

# Lessons Learned From Iris Trial

Huayan Amy Wang, Diana Melick,  
Rick Vollkommer, Bruce Willins  
Contact: [wanga@symbol.com](mailto:wanga@symbol.com)

**R&D, Symbol Technologies, Inc.**

Biometric Consortium Conference 2002  
Sept 25, 2002

# Outline

- Overview of Trial Setup
- Data Analysis: False Rejection & Failure to Acquire
- User Habituation: Acquisition Time
- Trial Summary
- User Questionnaire Results
- Mobile Experience
- Conclusions

# Trial Overview

- Objectives:
  - Scenario evaluation of iris biometrics with **inexpensive** cameras
  - Measure real-life performance
  - Understand user ergonomics, user habituation, user reaction...
- Time Period: January to March 2002.
- System installed at Symbol Cafeteria
- User base: employee volunteers
  - 107 participants, 66 male, 41 female, ages between 20 to 60



# Trial Procedure

2-step process:

## ■ **Enroll:**

- Both eyes
- Issued Badge with ID # (to detect false accepts)
- Training/Practice sessions

## ■ **Authentication (Identification)**

- 5~6 weeks after enrollment
- Unattended
- Encourage people to do more than 2 trials/day
- Procedure:
  1. scan badge,
  2. present iris,
  3. get result (picture shown if identified)

## ■ Questionnaires issued near the end of the trial



# Iris Testbed

## Setup

- Panasonic AuthentiCam
- Iridian PrivateID v2.0  
(Hamming distance threshold: 0.32)
- Camera Height: 4'8" From Floor
- IR Illumination
- Aiming Parallel To Floor
- Aiming Timeout: 17 sec
- Operational Depth of Field: 19" +/- 1.5"



## Overall Result

- Trial Period..... 41 work days
- Total Enrollment ..... 107 (214 eyes)
- Total Samples ..... 4,531
- **Failure To Enroll ..... 2 (1.9%, due to eyeglasses)**
- **False Accepts ..... 0**
- Failure To Acquire ..... 419 (9.3%, aiming timeout)
- False Rejects ..... 525 (11.6%)



# Data Analysis

Users	Data Set	# trials	FTA%	FRR%	# users with zero FTA / FR	Avg. Acquisition Time
All (107)	Total Period	4531	<b>9.3</b>	<b>11.6</b>	--	6.3 sec
Frequent Users* (21)	Overall	1841	<b>8.6</b>	<b>6.8</b>	0 / 1	5.9 sec
	Steady	1686	<b>5.9</b>	<b>5.3</b>	4 / 3	5.5 sec
	2 <sup>nd</sup> Half	685	<b>2.9</b>	<b>4.2</b>	14 / 8	<b>4.5 sec</b>

\* *Frequent Users*: Used the system more than 30 days and 60 trials;

*Overall*: total period; *Steady*: delete practice sessions and 1<sup>st</sup>; *2<sup>nd</sup> Half*: last 3 weeks of trial

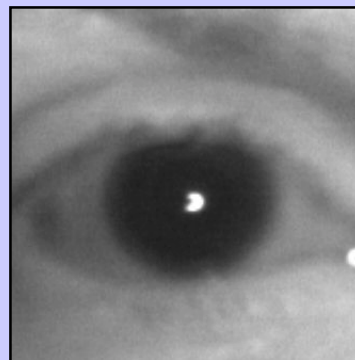
- **Observations:**

- Significant reduction in FTA as users learn, and improved FRR as well.
- FTA and acquisition time may be inflated due to user distraction after badge scan (which starts the timeout period).

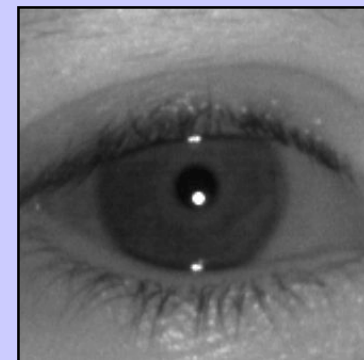
# False Rejection Analysis

- Poor image qualities (see pictures →)
  - Better image pre-qualification helps
- Enrollment issues
  - Enrolled with the same eye
    - Difficulty using the non-dominant eye
  - Poor enrollment images
- User FRR correlation with physiology\*

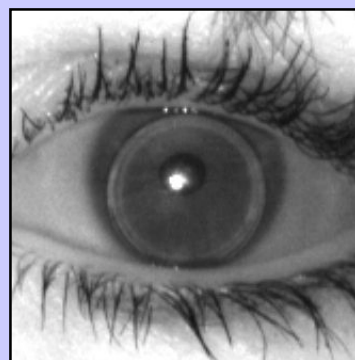
	Corr. Coef.
Visible Iris Area	-0.23
Iris Sclera Contrast	-0.21
Iris Texture Energy	-0.21
Iris Pupil Contrast	-0.19
Pupil to Iris Ratio	0.17



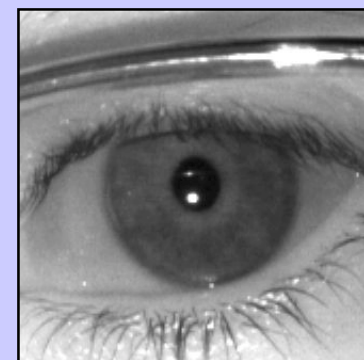
Blurred



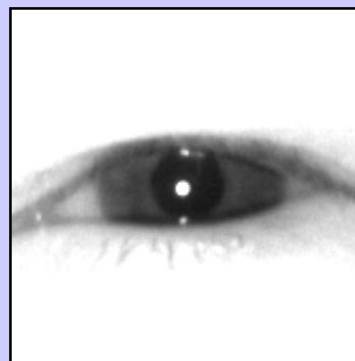
Too Dark



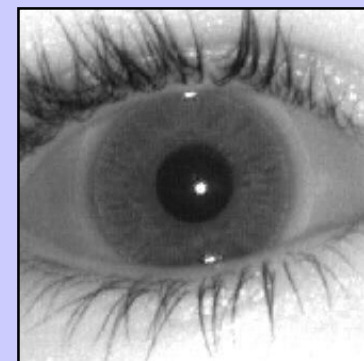
Contact lens (User 6)



Glasses



Iris occlusion

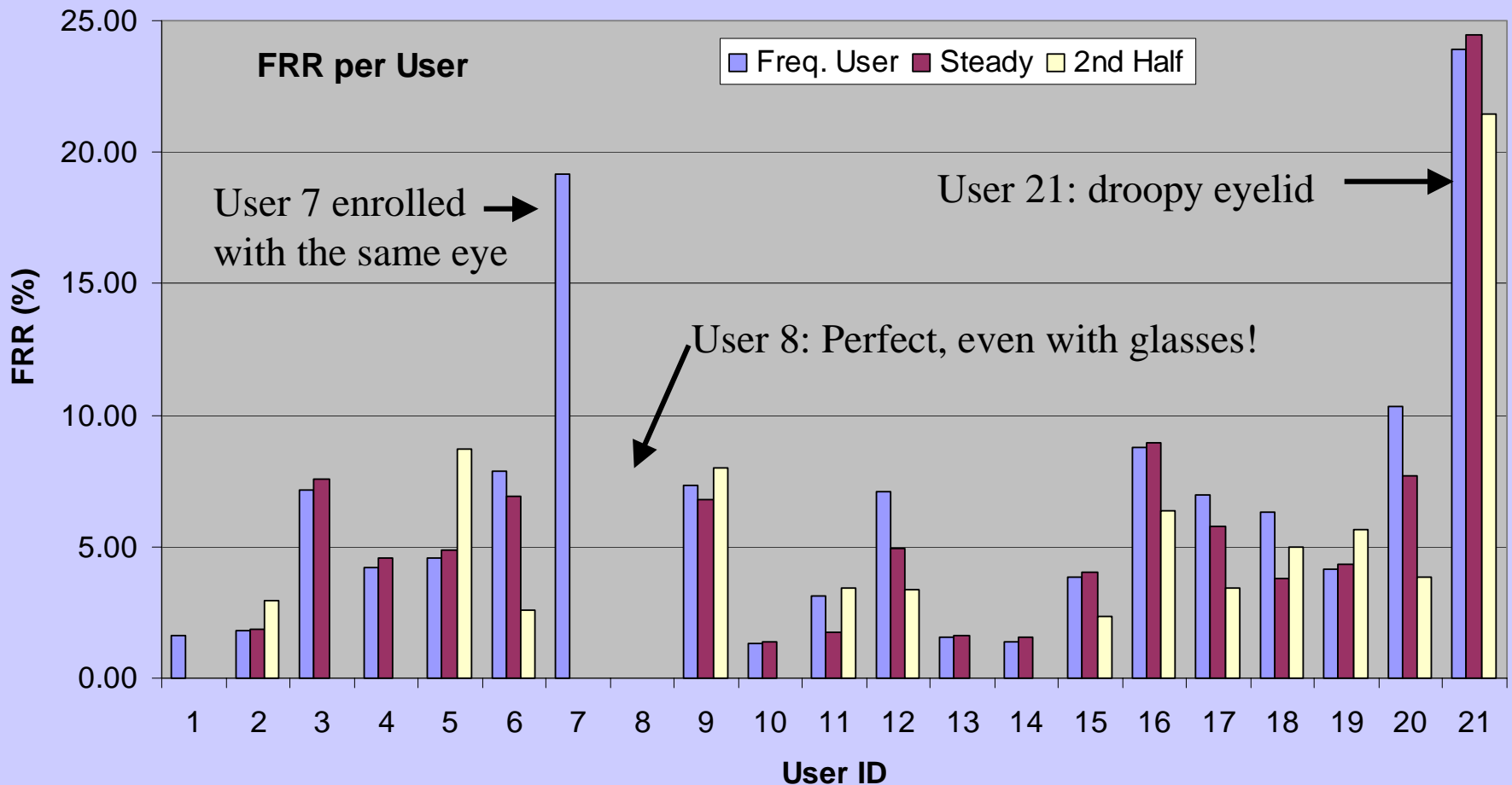


Cannot tell why

\* Based on data of 52 users during 2<sup>nd</sup> half of the trial

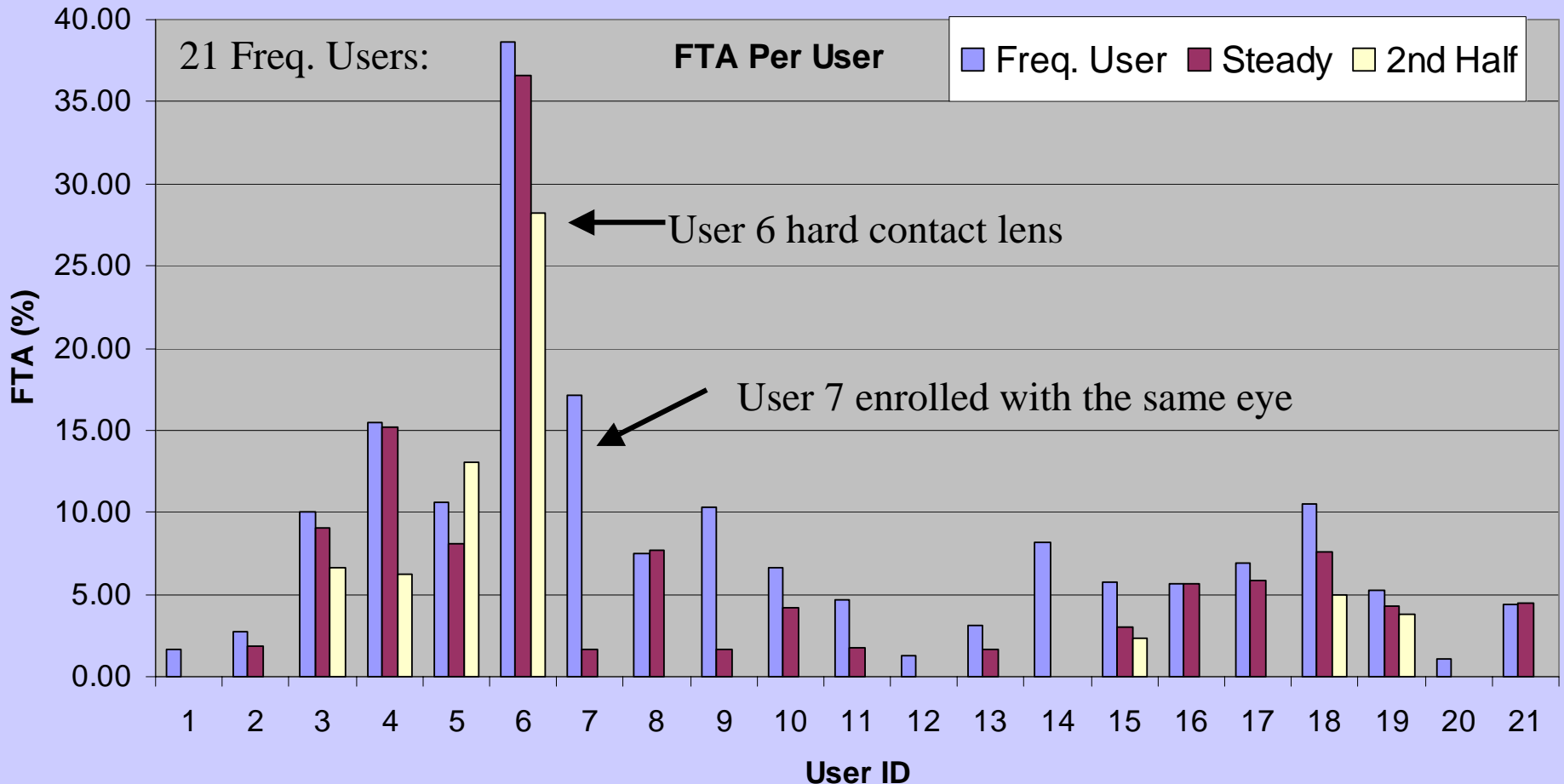
# FRR Is User Dependent

- Avg. FRR does not tell the whole story: Individual user performance varies widely
  - Worst per user FRR among all users: 90.5% (19 FR out of 21 trials)
    - Large pupil (pupil to iris ratio > 0.5) in enrollment, wore contact lens, quit at 3<sup>rd</sup> day
  - The 21 frequent users are a good representation:

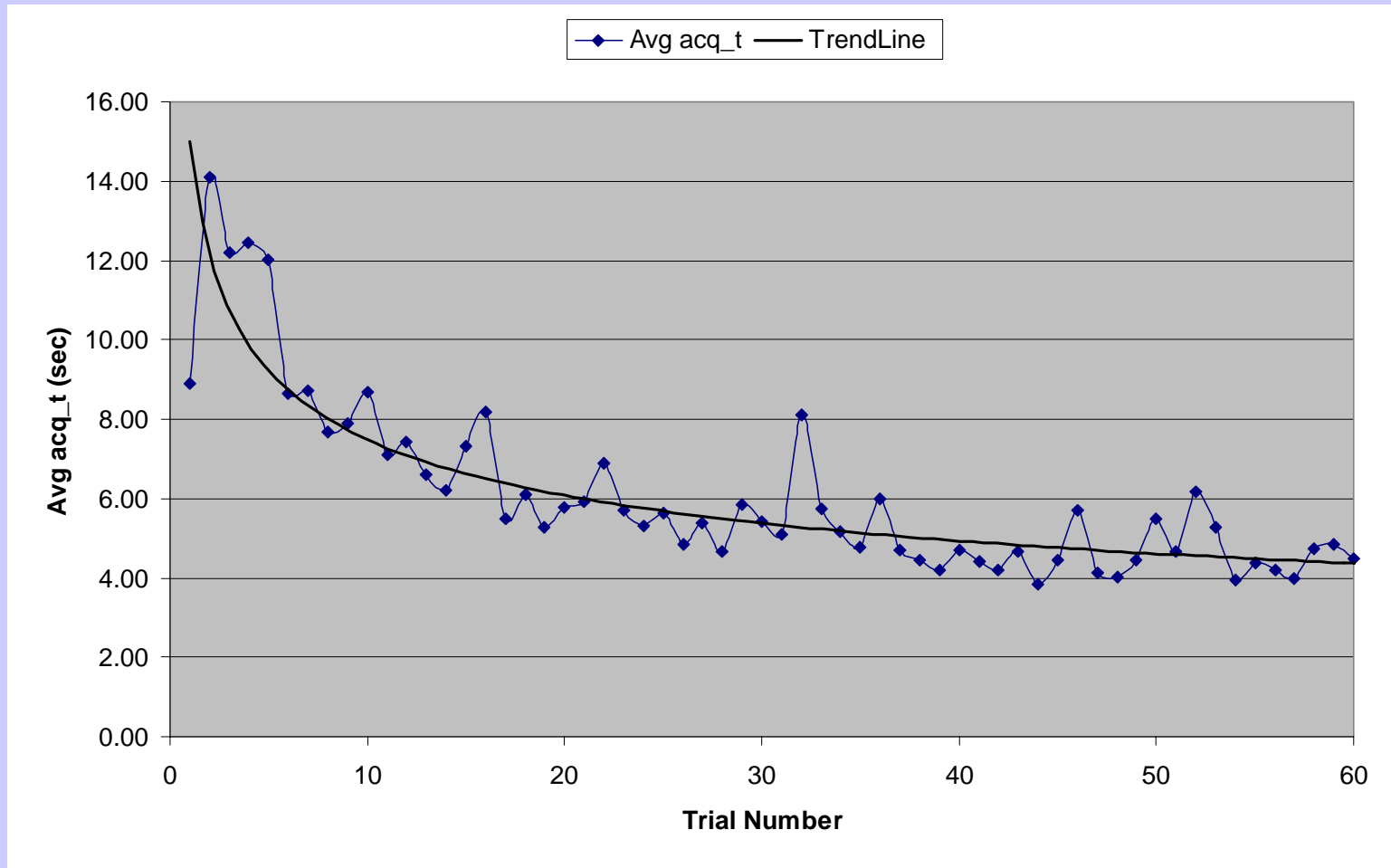


# FTA Per User

- Individual user performance varies for FTA
  - High FTA mostly because of infrequent use
  - For most users, FTA improves over time
  - Few users have persistent higher FTA: e.g. User 6.



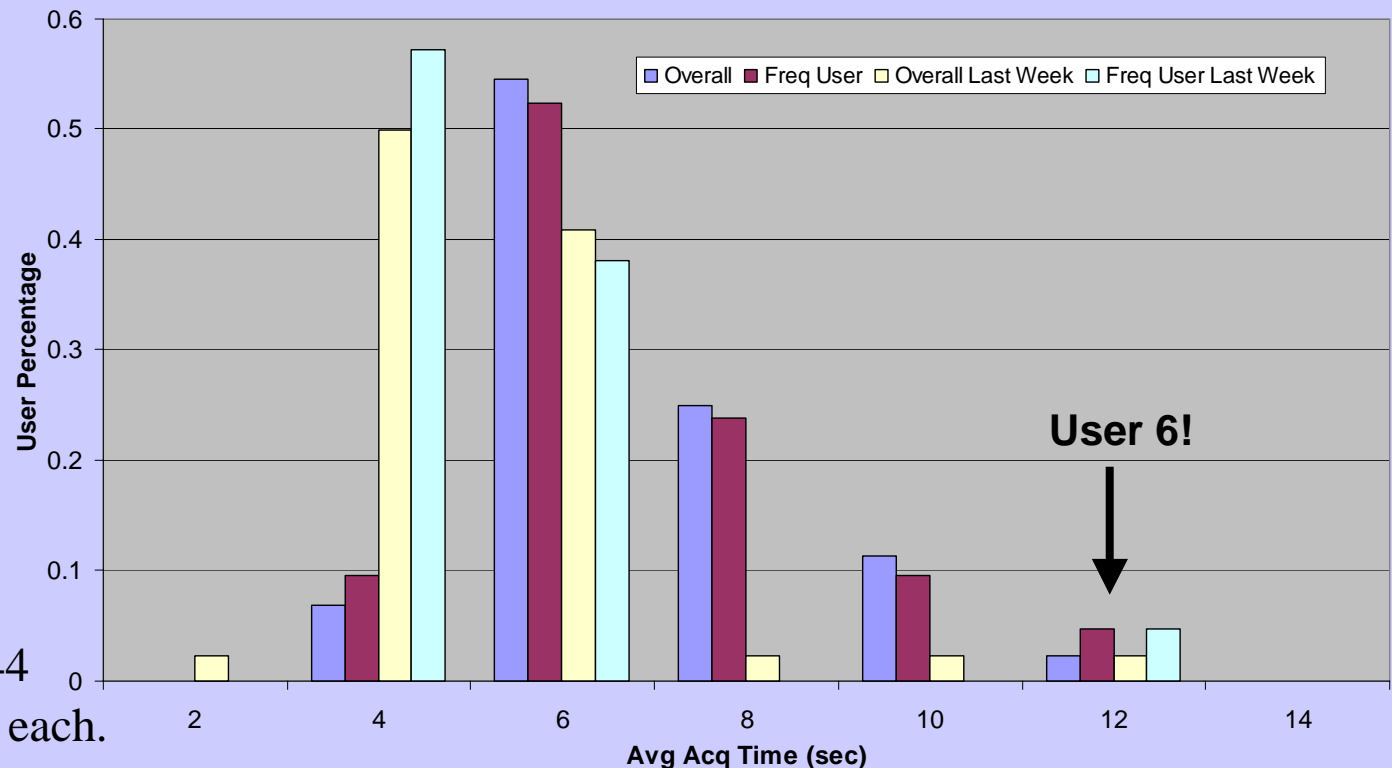
# User Habituation: Acquisition Time



- Improved Acquisition Time (avg. of frequent users)
  - Reached 90 Percentile In Approximately 40 Trials (or 20 days)

# Acquisition Time Per User

- By the last week of the trial,
  - Avg. acquisition time = 4.35 sec
  - > 50% users achieve avg. acquisition times < 4 sec
  - > 90% users achieve avg. acquisition times < 6 sec



Note: "Overall" are 44 users with > 30 trials each.

# Statistical Significance

- Zero False Accept:

- Binomial Approximation:

$$p(k = 0) = \sum_{i=0}^0 \frac{N!}{i!(N-i)!} p^i (1-p)^{N-i} = (1-p)^N$$

$N$  = total # of trials

$k$  = # of successes

$p$  = prob trial success

$1 - \delta$  = confidence level

$p(k = 0) < \delta \rightarrow N > 3/p$  approximately, with 95% Confidence

- With DB size of 214, no. of false accept tests  $\sim 214 * 4531/2 = 484817$

- **FAR < 6 x 10<sup>-6</sup>, with 95% confidence**

- False Rejection Rates: Use normal distribution approx.

$$\varepsilon \approx \sqrt{\frac{p(1-p)}{\delta N}}$$

$$\delta = 0.05$$

	# trials	FTA $\pm \varepsilon$ %	FRR $\pm \varepsilon$ (%)
Overall	4531	9.3 $\pm$ 1.9	11.6 $\pm$ 2.1
Frequent Users	1841	8.6 $\pm$ 2.9	6.8 $\pm$ 2.6
Frequent Steady	1686	5.9 $\pm$ 2.6	5.3 $\pm$ 2.5
Freq. 2 <sup>nd</sup> Half	685	2.9 $\pm$ 2.9	4.2 $\pm$ 3.4

# Causes of FTA and FRR

- 5-6 Weeks Enroll To Verify: Users Forgot How To Use System
- Droopy Eyelids (Iris occlusion)
- Specular From Glasses (e.g. monitor reflection)
- Difficulty In Distinguishing Which Eye Being Imaged
  - Dominant eye used most of the time
- Difficulty Judging Distance To Camera w/o Feedback
- “Prize-Fighter” Effect (constant movement of user)
- Attempts To Verify By Unenrolled Users
- Camera Height Set For Shortest Person
  - Difficult For Tall People To Judge Distance When Crouching

# Lessons Learned

- People use other's badge → “false” false accepts
  - Have to check with each individual to weed out false results
  - Better approach is to eliminate badge, require user to acknowledge the result.
- Should have detected and redone poor enrollment
  - Cover one eye to avoid enrolling the same eye
- Need more information to better understand reasons for FRR & FTA
- User distraction after badge scan affects FTA and acquisition time measurements

# Trial Summary

- Experience, positive overall
    - Reliability & downtime: no major problems
    - Volunteers are enthusiastic:
      - Enjoy the learning experience, awareness of biometrics and security
      - Some drop out due to schedule issues
      - Many drop out due to excessive FTA/FRR
    - For the authors (trial planners)
      - Trial objectives accomplished; Lessons learned.
      - Helpful experience for developing prototype iris mobile terminals.
      - The best part is the anecdotal stories we collected 😊 (come to the talk!)
  - Desirable system improvements:
    - Better and multiple alignment mechanisms
    - Cues for adjusting distance to camera
    - Better image pre-qualification
- \* Iridian claims latest HW and SW have enhancements resolved some issues

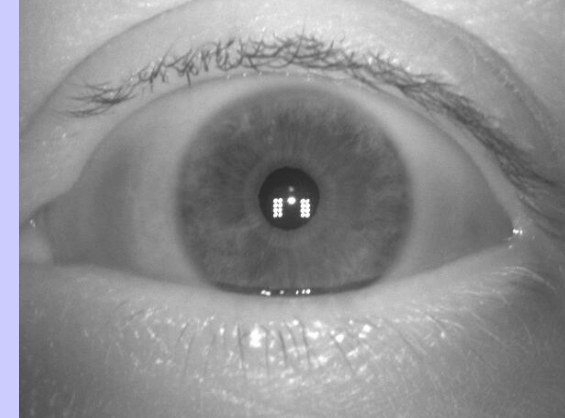
# User Questionnaire Key Take-aways

Ease of use	<b>70%</b> rated good or excellent
Effort in alignment	41% rated good or excellent
Effort in opening eyes	75% said without special effort
Speed	53% said it is slower than PIN entry
Invasiveness	62% said not invasive at all
Prefer Iris over PIN	<b>82%</b>
Prefer Iris over Fingerprint	62%
Prefer Iris over Badge for access	75%
Sense of security	76% rated very secure
Top concerns	47% for health risk, 26% for Identity theft
Iris biometric for speedy airport check in	<b>100%</b>

\* 34 respondents

# Extending to Mobile Platform

- Mobility Increasingly Critical
  - Anytime anywhere authentication
  - Anytime anywhere registration
  - More secure, more productive, less intrusive
- Mobile Iris Terminal Prototype
  - Concept proved
  - Lessons Learned
    - Processing and memory requirements non-issue
    - User comfortable distance: application dependent
    - Illumination is key (IR used)
    - Hand jitter issue
    - Aiming important
      - Display, Audio Feedback, Light Pointing (not laser)



# Comparison to Other Trials

Trials:

Trials	Equipment	Software	# users	Time Period
Symbol	Authenticam	IridianPrivateID V2	107	Jan - Mar 2002
DoD [1]	SensarR1	Unknown	258	Oct 2000 - Apr. 2001
NPL [2]	LG2200	Unknown	~200	May - Dec. 2000

Performance comparison:

	FTE	FAR	Steady State FTA	Steady State FRR	Steady State Acq. Time	Initial Acq. Time	Learning curve
Symbol	1.9%	0	2.9%	4.2%	4 sec	15 sec	4 weeks
DoD	Unknown	0	Unknown	6-7%	10 sec	15 sec	2 weeks
NPL	0.5%	0	0	2%	12 sec*	Unknown	Unknown

\* “12 sec” includes 4-digit-PIN entry time

References:

[1] “Testing Iris and Face Recognition in a Personal Identification Application”, Dr. Steven King (DoD), Hal Harrelson & George Tran (Army Research Lab)

[2] “Biometric Product Testing Final Report”, Mansfield, Kelley, Chandler, Kane, NPL.

# Conclusions

- Inexpensive iris camera performed well with habituated users
  - However, individual user performance varies widely.
  - Users with poor FRR: droopy eyelid, some glasses/contact lens, bad enrollment
- No single biometrics for all users:
  - Failure to enroll: cannot see visual alignment aids without glasses
  - “Outliers”: high FRR (> 20%)
- Questionable for non-habituated users:
  - High FTA/FRR (> 10%), Avg. Acq\_Time ~15 sec, better aiming can help
  - Depends on your cost/performance tradeoff
  - Non-issue for Authenticam (designed for personal, habitual use)
- Overall, users have favorable reaction to iris imaging
- Feasible on mobile platforms for 3<sup>rd</sup> party authentication
  - Attendant assisted aiming helps

More info: [www.symbol.com/solutions/homeland\\_security/secinitatives\\_symb.html](http://www.symbol.com/solutions/homeland_security/secinitatives_symb.html)