

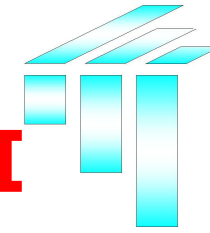
***Emerging Frontiers in
Research and Innovation***

**EFRI Overview
ASEE ERC 2010**

***Sohi Rastegar
Office of Emerging Frontiers in
Research and Innovation***

www.nsf.gov/eng/efri

MANDATE AND VISION OF EFRI

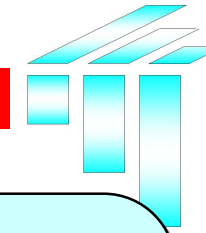


MANDATE - EFRI will serve a critical role in helping the Directorate for Engineering (ENG) focus on important emerging areas in a timely manner. EFRI will recommend annually a prioritization, fund, and monitor initiatives at the emerging frontier areas of engineering research and education.

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 Active Topics and Personnel



FY 2007

Auto-Reconfigurable Engineered Systems (ARES)
 Kishan Baheti, ECCS
 Maria Burka, CBET
 Bruce Hamilton, CBET
 Glen Larsen, IIP
 Abhi Deshmukh*, CMMI
 Scott Midkiff*, ECCS
 Stephen Nash*, CMMI
 ...*, CMMI

Systems that Modify Themselves

Cellular and Biomolecular Engineering (CBE)
 Robert Wellek, CBET
 Lynn Preston, EEC
 Fred Heineken*, CBET
 Jimmy Hsia*, CMMI
 Lenore Clesceri*, CBET

How Cells Work: Uniting Engineering & Biology

FY 2008

Cognitive Optimization (COPN)
 Paul Werbos, ECCS
 Semahat Demir, CBET
 Eduardo Misawa, CMMI
 Stephen Nash*, CMMI
 Lynn Preston, EEC
 Kenneth Whang, CISE
 Scott Midkiff*, ECCS
 Fred Heineken*, CBET

Learning From The Brain

Resilient and Sustainable Infrastructures (RESIN)
 Joy Pauschke, CMMI
 Bruce Hamilton, CBET
 William Schultz, CBET
 Richard Fragaszy, CMMI
 Barbara Kenny, EEC
 Matthew Realff*, CMMI
 Dennis ...*, CMMI
 Dan ...*, ECS

Building Resilient & Sustainable Interdependent Infrastructures

FY 2009

Biosensing & Bioactuation (BSBA)
 S. Chi Liu, CMMI
 Y. Gianchandani*, ECCS

Building On Nature

Hydrocarbon from Biomass (HyBi)
 George Antos, CBET
 J. Regalbuto*, CBET
 D. Niebur*, ECCS

FY 2010

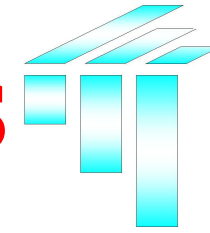
Science in Energy And Env. Design (SEED)
 Larry Bank, CMMI

Sustainability

Renewable Energy Storage (RESTOR)
 L. Esterowitz, CBET

http://nsf.gov/staff/staff_list.jsp?org=EFRI&from_org=EFRI

EFRI BUDGET AND AWARDS

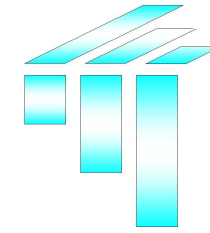


- **FY 2010 Budget: \$29M**
- **FY 2011 Budget Request: \$31M**
- **EFRI Awards: \$0.5M/year for 4 years**
- **Steady State:**
 - ~ 10 Active Topics and ~ 60 Active Projects

| <i>FY</i> | <i>Topic</i> | <i># Awards</i> |
|-------------|--------------|-----------------|
| 2007 | ARES | 5 |
| 2007 | CBE | 7 |
| 2007 | Total | 12 |
| 2008 | COPN | 4 |
| 2008 | RESIN | 8 |
| 2008 | Total | 12 |
| 2009 | BSBA | 12 |
| 2009 | HyBi | 8 |
| 2009 | Total | 20 |

AUTONOMOUSLY RECONFIGURABLE ENGINEERED SYSTEMS (ARES)

Key Idea: Autonomously Reconfigurable engineered systems robust to unexpected/unplanned events.



CELLULAR AND BIOMOLECULAR ENGINEERING (CBE)

Key Idea: Comprehensive modeling, measurement, and control of coupled biological, chemical, electrical, mechanical, and thermal processes at the cellular and biomolecular level

COGNITIVE OPTIMIZATION AND PREDICTION (COPN)

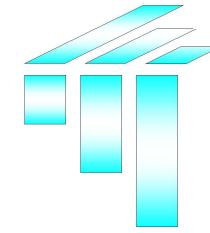
Key Idea: : Understanding subsymbolic intelligence can lead to development of new designs and algorithms for optimal decision making and prediction in engineered systems.

RESILIENT AND SUSTAINABLE INFRASTRUCTURES (RESIN)

Key Idea: Design, renew, expand, monitor, and control critical interdependent infrastructures to be both resilient and sustainable.

Biosensing and Bioactuation (BSBA)

Key Idea: creating revolutionary capabilities in sensing and response for health, infrastructure, and the environment.



Hydrocarbons from Biomass (HyBi)

Key Idea: obtaining hydrocarbons from non-food plants and microorganisms for renewable energy and chemicals.

Renewable Energy Storage (RESTOR)

Key Idea: Seeking fundamental breakthroughs in nanostructures, multi-functional materials, computational tools, and intelligent systems for large-scale energy storage suitable for renewable energy sources.

Science in Energy and Env. Design (SEED)

Key Idea: To transform materials, devices, control systems, interoperable computational tools, building systems design for engineering sustainable buildings.

WHAT DO YOU THINK?

NAE GRAND CHALLENGES

RESTOR



Make solar energy economical



Provide energy from fusion



Develop carbon sequestration methods



Manage the nitrogen cycle



Provide access to clean water



SEED

Restore and improve urban infrastructure



Advance health informatics

CBE



Engineer better medicines



Reverse-engineer the brain

BSBA



Secure cyberspace



Secure cyberspace



Enhance virtual reality



Advance personalized learning



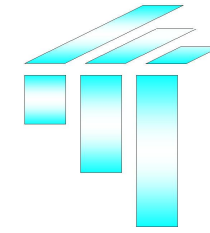
Engineer the tools of scientific discovery

HyBi

**A
R
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S**

RESIN

COPN



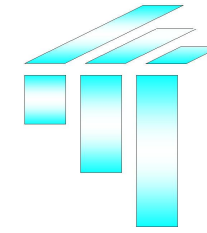
Creating intelligent eyes

- Inspired by six types of natural eyes, they seek to incorporate elements of natural visual systems into integrated, intelligent, micro imaging systems without anatomic and physiological constraints.
- The new system may surpass natural and engineered systems, both in terms of imaging performance and brain-like intelligent control.
- Discoveries could impact endoscopy tools, optics and electronics, cameras, and artificial vision.



Credit, T to B: Godfrey R. Bourne; Hongrui Jiang and Xuefeng Zeng, Univ. of Wisconsin - Madison

Led by [Hongrui Jiang](#) of the University of Wisconsin, Madison. He will collaborate with [Li Zhang](#) and [James Ver Hoeve](#), also at Wisconsin; [Christopher Murphy](#) of the University of California, Davis; and [John Rogers](#) of the University of Illinois at Urbana-Champaign (0937847).



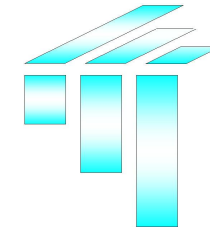
Quick conversion of biomass

- Their objective is to develop catalysts and reactor designs for converting solid biomass directly into gasoline-range hydrocarbons while generating electricity.
- Understanding the underlying physical and chemical phenomena involved in catalytic fast pyrolysis (CFP) will help develop models to guide reactor design, scale-up, and optimization.
- The team also integrate CFP into a power cycle, so that excess heat from the process can produce electricity.



Credit: Ben Barnhart

Led by [George Huber](#), with collaboration from researchers [Scott Auerbach](#), [Stephen de Bruyn Kops](#), [Triantafillos J. Mountziaris](#), and [W. Curt Conner](#), all from the University of Massachusetts-Amherst (0937895).



Post-EFRI Support **Possible Routes** **(envisioned early on)**

- Possible routes
 - Centers Programs (ERC, STC, other)
 - **ROGER KAMM (EFRI-CBE) awarded a Science and Technology Center**
 - New Program in a Division
 - **RESIN: a CMMI research cluster**
 - Change/Restructure an existing Program
 - New Program at interface of Divisions
 - Other Agencies

FY 2010: Additional Exploratory Investment **Building Engineered Complex Systems**

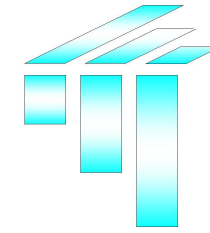



NSF 09-610

- **To Develop a theoretical basis of engineered complex systems (where the emergent behaviors or structures are not evident from considering only the system's separate components).**
- "seed funding" for small teams of innovative engineers and mathematical scientists.
- EFRI, CBET, CMMI, ECCS, and MPS/DMS and OMA
- \$4M Total (\$2M from EFRI)
- Deadline: January 19, 2010
- 2-year; \$200K-\$300K
- Received 75 proposals (59 unique projects)

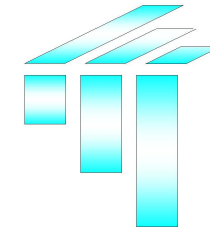
EFRI TOPIC SELECTION

(For FY2011 EFRI Solicitation)



- Continuous Community Input (Publications, Conferences, Advisory Committee, Committees of Visitors, Panels, Workshops, ...)
- Explicit Community Input through Website (Dear Colleague Letter; September Deadline) **90 RECEIVED**
- Fall Advisory Committee (October)
- EFRI Community Series (Nov/Dec) **10 PRESENTATIONS**
- Program Directors' Retreat (Jan)
- ENG Leadership Retreat (March)
 - **TOPICS ARE FINALIZED**
- Spring Advisory Committee (April) 
 - **TOPICS ARE ANNOUNCED AND MADE PUBLIC**

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



EFRI Grantee Meeting

- Latest Research Overviews at Grantee meetings website.
- Latest meeting held on March 5-6, 2009
<http://www.abecker.com/nsf/efri/grantees09>
- Next meeting is planned for March 18-19, 2010.