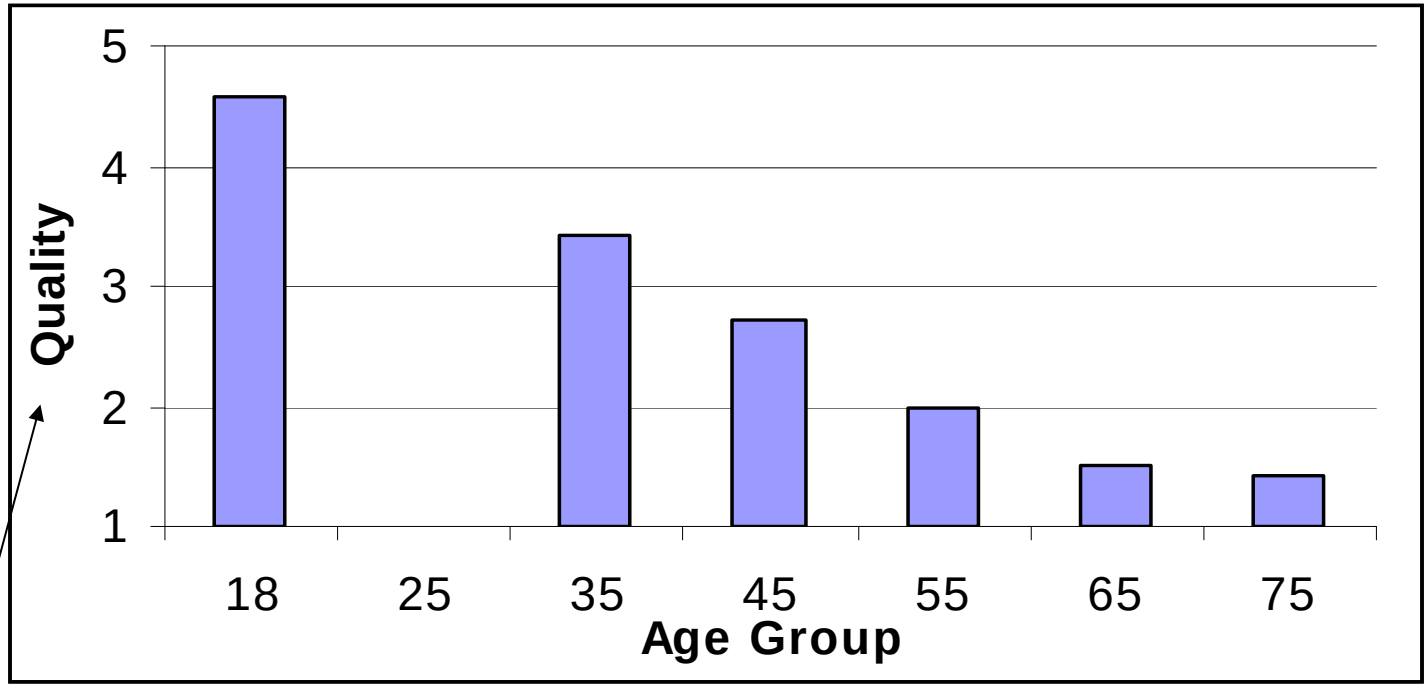
Guidelines must address

- 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?

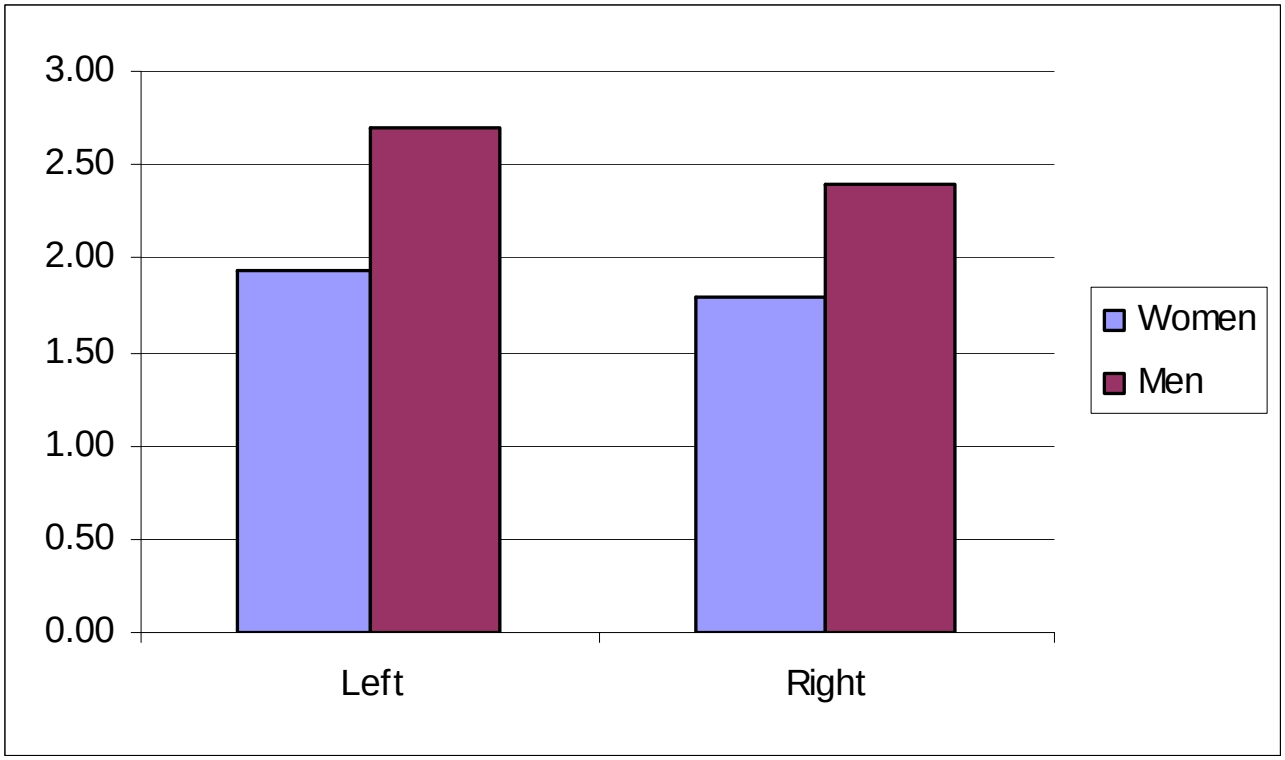
Younger subjects submit higher quality prints than older subjects



Quality of fingerprints by age group

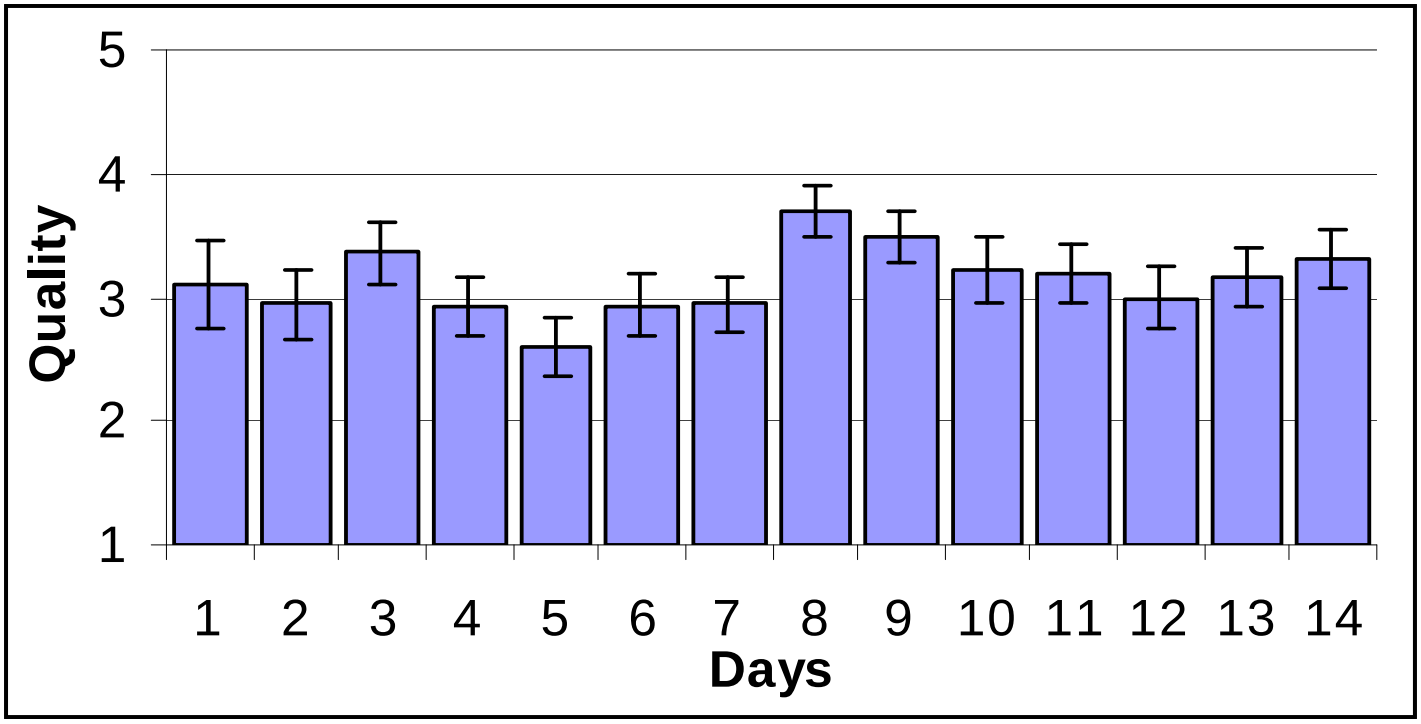
Quality *as presented to user* = 6-NFIQ

Women's fingerprints, on average, are of poorer quality than men's



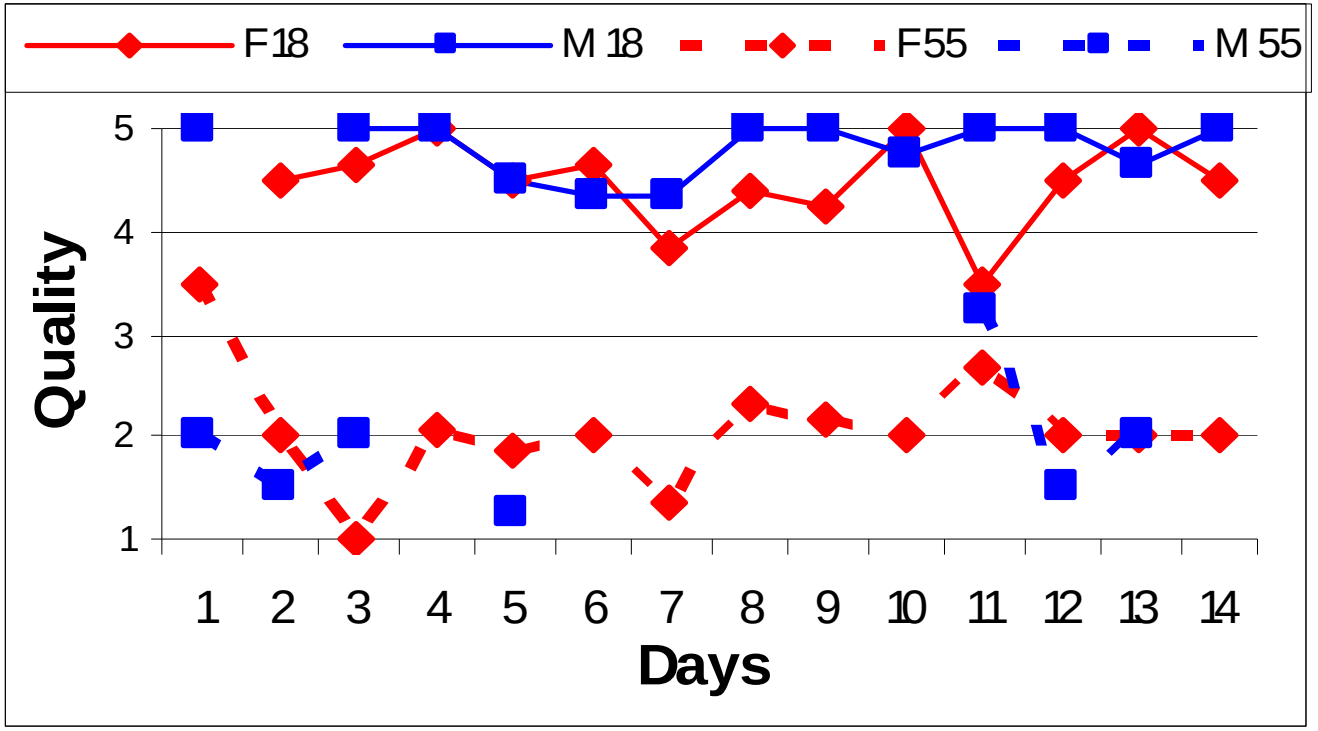
Quality of fingerprints by gender

Without feedback, habituation has no affect on image quality



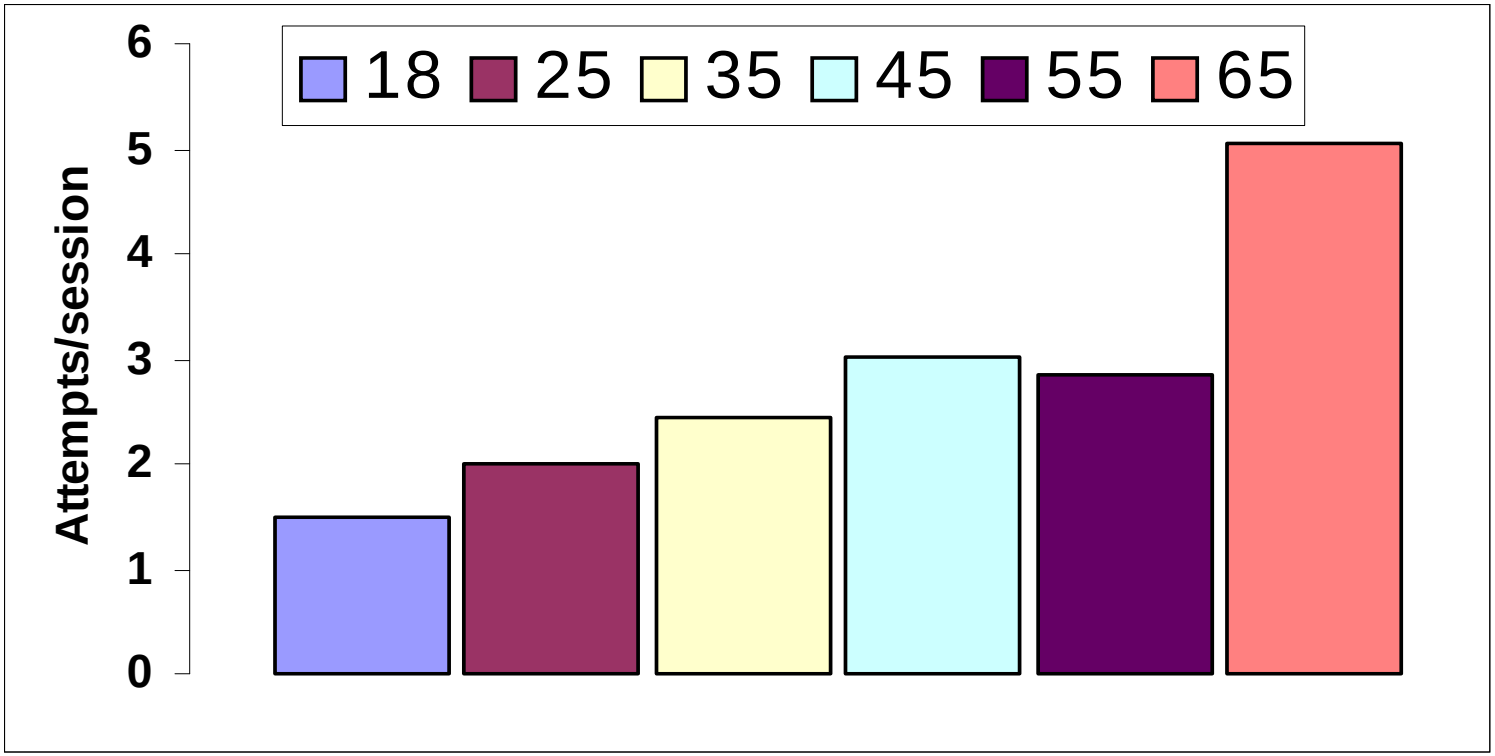
Quality of finger prints over time

Daily Variability was observed, but no overlap of 2 groups



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

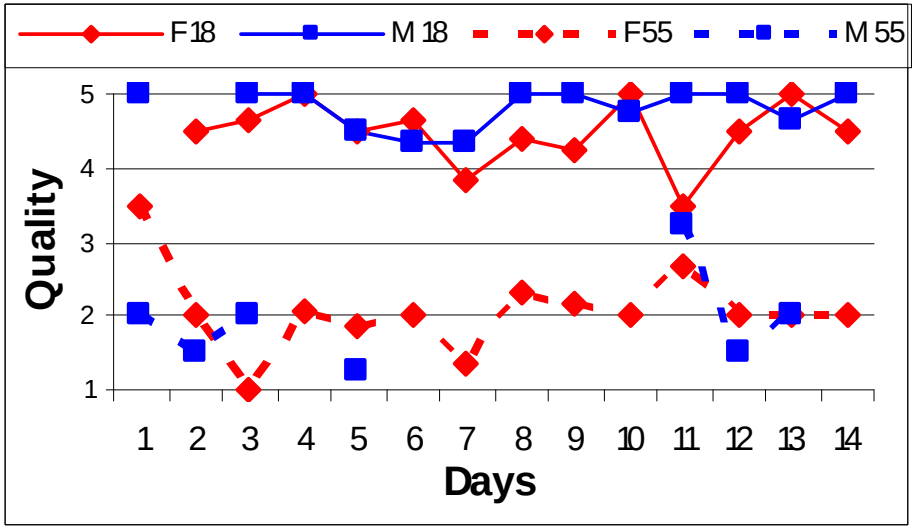
When feedback was introduced older participants tried more times



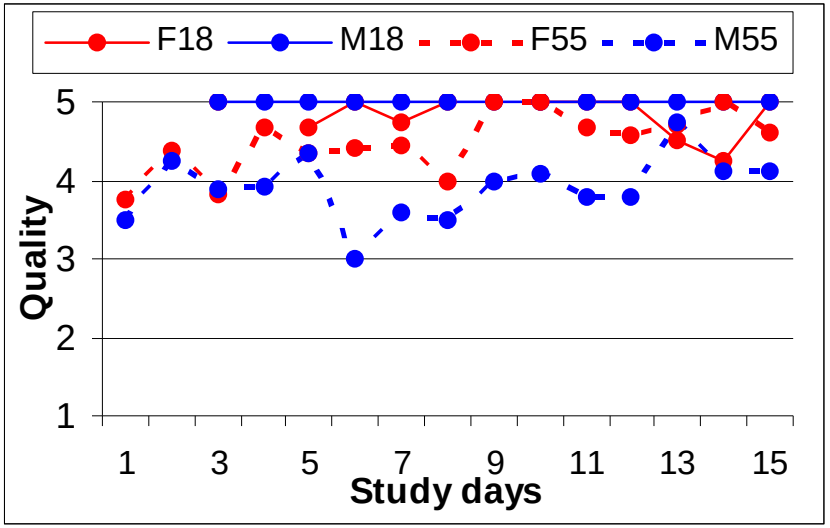
Attempts by age group

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)

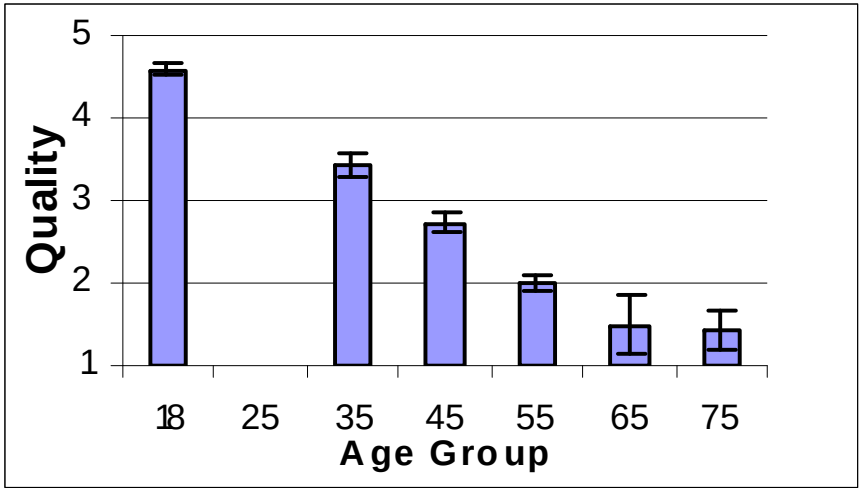


Phase 2 (with feedback)

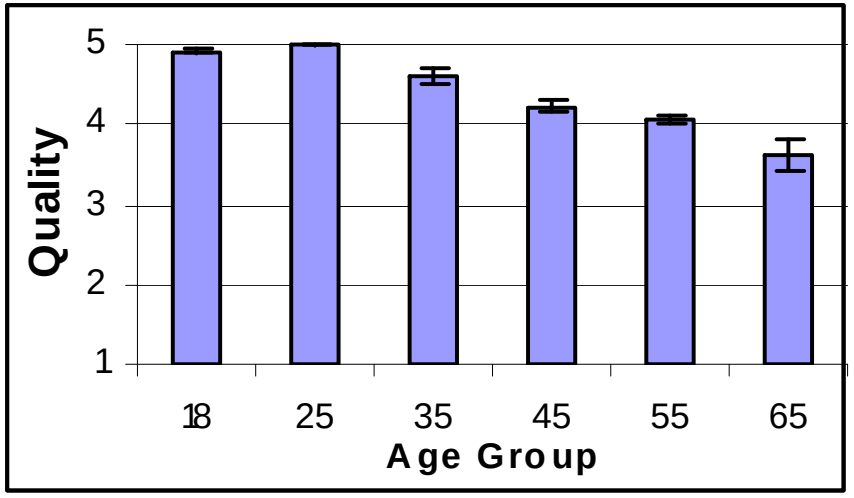
Younger subjects still submit higher quality prints

But older subjects did improve

Quality of fingerprints by age group

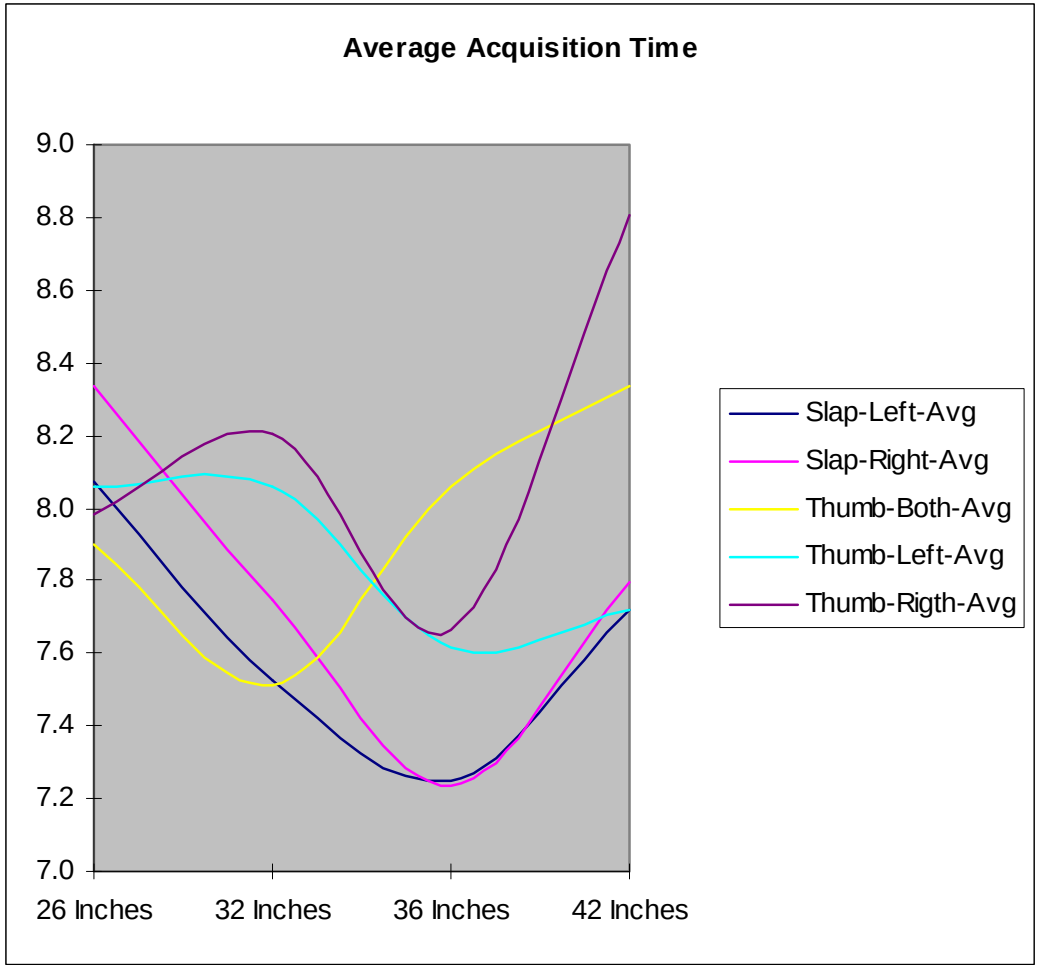


Phase 1(no feedback)

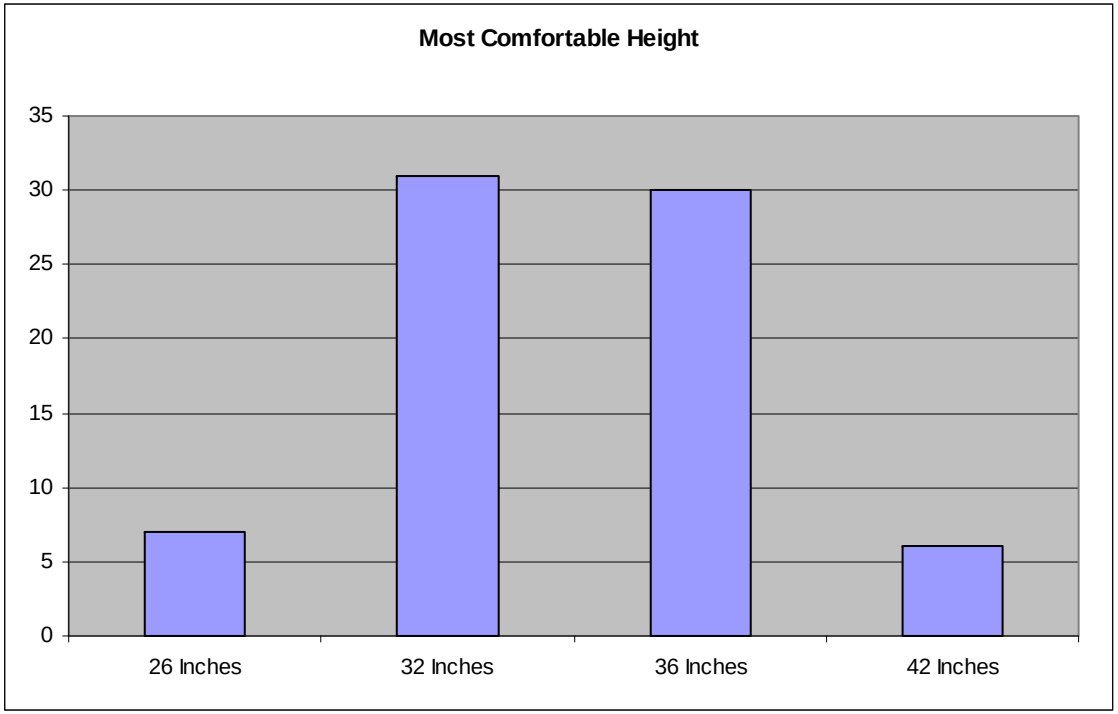


Phase 2 (with feedback)

Height does affect acquisition times

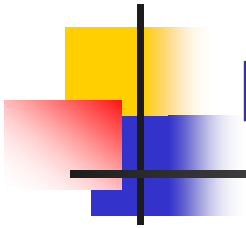


Users prefer



Recommended guidelines from these studies would include:

- Habituation without feedback cannot be expected to significantly effect 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

Contact Information

Mary F. Theofanos
NIST
100 Bureau Drive, MS 8940
Gaithersburg, Maryland
20899-8940 USA
voice: 301 975-5889

mary.theofanos@nist.gov

Ross Micheals, PhD
NIST
100 Bureau Drive, MS 8940
Gaithersburg, Maryland
20899-8940 USA
voice: 301 975-3234

ross.micheals@nist.gov