

Introduction to Biometrics

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Introduction to Biometrics

- ◆ 2002 - Basics
- ◆ 2003 - Basics updated
- ◆ 2004 - Basics updated plus some vocabulary issues addressed
- ◆ 2005 - Maturing, growing vocabulary issues, vulnerabilities, etc.
- ◆ 2006 - Yet another perspective

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Session One 2002

◆ State-of-the Art

- What are biometrics and how do they work
- Fingerprint recognition
- Face recognition
- Voice recognition
- Hand recognition
- Iris recognition

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Session Two 2002

◆ Implementation Issues & Challenges

- What biometrics are used for
- Factors that influence the performance
- What are some of the challenges
- Applications for Homeland defense and INS
- The role of biometric standards

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What are Biometrics? 2002

- ◆ **Biometrics** are automated methods of recognizing a person based on a physiological or behavioral characteristic.
 - *Biometrics Consortium definition*

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Statistical Underpinnings

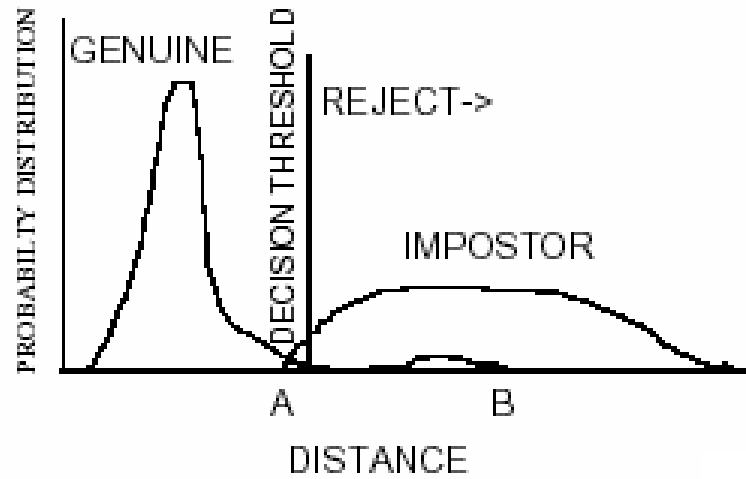
- ◆ Measure differences in samples collected
 - Score distribution across a large sample is bi-modal.
 - Threshold of closeness is set-dependent based on multiple variables:
 - ◆ Technology
 - ◆ Purpose of system
 - ◆ Degree of cooperation
 - ◆ Amount of supervision
 - ◆ Target population

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Score Distribution



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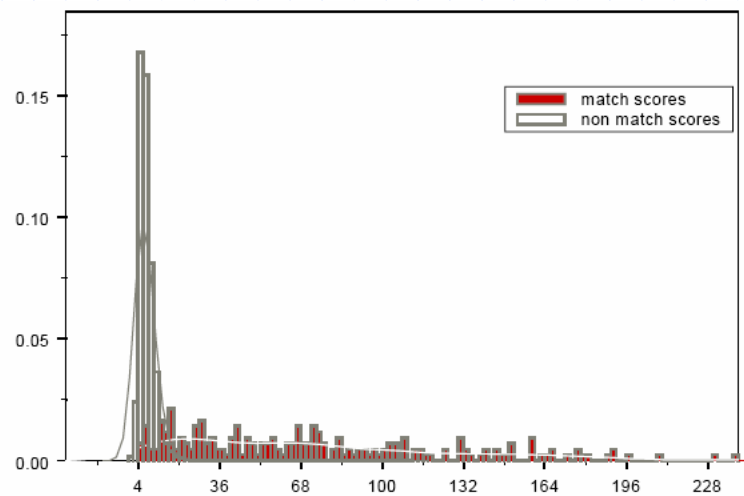


Figure 1 - SD29 VTB match and non-match scores histogram

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Performance Characteristics

- ◆ Threshold driven
 - Fixed setting or dynamic setting
 - Trade-off between false rejects and false accepts
- ◆ Metrics used
 - Failure to Enroll and Failure to Acquire Rates
 - False Reject Rate = False Non-Match Rate
 - False Accept Rate = False Match Rate

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Lecture - 2003

- ◆ Same outline as 2003
- ◆ Updated information

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Lecture - 2004

- ◆ New approach
 - Vocabulary issues
 - The dream
 - How hand geometry works - updated slides

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Vocabulary Confusion

- ◆ Gallery - repository - corpus
- ◆ Probe - search record - utterance
- ◆ Pose - presentation
- ◆ Flat - plain - slap

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Facial ID - the Dream

From
Wired™
magazine

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

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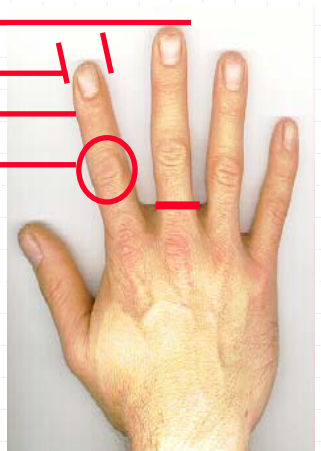
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How Hand Geometry Works

- ◆ A 3D image of the hand is acquired
- ◆ Over 90 distinct measurements are made
 - Length
 - Width
 - Thickness
 - Surface Area
- ◆ 9 Byte template is generated

Image courtesy of Recognition Systems.



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Lecture - 2005

- ◆ New approach
 - Maturing technology
 - Growing vocabulary issues
 - Vulnerabilities - the silent side of the story
 - Standards - a long slow trip
 - Mandates - some of the major ones

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Outline of 2005 Presentation

- ◆ Biometrics - you are maturing
- ◆ Biometrics - your roots are showing
 - Vocabulary, performance metrics, etc.
- ◆ Basic Concept of Operations - models
- ◆ Vulnerabilities
- ◆ Standards
- ◆ Mandates

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Biometrics - Still Maturing

- ◆ **Technology** - maturing quite nicely
 - Year-to-year performance tests show positive trends
- ◆ **Industry** - maturing
 - Consolidations and realism overcoming enthusiasm and marketing hype
 - Investors still seeking “the year of biometrics”
- ◆ **Purchasers** - broader base but governments still carrying the load

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Biometrics Is ...

- ◆ “Something you know, something you have, something you are.”
 - IBM InfoSec paper (G520-2169) - 1970
 - Ben Miller’s “Dynamic Model of Identification” - 1984
 - Everyone - 2005
 - **Update** - FIPS PUB 201; February 2005

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Biometrics Is ...

- ◆ The automated recognition of individuals based on biological and behavioral characteristics.

OR

- ◆ A measurable physical characteristic or personal behavioral trait used to recognize the identity of an enrollee or verify a claimed identity

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Biometrics Is ...

- ◆ Biometric is an adjective
- ◆ Biometrics is a noun
- ◆ Presentation of your “biometric sample” is strongly influenced by your behavior

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Workflows

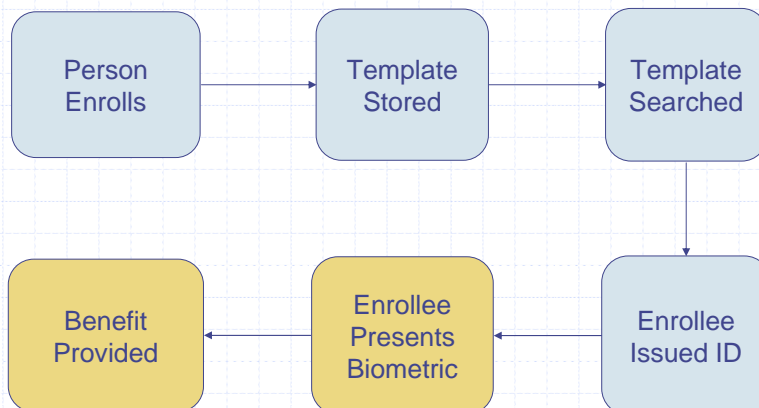
- ◆ Workflows vary all over the map
 - Think law enforcement vs. access to your own laptop
- ◆ Enrollment-through-use examples follow
 - End-to-end-processes for benefits, enforcement, convenience

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Idealized Model



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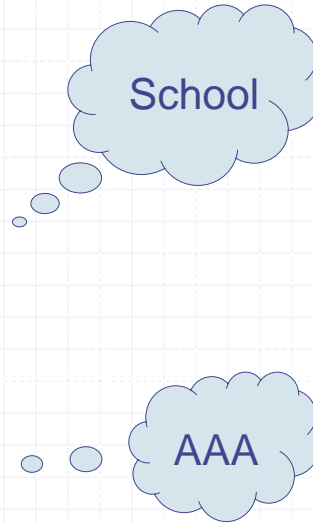
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Enrollment

◆ Definition

- 1. vt to enter your own or somebody else's name on an official register or list of members
- 2. vt to make sure that something, especially somebody's help, will definitely be available



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Capture: at Enrollment & Use

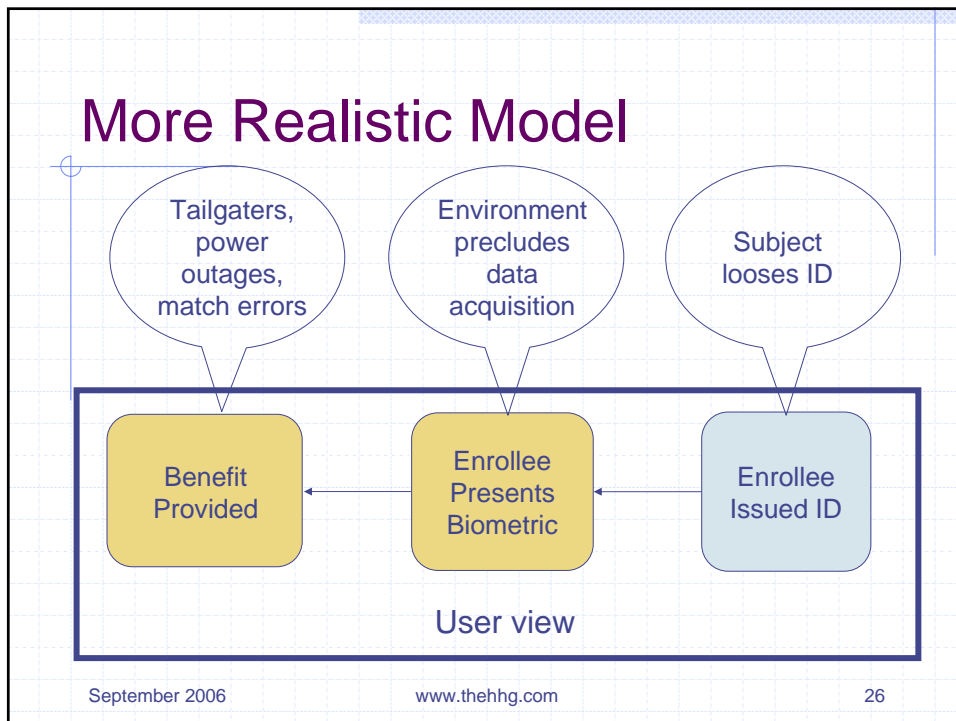
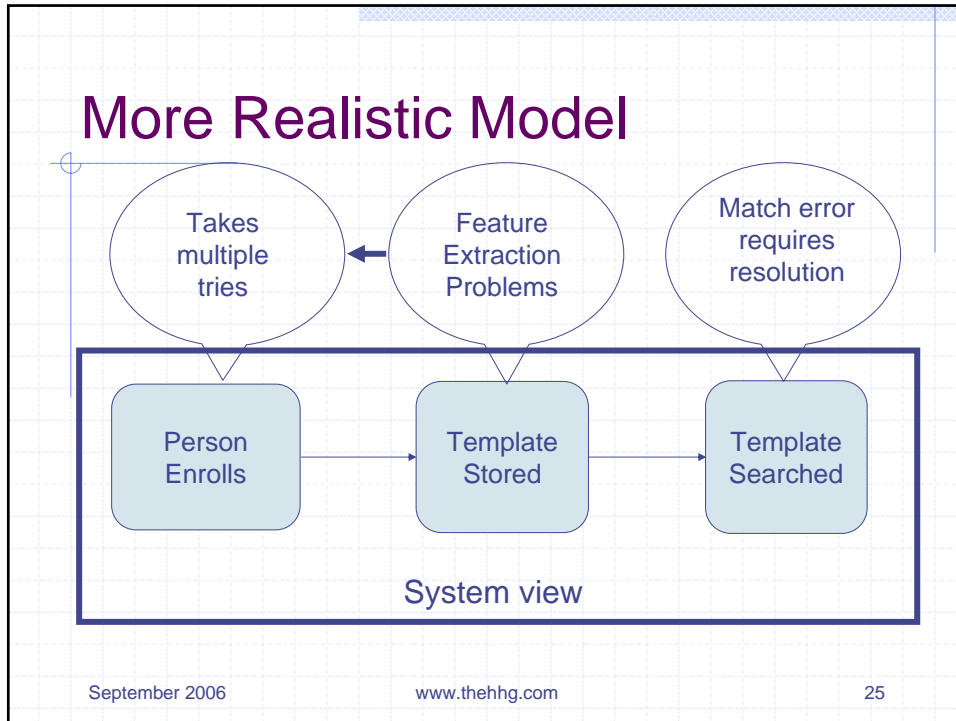
◆ Variables include

- Presentation
- Environment (light - noise - objects)
- Person (age - time of day - time since last use - illness/injuries)
- Collection device (calibration, quality, similarity to original enrollment device)

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Introduction - 2006

- ◆ Definition - updated
- ◆ Basic concept
- ◆ Large scale implementations
- ◆ Trends
- ◆ Reports Available
- ◆ Myths

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Quote of the Year

- ◆ *"Biometrics companies themselves are not particularly stable, quite a few of them are one bad press release away from folding."*
 - Duane Blackburn
 - UPI April 2006

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Definition

- ◆ Automatically recognizing an individual based on biological and behavioral traits
 - So-called identification mode: no claim of identity is made
 - So-called verification mode: a claim of identity is made (not always 1:1 search)
- ◆ Realize: one individual can have many identities

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Basic concept

- ◆ Samples of representations of individual traits and characteristics are closer for one person than between people
 - Samples can be images, sound recordings, etc. - strongly influenced by behavior
 - Samples are converted, typically, into mathematical representations that can be compared by a computer-based algorithm

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Basic Concept

- ◆ Uniqueness and stability of the biometric characteristics are the keys to matchability
 - That is why we do not use such things as hair color and weight
 - Earlier approaches (Bertillonage or anthropometry) did not address the necessity for independent characteristics
 - ◆ Height and arm length are not independent

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Basic Concept

- ◆ Biometrics differs from the legal process of positive identification in that biometrics is an automated (or at least semi-automated) and purely statistical process.
 - Can be a tool in legal identification - think fingerprints

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Large scale implementations

- ◆ FBI's IAFIS is often touted as the largest biometric system in the world
 - Number of enrolled Biometric samples / persons and number of daily transactions
- ◆ Other systems will or do eclipse one or both of these metrics
 - US VIST
 - Indian State Benefits Card program
 - DOS Consular Consolidated Database

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IAFIS

- ◆ 50 - 60 million persons enrolled
 - Primarily criminals
 - Federal applicants / DOD
- ◆ Peak load - 105,000 transactions per day (peak achieved April 2006)
 - Two largest contributors: OPM & DHS

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US VISIT

- ◆ 61 million persons enrolled
 - Excluding Mexicans with BCCs (104 M crossings per year)
 - Starting 8/2006 certain Canadians entering via air and sea POEs will have to enroll their fingerprints
- ◆ Approximately 100,000 transactions per day - moving to 10 prints from 2
- ◆ Over 1,100 criminals have been caught

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Indian State Benefits Card

- ◆ LG 's Andhra Pradesh ration card entitlement program, Iris-based.
 - Over 1200 enrollment locations.
 - 23 million persons enrolled.
 - 80 million enrollments envisioned.
 - Status as of Spring 2006

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Iris Testing

- ◆ The UAE system has collected over 630,000 iris scans from persons representing 152 nationalities
 - Permits over 200 billion cross comparisons in the lab
 - Limited ground truth - a match missed at enrollment - is an unknown

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DOS CCD Program

- ◆ The Consular Consolidated Database (CCD) Contains
- ◆ 76,000,000+ Visa cases
 - 38,000,000+ photographs
 - Growing at 35,000 visas cases per day
 - Includes replicated scanned visa applications and supporting documents
 - 35,000+ Queries worldwide per day

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DOS CCD Program

- ◆ 200,000,000+ Passport cases
 - 95,000,000+ photographs and scanned passport applications
 - Complete set of all currently valid Passports (10 years)
 - 50,000-60,000+ Passport cases per day

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DOS CCD Program

- ◆ Fingerprints for identity check by DHS for all visa applicants
- ◆ Fingerprints for identity check by FBI for selected visa applicants
- ◆ Connected to State's Category One Critical Visa Refusal files

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Trends

- ◆ Fusion
- ◆ 1,000 ppi Forensic AFIS
- ◆ Continuation of M & A activities
- ◆ AFIS Price War
- ◆ Definitions of Biometric terms
- ◆ Large Scale national / Government Employee ID Programs

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Fusion

- ◆ Multi-modal
 - (e.g., finger, voice, face),
- ◆ Multi-instances
 - (e.g., right and left index fingers or multiple images of a face)
- ◆ Multi-sensors
 - (e.g., visible and IR light chips)
- ◆ Multi-algorithms
 - Used in face and fingerprint systems

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Fusion

- ◆ Most current uses of Fusion are Multi-Instance
 - Two fingers, both irises, etc.
- ◆ Large-scale AFIS systems use multi-algorithm approach
 - Some sequentially
 - Some in parallel

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Multi-Modal / NIST MBARK

- ◆ Most biometric tools are uni-modal, relying on one identifying characteristic for identity authentication.
- ◆ Using just one form of biometric can cause problems such as a damaged fingerprint or a facial image without proper lighting registering incorrectly and denying access.
- ◆ Need a multimodal system which is able to recognize various different biometric modes.

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Multi-Modal / NIST MBARK

- ◆ To help reduce the complexity and costs of implementing an application with interchangeable biometrics, sensors, and workflows, NIST released the **Multimodal Biometric Application Resource Kit (MBARK)**.

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Multi-Modal / NIST MBARK

- ◆ MBARK provides a usability-tested and consistent user interface, regardless of the particular sensor. In addition, the use of XML facilitates true sensor interoperability via “plug-ins” and allows for changes in workflow on-the-fly.
- ◆ MBARK may be downloaded for free from the NIST Image Group Open Source Server at <http://www.itl.nist.gov/iad/894.03/nigos/nigos.html>

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1,000 ppi Forensic AFIS

- ◆ With variable density images in the 2000 ANSI/NIST Standard update, FP Bureaus started purchasing 1000 ppi livescans and AFIS systems
 - Images are captured and displayed at 1000 ppi.
 - Search algorithms still operate at 500 ppi
 - Real Value:
 - ◆ Future algorithms
 - ◆ Visual inspection and comparison

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Continuation of M & A

- ◆ We are down to two major livescan manufacturers through mergers and acquisitions
- ◆ Many vendors are starting to offer second and third biometric modes

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AFIS Price War

- ◆ Significant price drops over past 18 months.
 - Likely to mean you will get less tailoring and more COTS
 - ◆ Just hope your problem is a previously solved one - Makes comprehensive requirements verification more important than ever
 - Cost per transaction dropping - processing is cheaper across IT arena

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Definitions of Biometric Terms

- ◆ Standards bodies are still working on this problem. In the interim there is a push by the US National Science and Technology Council to harmonize vocabulary
 - <http://www.biometriccatalog.org/biometrics/GlossaryDec2005.pdf>

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Definitions of Biometric Terms

- ◆ Long way to go to merge disciplines that each have their own historic vocabulary
 - Push is toward Gallery for the “known set” and probe for the “search set”
 - Better than calling them all images - but the idea of a “speaker utterance gallery” is rough on the ears

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ISO Definitions Effort

- ◆ ISO/IEC JTC1/SC37 has started developing a “harmonized vocabulary”
 - Have issued “Standing Document 2, Harmonized Biometric Vocabulary”
 - Estimate is that it will take until 2010 to complete the task
 - ◆ E.g., 11 definitions were found for the term Template

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Definitions of Biometric Terms

- ◆ Biometrics was borrowed in the 1980s from another discipline that is well over 100 years old
- ◆ The other Biometrics community uses the word to mean the more general application of quantitative and statistical methods in the biological sciences. They evaluate things like drug tests across different populations, etc.
 - Our biometrics are the subset associated with biometric identification

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Large Scale ID Programs

- ◆ US - PIV
- ◆ UK - National ID Card
- ◆ Hong Kong - ID Card

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HSPD-12 PIV

- ◆ The CAC card for the rest of us
- ◆ Moved from storing finger images on the card-based chip to storing MIN A templates
 - IBIA push back on images
 - NIST Study on Minutiae Exchange
- ◆ This Fall - plans in place and first cards issued

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PIV & TWIC

- ◆ August 2006, DHS quietly announced that port facility and maritime workers would not be issued the required biometric TWIC on schedule.
- ◆ A DHS pilot program used contactless card readers, but soon afterwards DHS announced a plan to align the transportation workers' credentials with FIPS 201 used for the non-maritime TWIC identification cards.
- ◆ FIPS 201 does not include software permitting secure contactless reading, yet card-swiping machines (contact readers) are extremely vulnerable to saltwater corrosion and other maritime hazards.

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PIV & TWIC

- ◆ "Vessels at sea present unique environmental challenges," said a senior congressional staffer. He predicted it would take at least six months before the problem was resolved. 750,000 maritime workers are expected to eventually receive the cards. (*HS Daily Wire 8.24.2006*)

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Myths:

- ◆ Fingerprint examiners infallible
- ◆ No medical or age / group information in biometric samples
- ◆ Biometrics can prevent acts of terror

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Fingerprint Examiners Infallible

- ◆ Several major cases cracked the cloak of error-free human examiners
 - McKie - Scotland
 - Mayfield - Spain / US
- ◆ Related issue - automation limitation
 - Jeremy Jones - IAFIS / US

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McKie - Scotland

- ◆ This case follows the Id of a finger mark found at a crime scene. Four FP officers from the Scottish Criminal Records Office identified this finger mark as having been made by the left thumb of Shirley McKie, a Detective Constable with Strathclyde Police.
- ◆ During the trial, Miss McKIE denied having been present at the location and therefore could not have left the identified finger mark. Miss McKie was subsequently charged with perjury.
- ◆ Later the match was called into question and she was eventually paid about \$1 M USD but the police never accepted that an error was made.

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Brandon Mayfield - Spain / US

- ◆ After the terrorist attacks on commuter trains in Madrid, digital images of partial latent fingerprints from plastic bags that contained detonator caps were submitted by Spanish authorities to the FBI.
- ◆ The images were searched through the IAFIS. Using standard protocols and methodologies, FBI fingerprint examiners determined that at least one latent fingerprint was of value for identification purposes. This print was subsequently linked to Brandon Mayfield, a lawyer in Oregon.
- ◆ Soon after, Spanish authorities alerted the FBI to additional information that cast doubt on the findings. It turned out that he was not involved at all - after all the press and the arrest.
 - Shades of Olympic Park, Atlanta and Richard Jewell

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Jeremy Jones - US

- ◆ Jones was wanted on a fugitive warrant in Ohio for jumping bond on a rape charge. IAFIS failed to match Jones' prints when he was arrested in Mississippi and Georgia. He claimed to be John Paul Chapman each time.
- ◆ "IAFIS handles the process, with human examiners no longer scrutinizing the prints. The fingerprint was presented through IAFIS, and the automated system failed to make the match," the FBI said.
- ◆ Jones went on to kill several more people before he was finally captured and held.

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Why Experts Make Errors

- ◆ Excellent study reported on in the Journal of Forensic Identification (600 / 56 (4), 2006)
- ◆ Three categories of errors:
 - Human error - fraud, negligence, low competency (eyes, training, selection of inappropriate personnel, etc.)
 - Instrumentation and technology errors
 - Instrumentation and technology limitations, cognitive process errors, etc.

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Study Conclusions

- ◆ Only 2 of the 6 subjects remained consistent when examining prior cases - in a “covert test”
- ◆ Contextual information influences decisions
- ◆ Psychological and cognitive vulnerabilities are most pronounced in the difficult cases

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Medical information?

- ◆ Lumidigm Reads Skin Physiology
 - In addition to obvious differences in skin pigmentation ... Cell size and density within the skin layers, as well as in the chemical makeup of these layers, also vary from person to person ... the optical signal is affected by changes to the chemistry and other properties of human skin ...
- ◆ Finger, palm, and eye images can also yield some (currently very limited) medical information

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Medical / Age information?

- ◆ Kodak's patent mentions previous research suggesting a correlation between age and the way pupils react to light. As a person gets older, their pupils have greater difficulty widening to cope with dim light, it says.
- ◆ The company suggests that an age-verification system could take mug shots of a person from a set distance in controlled lighting, using a flash. Software would then ... make an estimate of their age.

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Preventing Acts of Terror

- ◆ Drivers licenses (and other government issued IDs) are not yet secure nor are they indicators of trustworthiness but they are mandatory to fly
 - Unless Expired?

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Preventing Acts of Terror

- ◆ Terrorist Screening Center:
 - National Counterterrorism Center has the Terrorist Identities Datamart Environment
 - State has the Consular Lookout and Support System
 - FBI has NCIC
 - DIA has a system
 - DHS has several - to include No Fly

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Preventing Acts of Terror

- ◆ “The agreement, which took 18 months to negotiate and was to last through 2007, gave the American authorities access to 34 categories of information about passengers on all flights from the 25 nations in the EU.” EU’s highest court overturned the agreement.
- ◆ This would have led to 10 M forms with 34 bits of information each - per year. Some, skeptical about the value, rejoice at ruling.

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Preventing Acts of Terror

- ◆ Biometrics are not indicators of trustworthiness - but they seem to be perceived as silver bullets
 - Gone bad post enrollment?
 - ◆ McVey
 - Not known at enrollment time as terrorists
 - ◆ 9/11 gang of killers (a few were overstays)
 - Behavior better indicator than biometrics?

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Preventing Acts of Terror

- ◆ Background a likely indicator?
 - Unmarried persons
 - Persons with no property ownership
 - Unemployed
 - Living outside of their home countries for a while
- ◆ All indicators of potential overstays not necessarily terrorism

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Preventing Acts of Terror

- ◆ **Successfully** keep deported persons or other known trouble makers from entering at a POE:
 - US VISIT: "Since January 2004, US-VISIT has processed more than 44 million visitors. It has spotted and apprehended nearly 1,000 people with criminal or immigration violations."
 - UAE Expellee Tracking System: assisted the UAE in apprehended over 29,000 people with fraudulent travel documents trying to re-enter the country under different identities

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Preventing Acts of Terror

- ◆ **Un-Successful ?** “Rating F grades from CAPA were such critical security measures as screening airline employees, screening cargo, and biometric credentialing for crewmembers according to Captain Jon Safley of CAPA.
- ◆ “The Intelligence Reform and Terrorism Prevention Act passed by Congress and signed into law by President Bush addresses biometric credentials, but until Congress actually appropriates funds, it remains an unfunded mandate.”

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Preventing Acts of Terror

- ◆ **Un-Successful ?** "What the Trusted Traveler program does is create two different access paths into the airport: high security and low security. The intent is that only good guys will take the low-security path, and the bad guys will be forced to take the high-security path, but it rarely works out that way.
 - "The Trusted Traveler program is based on the dangerous myth that terrorists match a particular profile and that we can somehow pick terrorists out of a crowd if we only can identify everyone."

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Preventing Acts of Terror

- ◆ At airport security checkpoints in Knoxville, this summer, some departing passengers were chosen to sit in a booth and don headphones. With one hand inserted into a sensor that monitors physical responses, the travelers used the other hand to answer questions on a touch screen.

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Preventing Acts of Terror

- ◆ The sensor measured biometric responses --blood pressure, pulse and sweat levels -- that were analyzed by software. Not our brand of Biometrics
- ◆ The idea was to ferret out U.S. officials who were carrying out carefully constructed but make-believe terrorist missions.

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Questions?