

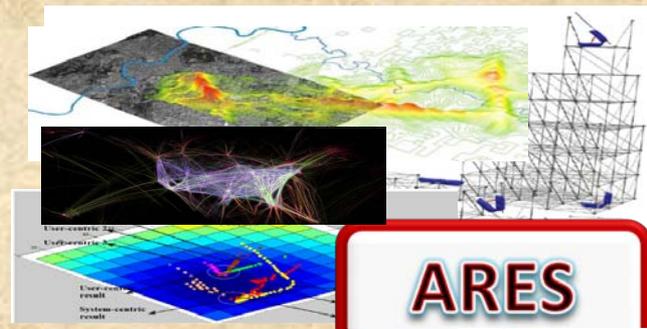
Overview of Office of Emerging Frontiers in Research and Innovation

Sohi Rastegar

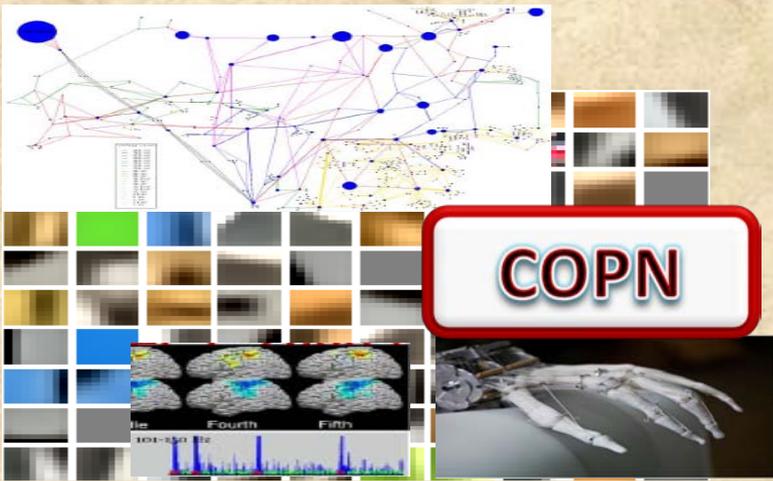
**Engineering Advisory Committee
April 14, 2011**



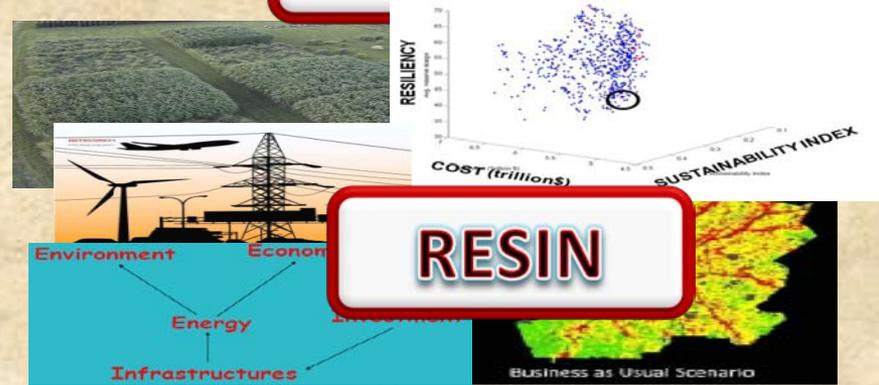
CBE



ARES



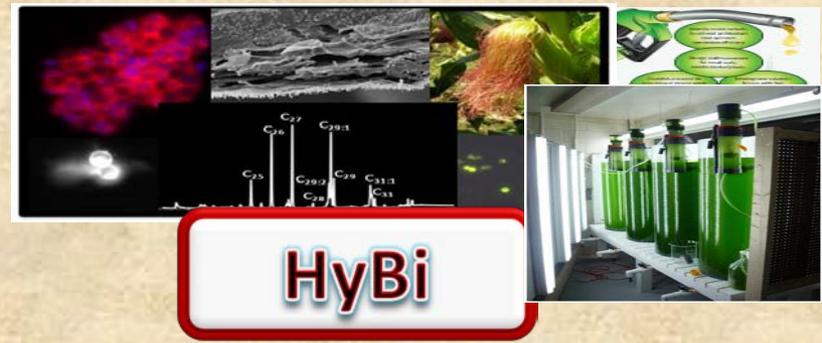
COPN



RESIN



BSBA



HyBi

EFRI- *In One Slide*

- **MANDATE** – Established in October 2006 to serve a critical role in helping the Directorate for Engineering focus on important emerging areas in a timely manner.
- **CRITERIA: Transformative; Grand Challenge/National Need; Interdisciplinary**
- **EFRI TOPICS SELECTED:**
 - FY 2007 Auto-Reconfigurable Engineered Systems (**ARES**)
Cellular and Biomolecular Engineering (**CBE**)
 - FY 2008 Cognitive Optimization (**COPN**)
Resilient and Sustainable Infrastructures (**RESIN**)
 - FY 2009 Biosensing and Bioactuation (**BSBA**)
Hydrocarbon from Biomass (**HyBi**)
 - FY 2010 Science in Energy and Environmental Design (**SEED**)
Renewable Energy Storage (**RESTOR**)
 - FY 2011 Engineering Multicellular and Interkingdom Signaling
(**MIKS**); Mind, Machines, and Motor Control (**M3C**)
- **TOPIC LEADERS** - Program Directors from ENG Divisions in collaboration with PDs from other Directorates and Agencies when appropriate
http://nsf.gov/staff/staff_list.jsp?org=EFRI&from_org=EFRI

WHAT DO YOU THINK?

Click on the engineering challenge you think is the most important:

NAE GRAND CHALLENGES



Make solar energy economical



Provide energy from fusion



Develop carbon sequestration methods



Manage the nitrogen cycle



Provide access to clean water



Restore, improve infrastructure



Advance health informatics



Engineer better medicines



Reverse-engineer the brain



Prevent nuclear terrorism



Secure cyberspace



Enhance virtual reality



Advance personalized learning



Engineer the tools of scientific discovery

RESTOR

**A
R
E
S**

SEED

RESIN

CBE

BSBA

M3C

COPN

HyBi

MIKS

ANNUAL EFRI ACTIVITIES

three simultaneous processes



TOPIC SELECTION

DCL for
Community Input
and Webcast

Community Ideas
Presentations and
Review Process

Finalize and Announce
New Topics: PD
Retreat.; ELT Retreat

Prepare
Solicitation

PROJECT SELECTION

Solicitation
Release and
Webcast

Letters of Intent and
Preliminary Proposals

Full Proposal
Review Process and Awards

PROJECT OVERSIGHT

Annual Award Management
Teleconferences

Grantee
Conference

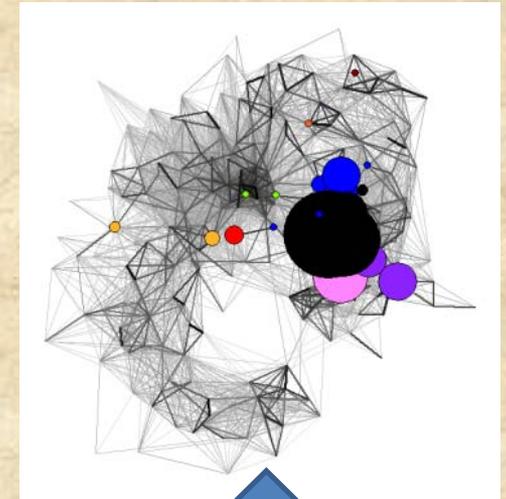
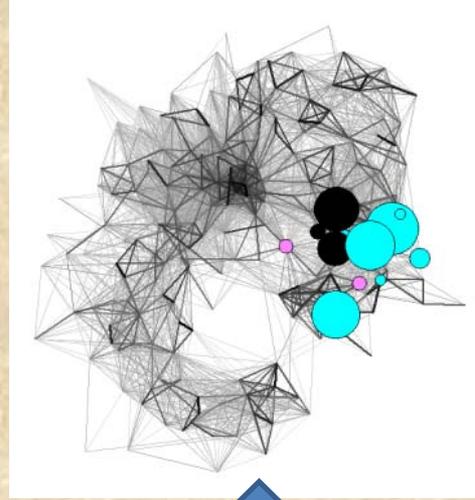
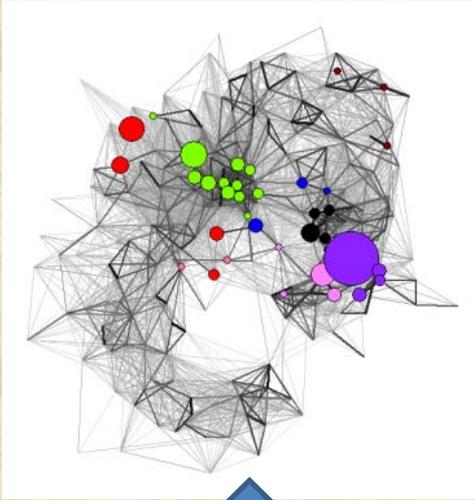
From STPI* Study

(A Formative Assessment)

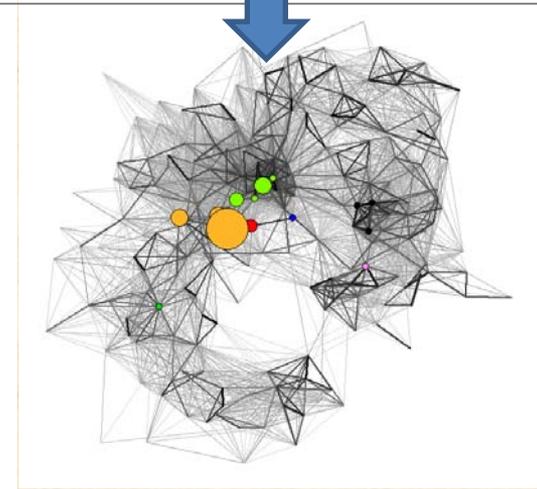
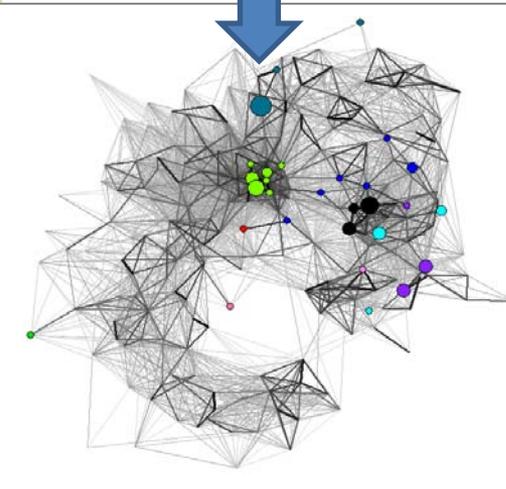
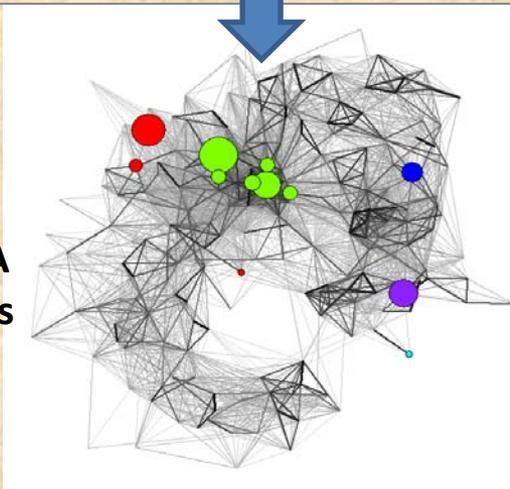
- MULTIDISCIPLINARY INTEGRATION - EFRI Proposal 'Integration Scores' were higher than Comparison Group Proposal Integration Scores
- TRANSFORMATIVE : More Responses Rated EFRI Awards as “Highly Likely to be Transformative” than comparison group.

Sample Maps of Science Comparing PI and Proposal Interdisciplinarity

Example BSBA
PI Maps



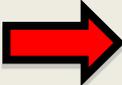
Example BSBA
Proposal Maps



STPI Recommendation For Topic Selection

- **CRITERIA:** Use grand challenges as the sole EFRI topic criterion. Then select the most transformative research ideas/projects that use interdisciplinary approaches.
- **USE WEB TOOLS:** collective intelligence and Web 2.0 tools; Voting and commenting mechanisms on a wiki or website
- **EXTERNAL REVIEW** - Include an External Review Committee
- **IMPROVE COMMUNITY INPUT**
 - Hold workshops ; give community opportunity to develop Frontier Ideas
 - Allow community submission to compete together with other frontier ideas
 - Allow repeating selected topics and past frontier ideas
 - Remain open to research areas that are already supported by other agencies.
- **'NO TOPIC EFRI':** three of 16 PDs interviewed suggested this

EFRI TOPIC SELECTION

- Continuous Community Input (Publications, Conferences, Advisory Committee, Committees of Visitors, Panels, Workshops, ...)
- Explicit Community Input through Website (Dear Colleague Letter; September Deadline) **119 Received**
- Fall Advisory Committee (October)
- EFRI Community Series Meeting (Jan) **12 PRESENTATIONS**
-  **INCLUDED EXTERNAL EXPERTS THIS YEAR** (per External Evaluation recommendation)
- Program Directors Frontier Ideas Meeting (Feb)
- ENG Leadership Retreat (March)
 - **TOPICS FINALIZED**
- Spring Advisory Committee (April)
 - **TOPICS ARE ANNOUNCED AND MADE PUBLIC**



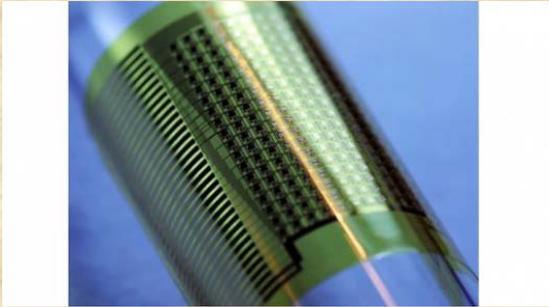
*Program Directors are the Kernel of Integration
and Leaders for EFRI Topics*

TOPIC SELECTION DECISIONS

- TOPIC SELECTION FREQUENCY
 - EVERY OTHER YEAR
- **PLANS FOR FY 2012**
 1. Three Topics for EFRI Solicitation
 - (1) BioFLEX: Flexible Electronics For Biomedical Applications**
 - (2) FOLD: Origami Design for Adaptive Morphing Systems**
 - (3) Sustainable Photosynthetic Biorefinery**
 2. WORKSHOPS AND/OR EXPLORATORY OPPORTUNITIES ON SOME OTHER IDEAS

Topic 1: BioFLEX – Flexible Electronics For Biomedical Applications

Flexible electronics

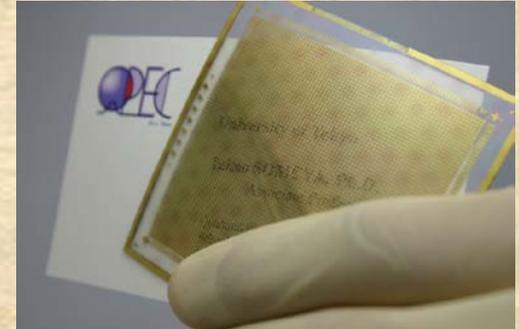


Wrap around cylindrical surface

Stretchable electronics



Flexible Scanner



Rogers et al., “Materials and Mechanics for Stretchable Electronics”, Science 327, 1603 (2010)

Expected Transformative Impact:

Advances in basic science and engineering, including materials, devices, circuit design, novel sensors, biomedical applications

Develop/focus enabling technologies that allow enhancing quality of life and patient care while lowering total healthcare costs

New collaborations between different communities (materials, electrical, biomedical, chemical, manufacturing etc.)



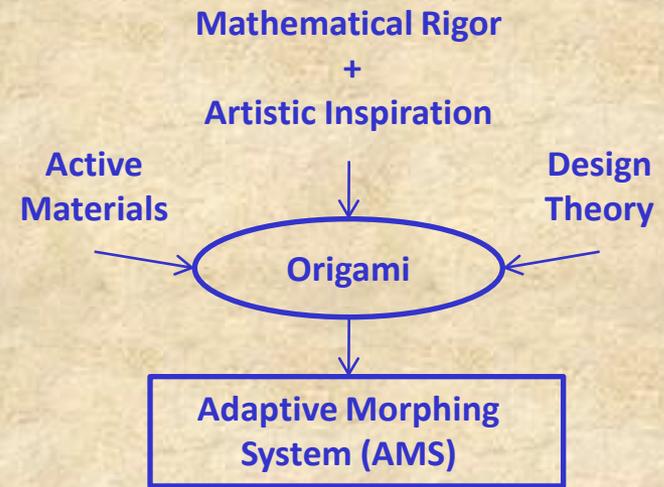
TOPIC 2:

FOLD: Origami Design for Integration of Adaptive Morphing Systems

Objective: Use origami to enable self-assembling, multifunctional, compliant structures (Adaptive Morphing Systems) through the integration of active materials, design theory and compliant mechanisms, mathematics, and artistic inspiration.

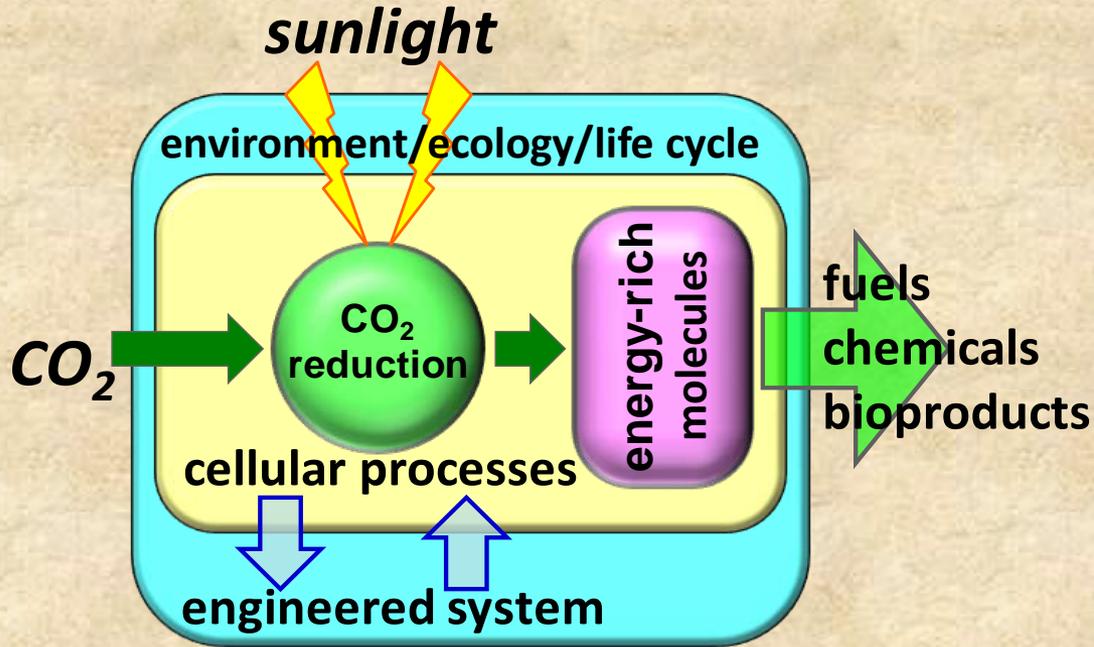
Expected Transformative Impact:

- Foster advances in fundamental understanding of folding and unfolding mechanisms in active materials, design theory, and mathematics
- Underpin design of foldable products at all scales and across scales
- Promote new collaborations between different communities
- Enable novel engineered adaptive morphing systems for breadth of national priorities, including energy, complex design, and manufacturing



Topic 3:

Upscaling Photobiological Processes - The Sustainable Photosynthetic Biorefinery



Objective: Establish the fundamental principles which efficiently deliver light and CO₂ to photosynthetic micro-organisms in scalable platforms for the sustainable & flexible production of fuels, chemicals, and bio-products

Expected Transformative Impact

- New paradigms for the rational/sustainable design and upscaling of photosynthesis-based, bio-manufacturing platforms that use sunlight and atmospheric CO₂ as inputs
- Advances in the basic science of flexibly transforming atmospheric CO₂ to complex and/or energy-rich molecules through metabolic processes
- Novel engineered systems for the emerging bio-economy

Ideas For Broadening Participation of Underrepresented Groups

- Held Discussions at EFRI Grantee Breakout Sessions
- REU/GRS opportunity for active awards
- Blind review component
- Regional Workshops at Minority Serving Institutions and Outreach at EPSCoR States
 - Univ. of New Orleans (V. Gupta plans to organize)
 - EPSCoR – did one in Summer 2010
- Other
 - Native American Academy – ‘Ethical Space’

Sustaining EFRI Topics

Status Check

- CBE (7 projects, FY 2007)
 - ✓ **STC AWARD TO ONE EFRI GROUP (KAMM)**
 - Others will try for ERC or other Center programs
 - NIH
- ARES (5 projects, FY 2007)
 - ECCS and CMMI support the technical area but group awards?
 - Department of Transportation
 - Cyber-Physical Systems
- COPN (4 projects, FY 2008)
 - ECCS and CBET support the technical areas but group awards?
 - Some may pursue Centers program
- RESIN (8 projects, FY 2008)
 - ✓ **A RESEARCH CLUSTER IN CMMI (Joy Pauschke)**
 - Group awards may be an issue
- BSBA (12 projects, FY 2009)
 - ✓ **NEW PROGRAM IN CBET: Biosensing (Alex Simonian)**
 - Sensing program in CMMI and ECCS
 - US-China Collaborative DCL
- HyBi (8 projects, FY 2009)
 - General support in CBET for this area
 - DOE

EFRI Grantee Meeting

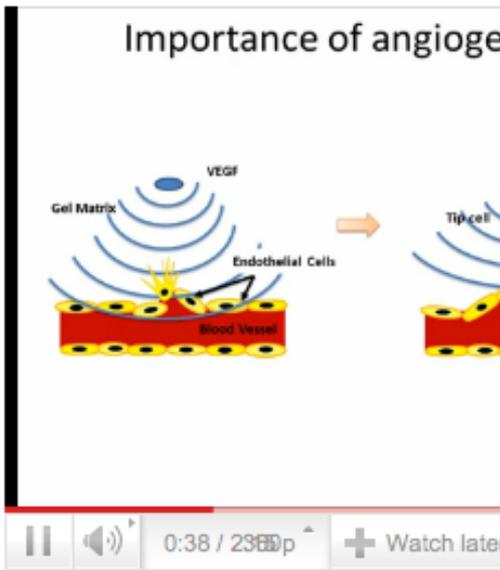
- www.abecker.com

- Videos 2011:

<http://abecker.com/index.php/2011-NSF-EFRI-Grantees-Conference/efri-grantee-videos.html>

"A Multifaceted Approach to the Modeling of Angiogenesis"

Roger Kamm, Massachusetts Institute of Technology



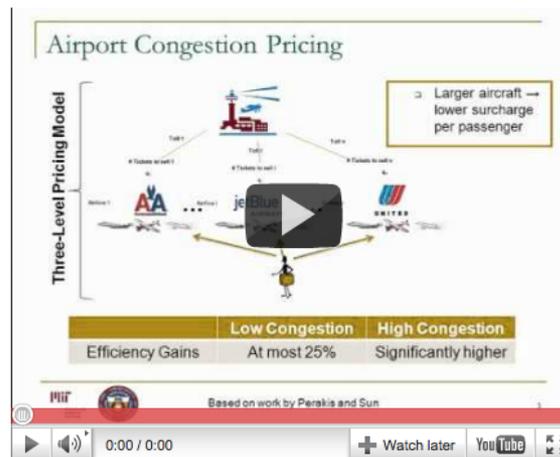
Name(s) of People in the Video: Levi Woolfson

PI's Name (if different): Roger Kamm

PI's (primary) University: MIT

"Theory and Algorithms for Autonomous Reconfigurability of the National Air Transportation System"

Cynthia Barnhart, Massachusetts Institute of Technology



Name(s) of People in the Video: Douglas Fearing

PI's Name (if different): Cynthia Barnhart

PI's (primary) University: Massachusetts Institute of Technology



Name(s) of People in the Video: Yusuf Khan, Ph.D., Meng Deng, Ph.D.

**THANK
YOU**

MANDATE AND VISION OF EFRI

MANDATE - EFRI will serve a critical role in helping the Directorate for Engineering (ENG) focus on important emerging areas in a timely manner. EFRI will annually recommend, prioritize, fund, and monitor initiatives at the emerging frontier areas of engineering research and education.

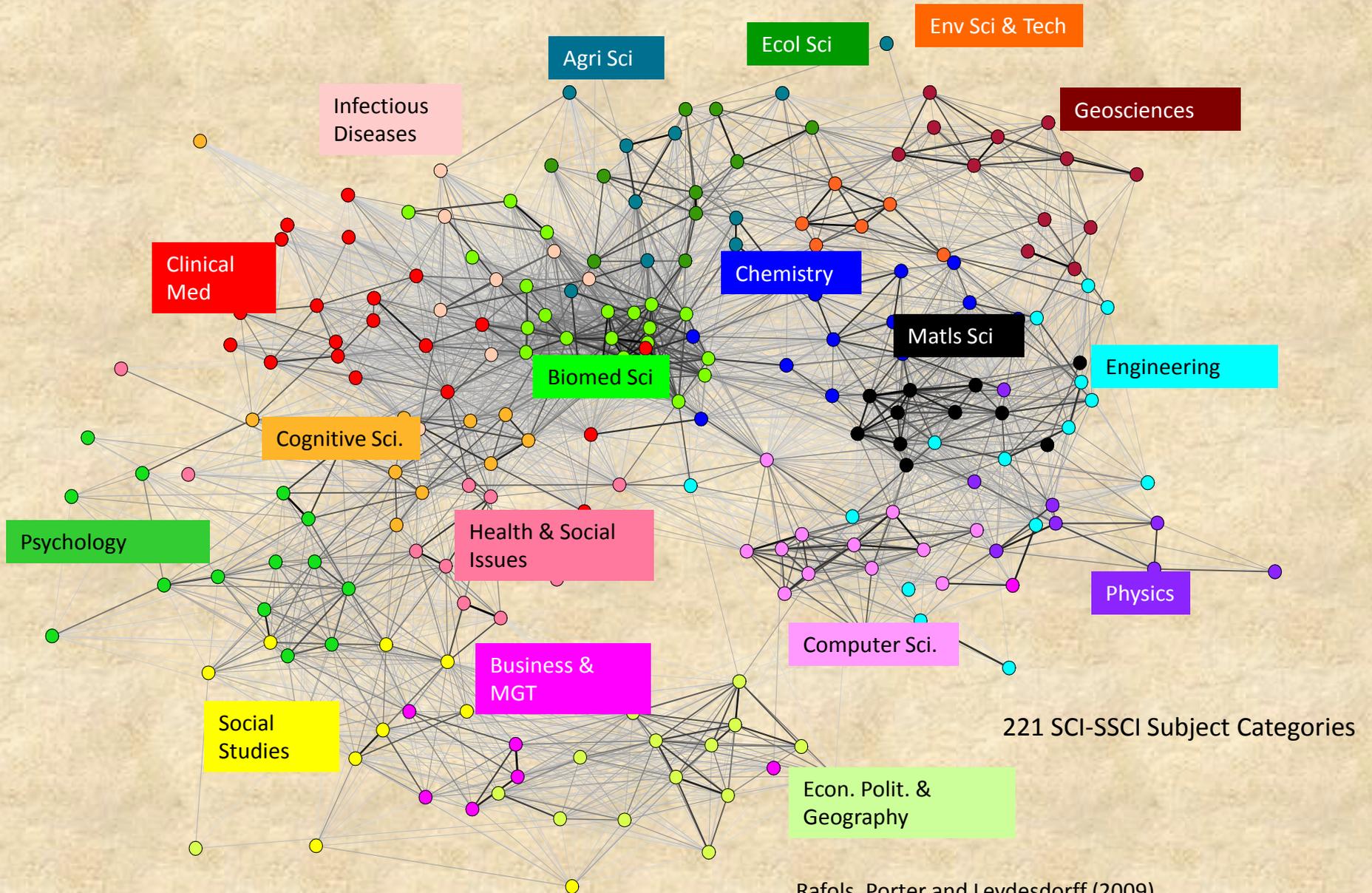
VISION – All NSF ENG Programs support research at the frontiers of research and innovation.

EFRI Office provides opportunities in interdisciplinary areas at the *emerging* frontiers of research and innovation that (a) are transformative, (b) address national needs/grand challenges, and (c) will make ENG unrivaled in its global leadership.

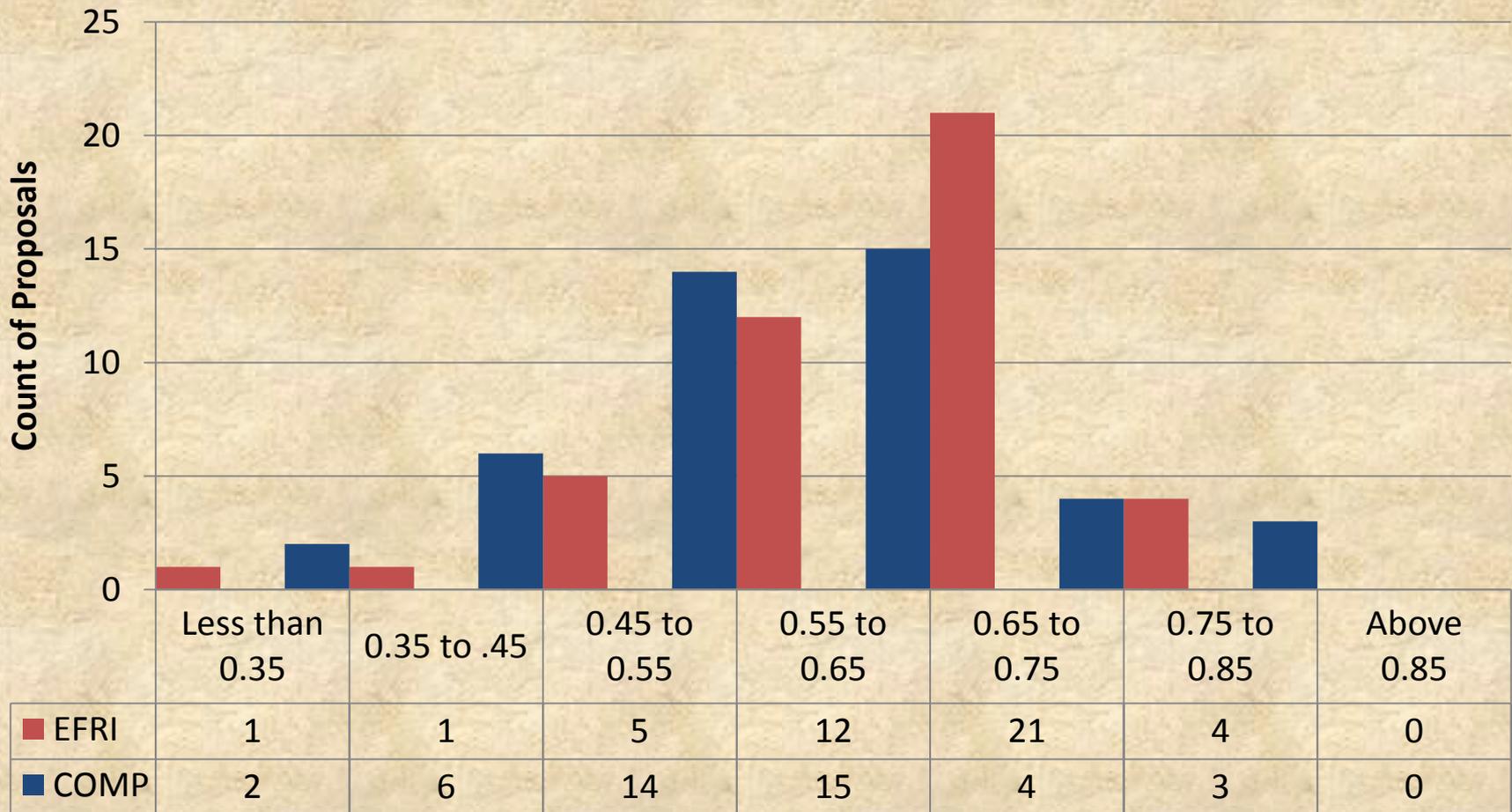
EFRI Criteria For Topic Selection

- **TRANSFORMATIVE:** Does the proposed topic represent an opportunity for a significant leap or paradigm shift in a research area, or have the potential to create a new research area? [What are the underpinning breakthroughs?]
- **NATIONAL NEED/GRAND CHALLENGE:** Is there potential for making significant progress on a current national need or grand challenge?
- **INTERDISCIPLINARY:** Does the topic require inter/multi-disciplinary expertise?

Global Map of Science

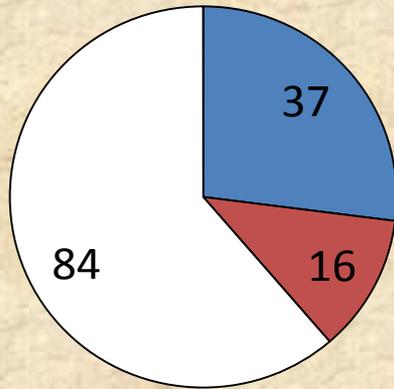


EFRI Proposal Integration Scores are Higher than Comparison Group Proposal Integration Scores

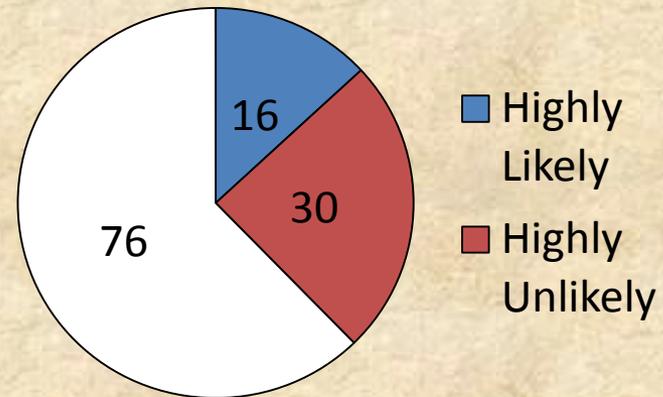


More EFRI Responses Rated as “Highly Likely to be Transformative”

EFRI Program



Comparison Group



Fewer Comparison Group Proposals Rated Highly Likely to be Transformative – EFRI and Comparison Group proposal rankings mirror images of each other

Ideas For Sustaining EFRI Topics

- Sustaining Topics
 - Work with Divisions to develop cross-divisional programs.
 - Have grantees to develop a sustainability plan for their project in year 3 and/or 4.
 - Continue to develop relationships with other federal agencies to develop pathways for potential sustained support for worthy ideas.
 - Allow PDs re-compete Topics that are still ‘emerging’ after after first cycle.