

Biometric Research

Edwin P. Rood, Ph.D., Director
The Biometric Knowledge Center

2004 Biometrics Symposium
National Defense University
Washington, DC
March 18, 2004



What is "Biometric Research"?

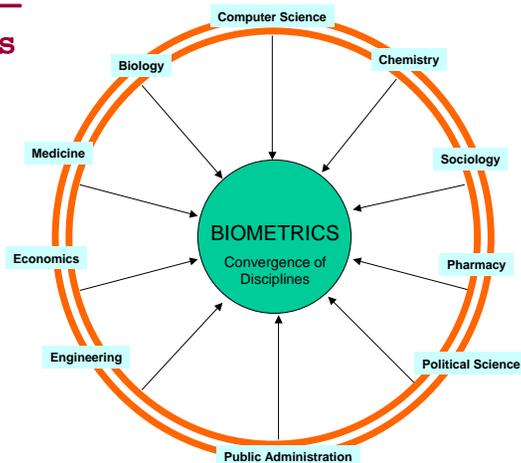
Basic and Applied Science *"scholarly research"*
(curiosity and question)

Science and Technology (useful solutions)

Research and Development
(exploitation of technology)

P.S. – it is not this simple!

Biometrics—
perceived as
scholarly
research



Research and
Development

Technology
Transfer

Academic
Disciplines

BIOMETRICS

The Mission of the *BKnC* is to foster *interdisciplinary* research.....



Increased Emphasis on Biometric Research

- February 2002: sparse in support of technology
stovepiped and not well organized; subcritical relative to needs
- **Fall 2002: The Biometric Knowledge Center (*BKnC*)**
- BC2002: recognition of need for coordination and direction
- Federal interests growing: DHS, NSF, NSA, NIST, BMO/DoD
- **Spring 2003: NSF Workshop for a Biometric Research Agenda**
- **Summer 2003: CITeR expansion**
- **Fall 2003: ITR award for interdisciplinary biometric research**
- Fall 2003: NAS Study of academic biometric research

The Biometric Knowledge Center

- Supported by a start-up grant from the State of West Virginia
- Research Mission: cultivate and foster scholarly biometric research
 - Academic network
 - Federal government network
- Responsibilities to represent the biometric research community at large

BIOMETRIC RESEARCH AGENDA

REPORT OF THE NSF WORKSHOP

April 29 – May 2, 2003

Morgantown, West Virginia

Organizers: Ruud M. Bolle, IBM Research
Anil K. Jain, Michigan State University
Jonathon Phillips, DARPA
Edwin P. Rood, West Virginia University
Jim Wayman, San Jose State University
John D. Woodward, RAND

NSF Program Director: Dr. Gary Strong, CISE

Objective

To develop a rational and practical description of crucial scholarly research to support the development of biometric systems for human verification and identification.

Organization of the Workshop

Fifty-five peer-selected experts from academia, government, and industry – deliberated on crucial research needs in the areas of

1. technologies
2. measures of effectiveness
3. societal and political implications
4. economics and workforce

Research Agenda Highlights

The major finding of the Workshop is that there is a critical need to understand and exploit existing biometric technologies with respect to modeling and scaling, quality of biometric data, fusion of modality and results, and system performance.

Public perception, consumer reaction, ergonomics, and habituation are important research agenda items underlying public acceptance of biometric technology.

Privacy agenda items revolve around notions of “privacy enhancing” and “privacy invasive” perspectives, and agenda items include developing the relevant and most significant questions to be addressed in terms of meaningful implementation of biometric technology.

Economic agenda items include developing metrics that are appropriate to biometric systems that by nature may have far-reaching impact on user behavior and business cost.

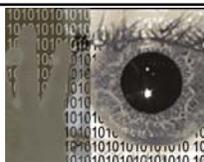
Conclusions and Other Findings

1. There is evident need for the biometrics research community to **interact** among technologies (biometric modalities) as well as among research issues.
2. Biometrics is both a traditional field of study as well as an **emerging** field of science.
3. Biometrics is developing into a significant industry with a very broad base of applications in a) defense and security, and b) in business process and e-commerce. Because of the pervasive nature of this technology, it is important to aggressively foster the industry with sponsored **basic research**.

4. Currently each biometric technology (face, voice, iris, fingerprint, etc.) uses its own jargon and methodology to the point of stifling collaboration across technologies. There is a genuine interest in **standardizing** the vocabulary and methodology, where possible, and such an effort would help enhance collaboration between focused research communities.
5. Standardization of terminology could bridge the synonyms used by biometric application communities and the statistical and machine learning communities. The use of "separate languages" is a hindrance to furthering the statistical enhancements necessary to advance **test and evaluation** of biometric systems.

Recommendations

- The United States should embark on a biometric research program, addressing the items in the proposed research agenda.
- Biometrics should be viewed as a national resource industry.
- Biometric research is conducted according to traditional disciplines and has yet to be recognized as its own field of science.
- It is recommended that a research program provide for the continued interaction between biometrics researchers with the perspective of biometrics as an interdisciplinary science.



Biometrics Symposium

special session on research at
The Biometric Consortium Conference BC2003
 Sep 22 - 24
<http://www.biometrics.org/bc2003>
 Crystal City, VA

co-sponsored by
 The Biometric Knowledge Center
 and
 The National Science Foundation

The **Biometrics Symposium** provides a forum for the dissemination and exchange of basic and applied scholarly research leading to applications of biometrics to human identification and verification. The intent of the Symposium is to stimulate and foster research in biometrics with respect to:

- Technologies
- Measures of Effectiveness
- Societal and Political Implications
- Countermeasures and Spoofing
- Economics and Workforce
- K-12 Outreach

The objective of the Symposium is to bring together researchers working in the convergence of disciplines characterizing biometrics, and to encourage the growth of the biometric research culture conducive to long-range research supporting the field of biometrics. The Symposium will feature poster sessions and selected orally presented papers, plenary lectures, and panel discussions including Federal government sponsors. The report from the recent NSF-supported *Workshop for a Biometric Research Agenda* will be presented and discussed. Limited financial support is available to students and faculty on a case-by-case basis.



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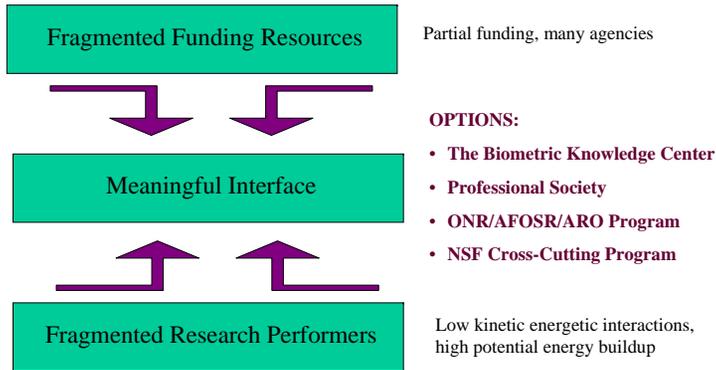
co-sponsored by
 The Biometric Knowledge Center (*BKNC*)
 West Virginia University and Michigan State University
 The National Science Foundation

Coordinator: Dr. Edwin P. Rood, The Biometric Knowledge Center

Program Committee:

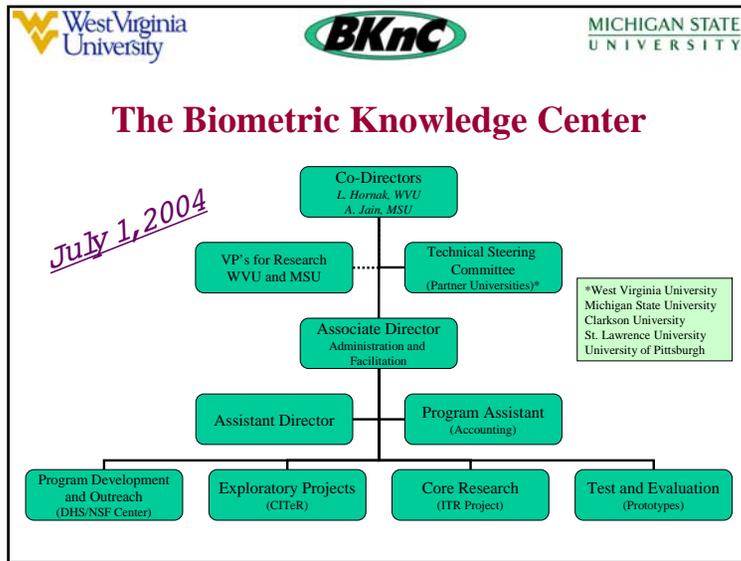
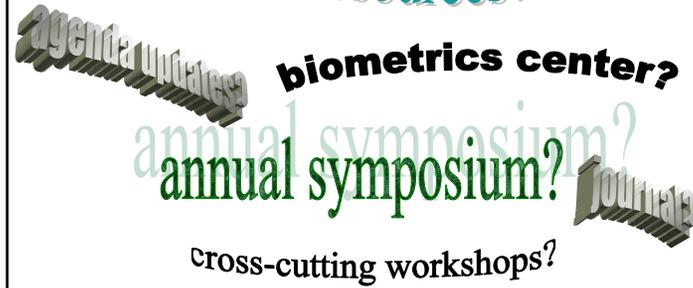
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| <p>Co-Chairs:
 Prof. Larry Hornak, West Virginia University
 Prof. Anil Jain, Michigan State University
 Dr. Craig Arndt, Mitretek Systems
 Prof. Bir Bhanu, UC Riverside
 Prof. Rama Chellappa, U. of Md
 Dr. Sarat Dass, MSU
 Prof. Patrick Flynn, Notre Dame University
 Prof. Venu Govindaraju, SUNY (Buffalo)
 Prof. Takeo Kanade, Carnegie Mellon University</p> | <p>Prof. Davide Maltoni, University of Bologna
 Dr. Lisa Nelson, University of Pittsburgh
 Prof. Alex (Sandy) Pentland, MIT
 Dr. Jonathon Phillips, NIST
 Dr. Michael Schuckers, St. Lawrence U.
 Dr. Stephanie Schuckers, Clarkson University
 Prof. Anuj Srivastava, FSU
 Prof. Tieniu Tan, Chinese Academy of Sciences
 Prof. David Zhang, Hong Kong Polytechnic U.</p> |
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Further Observation

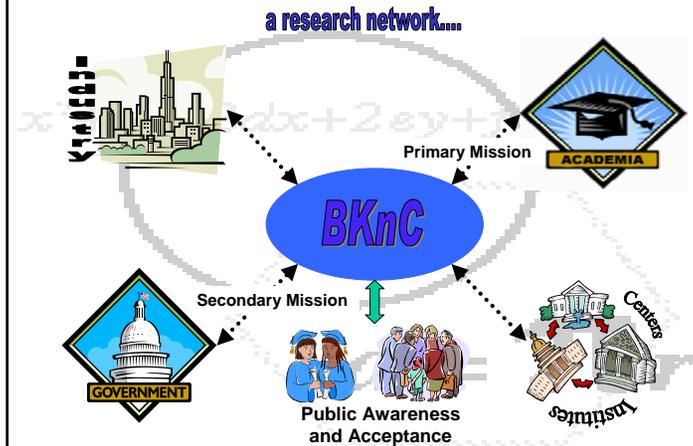


Organized Biometric Research?

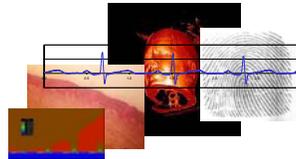
Federal resources?



The Biometric Knowledge Center



CITeR Overview



Larry Hornak
Co-Director, CITeR, West Virginia University

CITeR

Center for Identification Technology Research
*An NSF Industry/University Cooperative Research Center (IUCRC)
in the area of Biometrics*

<http://www.citer.wvu.edu>

CITeR Mission Statement

- CITeR is dedicated to serving the needs of its members by advancing the performance of biometric systems through cross-cutting research of enabling technologies, interdisciplinary training of scientists and engineers through its research, and the facilitation of the transfer of new biometrics technology through its membership.

CITeR

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planned in the area of Biometrics*

West Virginia University
Marshall University
Michigan State University
San Jose State University
<http://www.csee.wvu.edu/citer>

CITeR: A Virtual Multi- University Center

- Center Attributes
 - Draw upon multidisciplinary faculty expertise transparently across unit & university boundaries
 - Effectively couple with academic programs to train graduate and undergraduate students
 - Promote and achieve knowledge transfer

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CITeR as an NSF I/UCRC

- Industry/University *Cooperative Research Center*
 - Organized to maintain and grow a *Cooperative* research and education environment
 - Research center in which academia and industry/government members cooperatively share the responsibility and the benefits (e.g. research, students, and IP).
 - Processes tightly couples the Center's research to the collective membership's needs.

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CITeR I/UCRC Basic Funding Structure

- I/UCRCs provide tremendous research dollar leveraging (10 to 1 or more) to its members.



CITeR Membership

- CITeR Membership Agreement
 - In Meeting Packet and on Website
 - \$40K yearly membership fee
 - Advisory Board Membership
 - Single vote on board per member
 - Research portfolio direction and oversight
 - Center Strategic Planning
 - Publication Review Policy
 - IP Policy, licensing

Building CITeR: An Update

- Memberships and Commitments to date:

DoD Biometrics Management Office/ The Biometric Fusion Center	Verizon
Federal Bureau of Investigation	ManTech, Inc.
Digimarc	NSA
Transportation Security Administration	The Biometric Foundation
Gaiker, Centro Tecnologico	/National Biometric Security Project
	Northrop Grumman

- Visiting Prospective Members

- Partnering Academic Institutions:

West Virginia University	Michigan State University
Clarkson University	University of Pittsburgh
St. Lawrence University	

CITeR Semi-Annual Meetings

- Fall and Spring meetings are vital to building and maintaining a solid IUCRC.
 - Progress Reports and Input on Current Portfolio Projects
 - New Project Development and Selection
 - Advisory Board Business Meeting
 - *Opportunity for organizations considering membership to see the Center in operation.*

CITeR 2003 Research Portfolio

Multibiometric Score Normalization

A. Ross (WVU) and A. Jain (Michigan State University). \$80K, 12 months.

The effort will (i) Systematically study of the role of score normalization in multimodal matching performance, (ii) Developing robust and efficient score normalization techniques., and (iii) Explore automatic template selection and update using clustering principles.

Solidifying CITeR's Liveness Core Competency

S. Schuckers (Clarkson/WVU), L. A. Hornak (WVU) and T. Norman (Orthopedics WVU). \$72K, 18 months.

A unique specialized capability and skill set for performing spoofing, cadaver, and liveness testing and detection research have been developed. This project will build this capability, establish a broad-based fingerprint liveness testing resource for members and the biometrics community, and advance liveness performance and research in select biometrics.

Multimodal Biometric Systems: Phase II

A. Jain (Michigan State University). \$75K, 15 months.

Three different issues in designing a multimodal biometric system are investigated: (i) combine face and iris biometrics to reduce failure to enroll rate and decrease FRR, (ii) combine multiple face recognition approaches to improve the face recognition performance, and (iii) operate a multibiometric system in an identification (cascade) mode.

CITeR 2003 Research Portfolio

A Study of Various Methodologies for Error Estimation in Biometric Systems

M. Schuckers (St. Lawrence University). \$43K, 12 months.

Several methods for estimating false accept and false reject rates have been developed and recognized for their potential. Doddington's Rule of 30, Schuckers' Beta-binomial approach and the subset bootstrap[3] create inferential intervals that allow the consumer to assess plausible values for the error rate of interest. The goal of this proposal is to compare the quality of estimation for each of these methods against identical data.

Socio-Legal Assessment Study

L. Nelson (University of Pittsburgh). \$20K, 12 months.

The proposed study is designed to set the groundwork for the generation of social scientific data on perceptions of biometrics and privacy in divergent settings as well as on the policy impact of biometric privacy legislation on consumer confidence and on the implementation of biometric technology.

Statistical Basis of Multimodal Systems

B. Cukic and R. Singh (WVU). \$50K, 12 months

This work seeks to provide a clear analytical justification for multi-biometrics. Recently, Jain proposed the methodology to select weighting system that increases the probability of correct identification. We seek to generalize and extend this result based on the distributions describing genuine and imposter population.

CITeR 2003 Research Portfolio

Biometrics Business Case Study

Virginia Kleist and R. Riley (Business and Economics WVU), \$60K, 12 months.

This proposed research applies prior work in information technology to the specific problem of measuring the cost benefit payoffs from specific biometric technologies. We will link three business issues (measuring the impact of information technology, the performance aspects of expenditures on technology and the specific return on IT investment at the strategic level) to the business case for biometrics investment.

Geometric Coding of Biometric Images

Xin Li (WVU), \$35K, 12 months.

The objective of this project is to develop new geometric coding and processing algorithms for biometric images (e.g. fingerprint, face, and iris) which will improve the matching performance of existing verification/recognition systems.

New Research Projects in 2004

Developing the PRESS - Methodologies for Estimating Error Rates of Biometric Devices Michael Schuckers, St. Lawrence University

Scaling Analysis of Iris Codes using Large Deviations Approach

Natalia Schmid, Bojan Cukic, LDCSEE, WVU, and Harshinder Singh, Dept. of Statistics, WVU

Multibiometric Fusion at the Feature Extraction Level and Face Indexing

Arun Ross and Natalia Schmid, LDCSEE, WVU

Strategic Business Directions in Biometrics: Research with Vendors, Government and Corporate Buyers

Virginia Kleist, Richard Riley, Dept. of Management and MIS, WVU

Acquisition and Understanding of Nonideal Iris Imagery

L. Hornak, X. Li, G. Fahmy N. Schmidt, LDCSEE WVU, S. Schuckers, Clarkson/WVU, ; A. Realini, WVU Eye Center.

CITeR Group

NSF Information Technology Research (ITR) Project

L. A. Hornak

CITeR

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NSF ITR Proposal Theme

- In the emerging age of ubiquitous computing and pervasive IT, biometrics enables the trust and privacy which are prerequisites to a free society.

Biometrics – Performance, Security, and Social Impact

L. A. Hornak, B. Cukic, and H. Singh,
*West Virginia University**;
L. S. Nelson, *University of Pittsburgh*

S. Schuckers, *Clarkson University**;
A. Jain, *Michigan State University*;
M. Schuckers, *St. Lawrence University*

*Linked Proposal submitted from West Virginia and Clarkson Universities

Proposal Research Thrusts

1. Performance Evaluation Framework
2. Reduction of Performance Barriers and Vulnerabilities
3. Societal Impact and Implications of Technological Maturity
4. System Design Framework

ITR Project Goals

Performance Evaluation Framework

Contribute to the establishment of a comprehensive analytical framework within which the performance of individual biometric systems can be modeled and predicted.

Reduction of Performance Barriers and Vulnerabilities

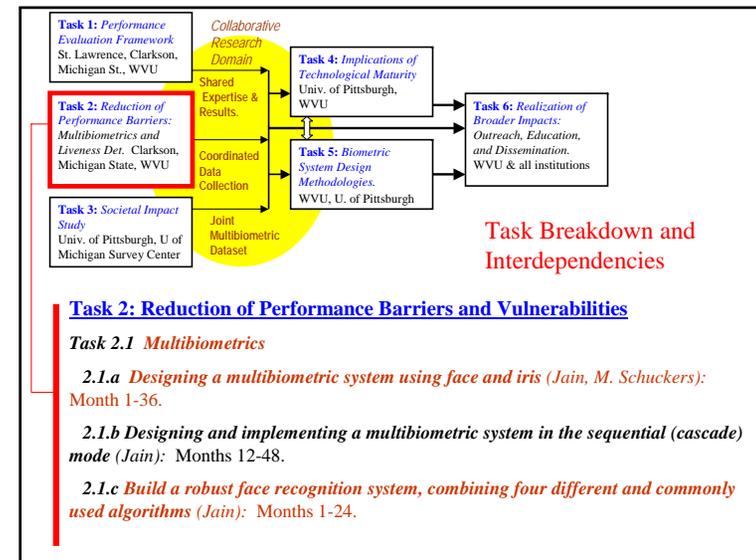
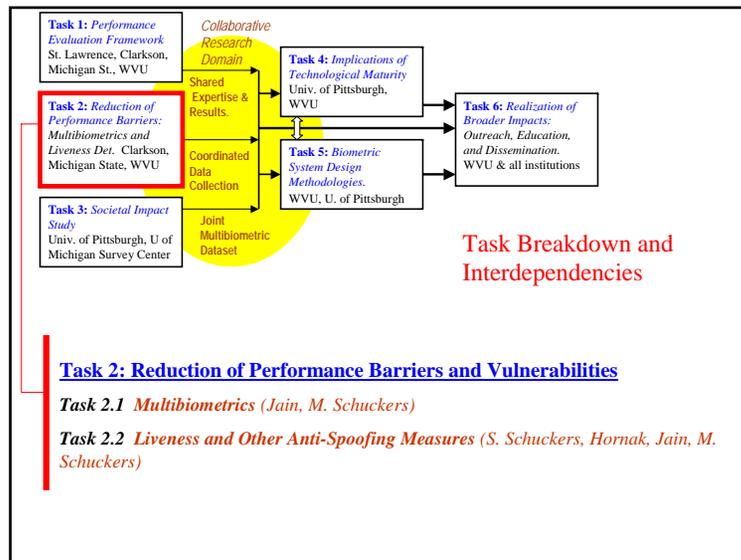
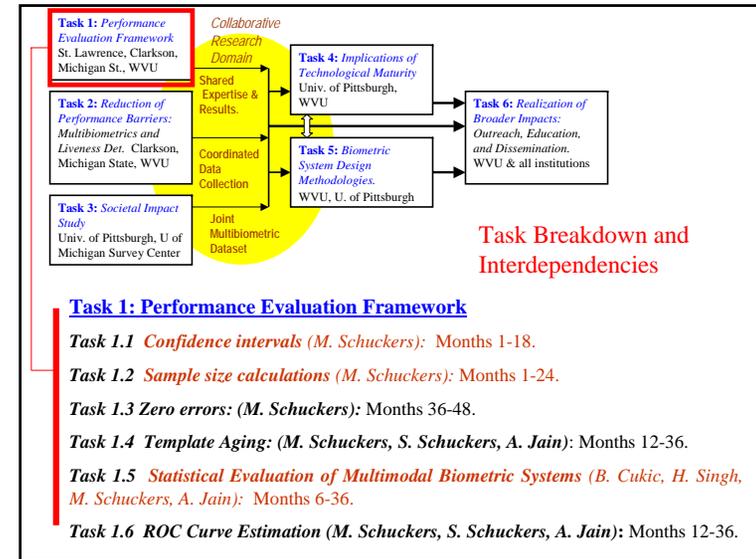
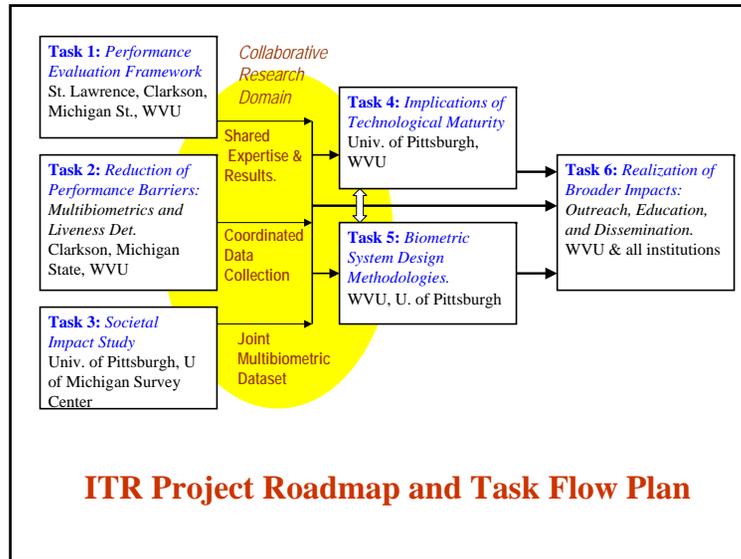
Enhance the ability and reduce the vulnerability of multi-modal systems.

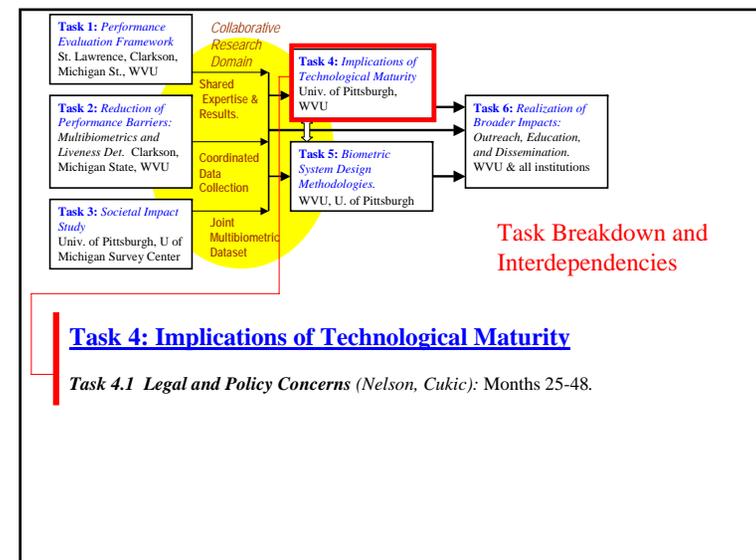
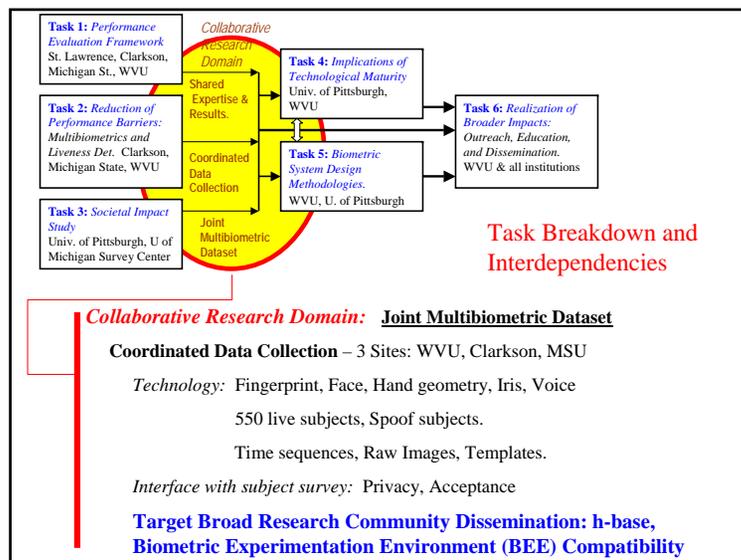
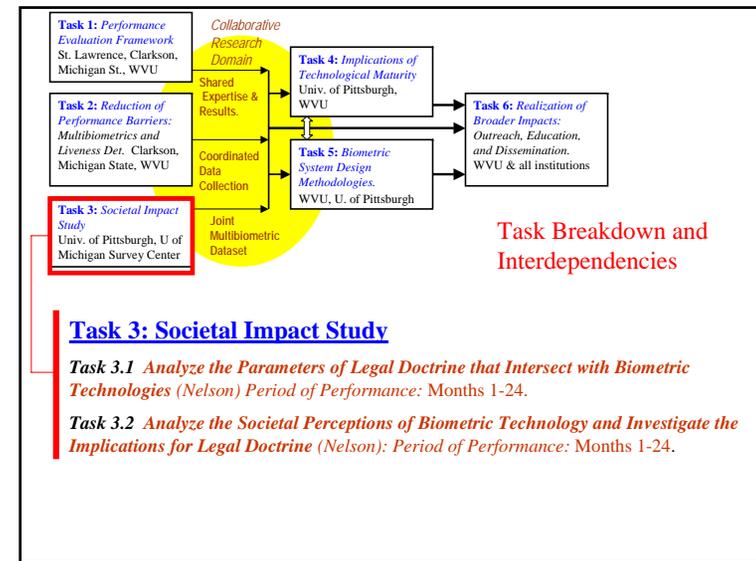
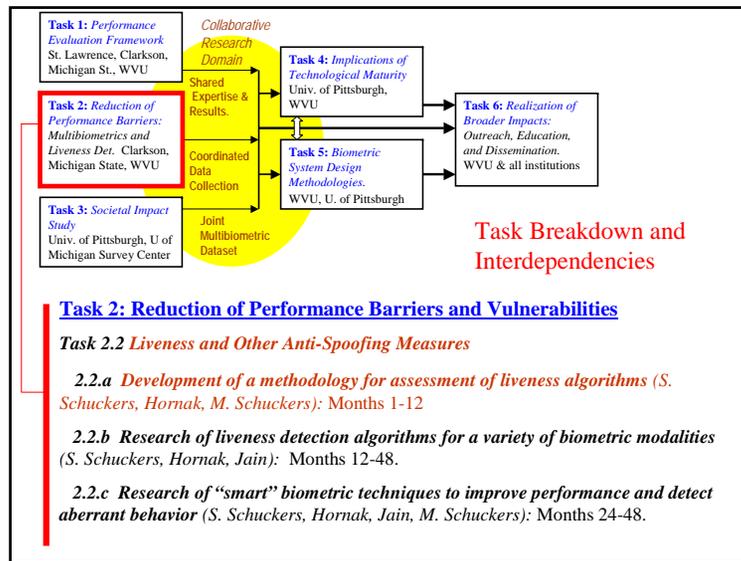
Societal Impact & Implications of Technological Maturity

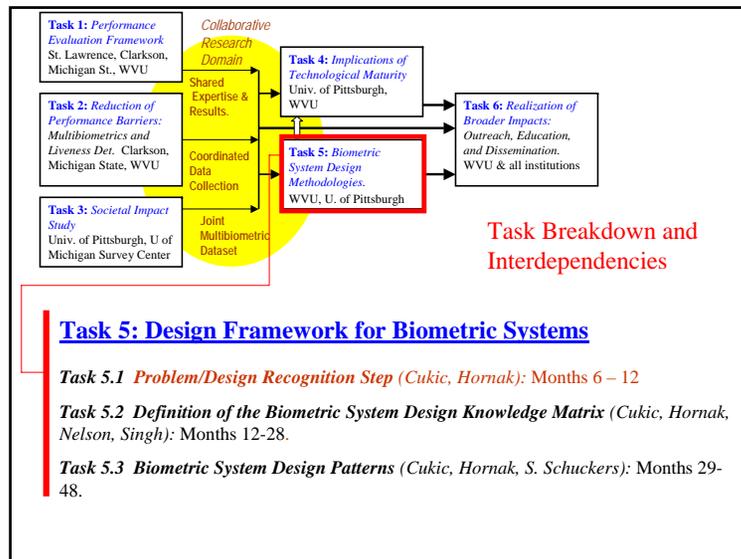
Develop an understanding and insight into the societal and legal issues in support of informed public policy decisions

System Design Framework

Establish a knowledge matrix relating known problems, user acceptance criteria, and recommendations







The Future of Biometric Research Challenges and Expectations....

- The *BKnC* in its overarching presence has been instrumental in providing visibility for scholarly research and connecting the knowledge base to applications.
- Federal wheels are slow to turn in response to nontraditional research needs.
- A critical mass of researchers is being developed, interest may wane in the absence of a funding presence and a visible leadership

