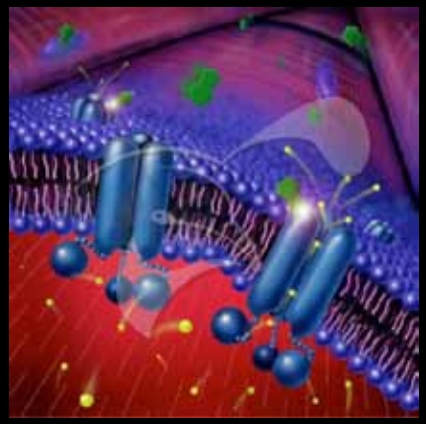
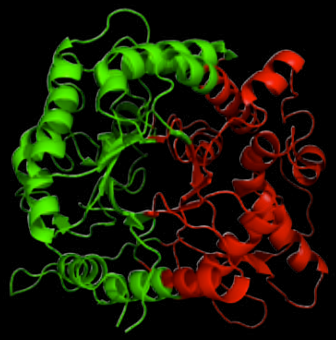
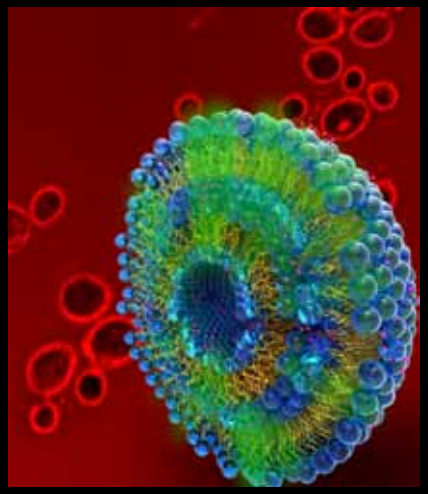
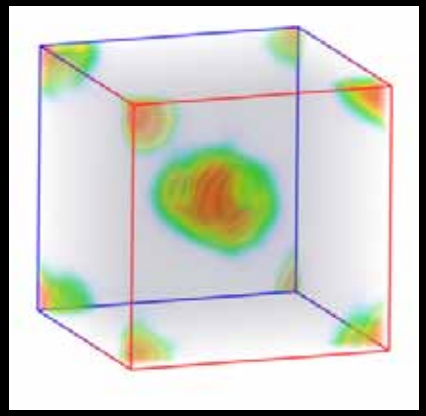
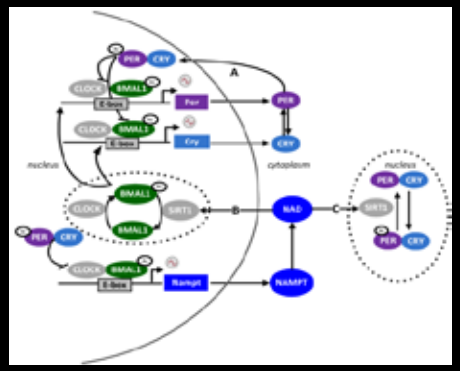
Overview and Highlights







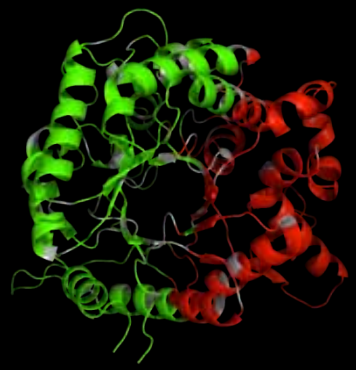


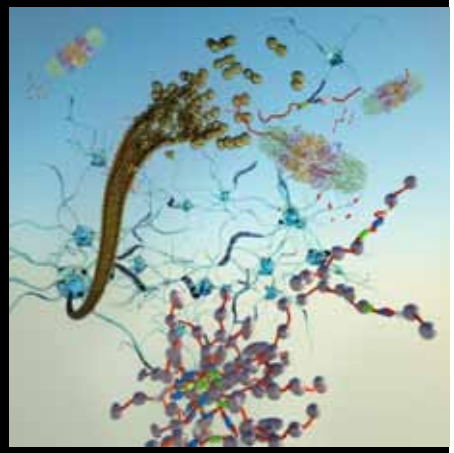


Institute for Collaborative Biotechnologies
TECHNICAL ASSESSMENT BOARD
October 2, 2012

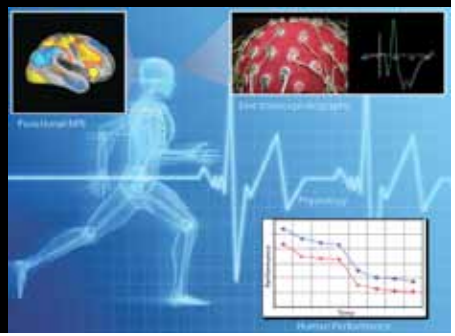
Institute for Collaborative Biotechnologies

Pioneering research and development in partnership with the Army, at the interface between biotechnology and engineering:

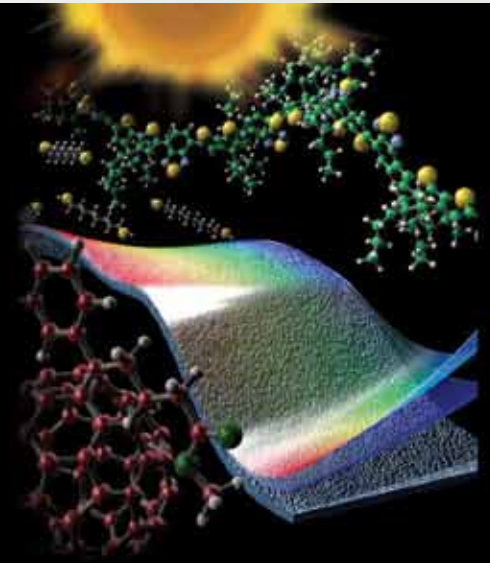




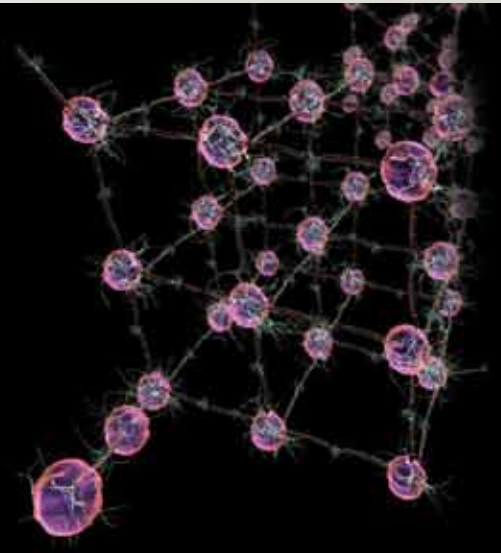
- **Launched 2003; authorized by ESB for second 5 years beginning FY09**
- **Powerful alliance of UCSB, Caltech & MIT; Industry & Army Partners**
- **74 ICB faculty in 15 departments, 105 graduate students, 60 post-docs**



ICB Alignment with *Future Needs of the Soldier*



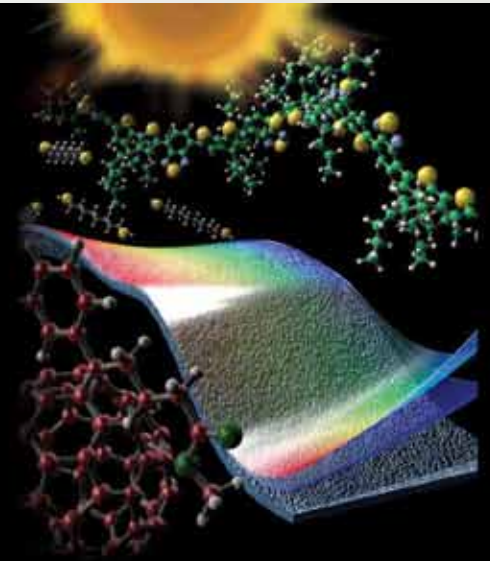
Bio-Inspired Materials for Energy, Detection & Force Protection



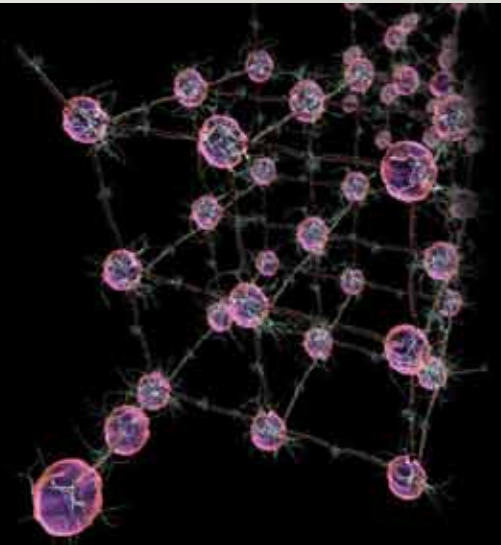
Bio-Inspired Technologies for Robust Networks, Situational Awareness & Evolving Threats

Innovations in Cognitive Neuroscience & Transformational Medicine: The Human Dimension

ICB Alignment with *Army S&T Basic Research Thrusts*

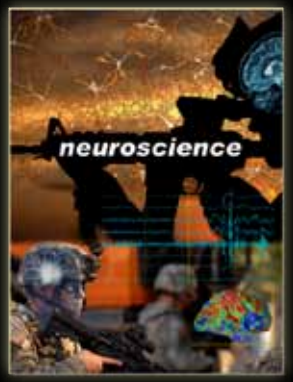


Bio-Inspired Materials for Energy, Detection & Force Protection



Bio-Inspired Technologies for Robust Networks, Situational Awareness & Evolving Threats

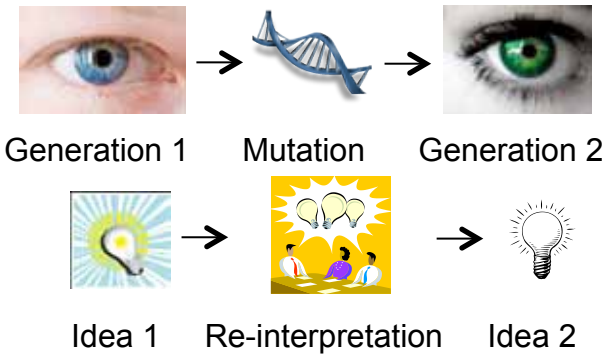
Innovations in Cognitive Neuroscience & Transformational Medicine: The Human Dimension



Collaborative Research Between ICB and Network Science CTA

Synthesizing and Analyzing the Twitter Genome

Jeffrey M. Moehlis(ICB) *Ambuj K. Singh(NSCTA)*



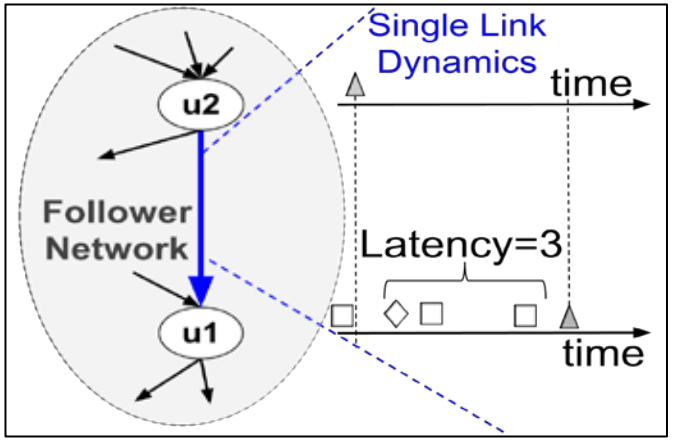
Scientific Objectives

Characterization of participants in a social network by a *genotype*, defining their behavior for set of topics

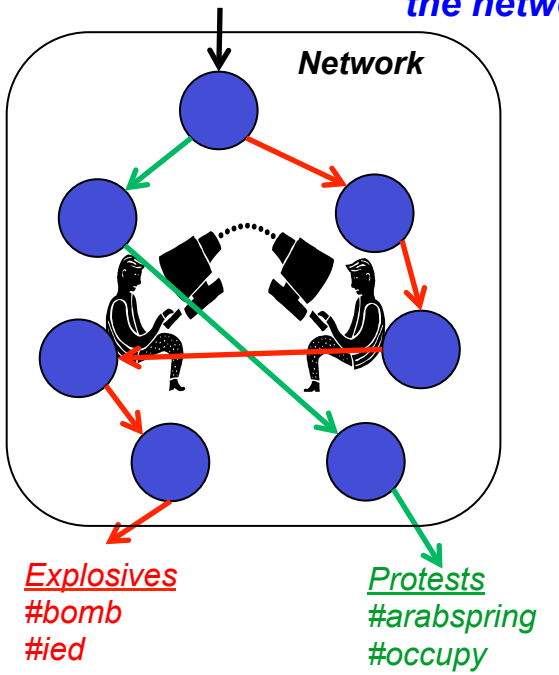
Understanding community structure for similar genotypes

Automation of message/hashtag classification

Genotype (relative latency) computation for a topic (hashtag)



Hashtags can be classified by how they pass through the network



Army Relevance

- Understand the dynamics of information
- Identify bounds on the spread of misinformation
- Develop strategies to contain misinformation

Collaborative Research Between ICB and Neuroergonomics CTA

Using Neural Biomarkers to Predict and Guide an Individual's Ability to Optimally Adapt Decisions

Michael Miller (ICB) Barry Giesbrecht (ICB) Jean Vettel (ARL)

Scientific Objectives

To identify neural biomarkers using fMRI/EEG that predict optimize decision rules during simulated Army missions

Army Relevance

To optimize decision rules using neurofeedback

Using Neural Activity to Predict Attentional Lapses During Multisensory Task Scenarios

Barry Giesbrecht (ICB) Daniel Weissman (U. Michigan)
D. Hairston (ARL) B. Lance (ARL) J. Vettel (ARL)

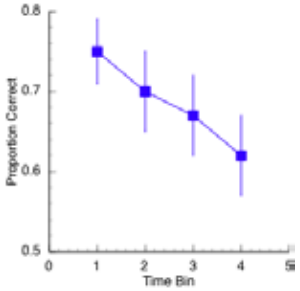
Scientific Objectives

To develop a neurally-based "early warning system" that can use a Soldier's own brain activity to predict when an attentional failure is about to occur

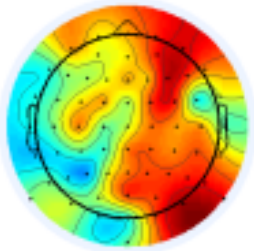
Army Relevance

To facilitate the development of strategies and/or information displays to reduce lapses in attention

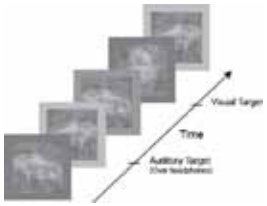
Single Task Performance



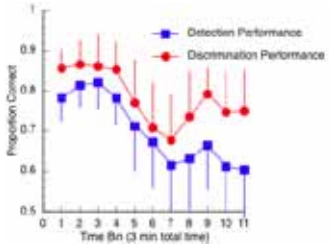
Alpha: Misses > Hits



Multisensory Macro/Micro Lapse Task



Visual Task Performance



Collaborative Research Between ICB and ISN

Bio-inspired Design of a Flexible Humanoid Armor Suit

Christine Ortiz (ICB) Mary C. Boyce (ISN) Neri Oxman (ISN)

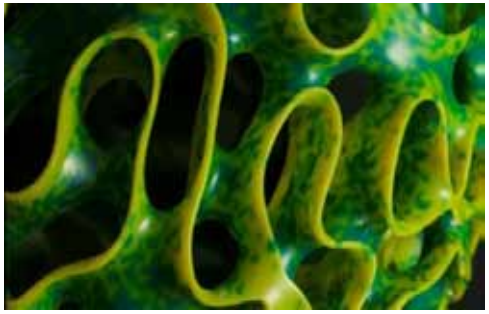
Scientific Objectives

Define geometric design principles of articulated biological armor (*P. senegalus* exoskeleton)

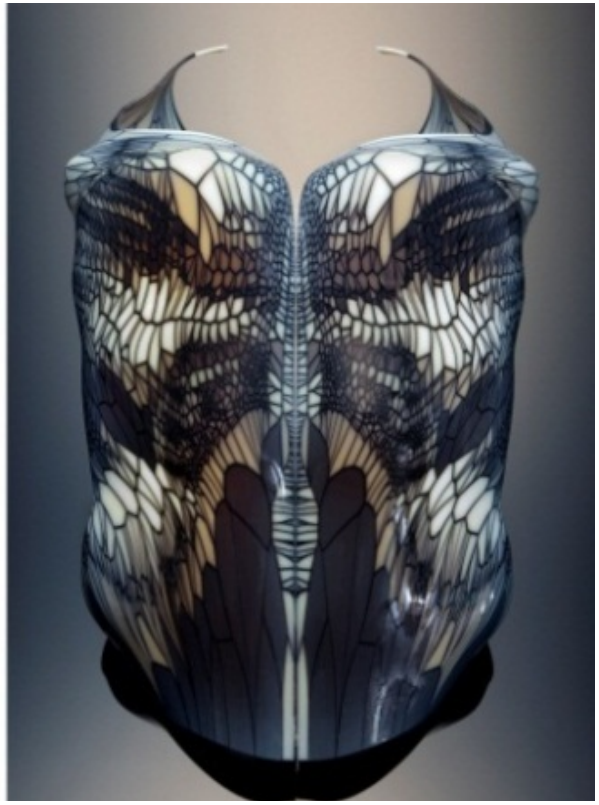
Computational development, production, and testing of bio-inspired, flexible prototypes for protective systems

Transfer design principles from biological fish armor to a flexible humanoid protective suit

P. senegalus pectoral fin



3D printing demonstrating variation in materials, properties, and structure at 16 μm resolution



Torso prototype via Objet multi-material 3D printing

Army Relevance

Flexible designs improve mobility, agility, and ergonomics of personnel without sacrificing protection

Segmented assemblies permit the use of a wide range of constituent materials and allow for selective replacement of damaged subunits

ICB Research Productivity 2009 - 2012

	Total	2012	2011	2010	2009
Faculty Honors and Awards	208	61	48	54	45
Peer-Reviewed Publications	418	105	102	104	107
Patents and Inventions	52	18	11	10	13
Doctoral Degrees Awarded	141	44	21	31	45
Master's Degrees Awarded	31	12	6	5	8

ICB Faculty Honors – NAE, NAS, IOM, Draper, Nobel

	NAE	NAS	IOM	Draper	Nobel
Jacob Israelachvili	1996	2004			
Alan Heeger	2002	2001			2000
Frances Arnold	2000	2008	2004	**2011**	
Douglas Lauffenburger	2001				
Glenn Fredrickson	2003				
Linda Petzold	2004				
Stephen Mayo		2004			
David Tirrell	2008	2006	**2011**		
Michael Gazzaniga		**2011**	2005		
Linda Griffith	**2011**				

International Recognition for Bio-inspired Innovation

ICB-trained Researchers Hired by the Army or DoD

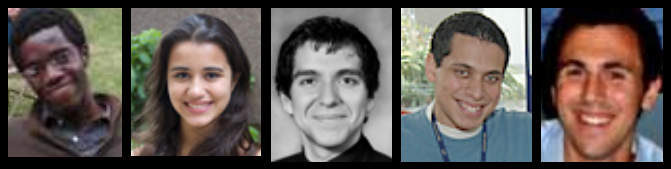
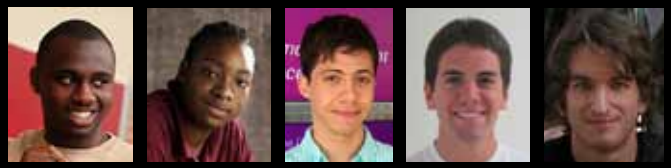
ICB Researcher	Trained By	Hired By
Ruoting Yang	F. Doyle	MRMC
Jordan Raney	C. Daraio	DoD/OSD
Tanya Chantawansri	G. Fredrickson	ARL/WMRD
Kato Killops	C. Hawker	ECBC
F. John Burpo	A. Belcher	USMA
Rachel Kolesnikov-Lindsey	A. Belcher	AFRL
Richard Harang	L. Petzold	ARL(ICF)
Peter Khooshabeh	J. Blascovich	ARL/HRED
Marc Woodka	N. Lewis	CERDEC
Dawn Nida	S. Manalis	NSRDEC
Hope Feldman	C. Meinhart	DoA
Leetha Sooter	D. Wittrup	ARL/SEDD

2012 Placements of ICB Researchers

2012 Placements of ICB Researchers at Universities, in Government, and with Industry

18 University Faculty Positions	USMA-West Point, Penn, Texas, Yale, Purdue, UConn, Colorado State, UC San Diego, UC Santa Barbara, UC Riverside, UMaryland-Baltimore (2), Arcadia, IIS-Bangalore, Jiao Tong, Wuhan, IIT-Dehli, Adolfo Ibañez-Chile.
31 Academic Post-Docs	UC Santa Barbara (12), Caltech, MIT, Johns Hopkins, UC Berkeley (2), Stanford, UConn, USC, UC San Francisco, UC San Diego, Carnegie Mellon UMass, Rockefeller, Texas, Albany Medical College, Seattle Children's Hospital, Humboldt-Berlin, KAIST, ETH-Zurich
5 Government Researchers	MRMC/USACEHR, White House OSTP, Office of the Secretary of Defense, Argonne National Lab, LTM-CNRS-France
22 Industry Researchers	Apple, Intel (2), Amazon, Micron Technology, BASF, Pfzier, Merck, Samsung, Lam Research, Silicium Energy, Gevo, Spectrafluidics, Intellectual Ventures, Sabrient Systems, Gingko Biosystems, Celanese, McKinsey, Synthetic Genomics, PepsiCo, BioMEMS, Wyatt Technologies
3 Other Destinations	MIT Koch Cancer Center, Colorado School of Medicine, Marshall, Gerstein & Borun LLP

ICB Educational Outreach 2008 - 2012

Summer Undergraduate Research in Synthetic Biology (SURE-SB)

Summer 2012 URAP Program Interns

Program Director: Prof. Patrick Daugherty

Gaven Larsen
Project: "Evolution of enzyme serum stability"
Faculty Advisor: P. Daugherty
Mentor: Amol Shivange

Izaak Rosen
Project: "Design of an amyloid-beta degrading protease"
Faculty Advisor: P. Daugherty
Mentor: Tyler Shropshire

Harrison Goldwyn
Project: "Reversible assembly of DNA nanotubes"
Faculty Advisor: D. Fygenson
Mentor: Danielle Shultz

- **Undergraduate students paired with graduate mentors**
- **Introduced to emerging science of synthetic biology**
- **Training in oral scientific presentations**
- **Preparation for graduate school**
- **Final project oral presentations**

ICB Educational Outreach 2008 - 2012

	Total	2012	2011	2010	2009	2008
SABRE HBCU-MI (UCSB)	32	7	8	6	7	4
Minority Fellowships (Caltech & MIT)	14	4	4	3	3	
High School Internships / HSAP (UCSB)	14	6	4	4		
Undergraduate Research / URAP (UCSB)	3	3				

Accelerating Technology Transitions

Army General Officers and Senior DoD and Army Officials Provided Strategic Direction to the ICB during 2009 – 2012

LTG Keith Walker
TRADOC

LTG Mark Hertling
TRADOC

LTG Michael Vane
TRADOC

MG Nick Justice
RDECOM

MG James Gilman
MRMC

Ms. Heidi Shyu
ASA(ALT)

Dr. Thomas Killion
ASA(ALT)

Dr. Marilyn Freeman
ASA(ALT)

Dr. Scott Fish
ASA(ALT)

Dr. Fraiser Glenn
MRMC

Dr. Robin Staffin
DR&E (BSO)

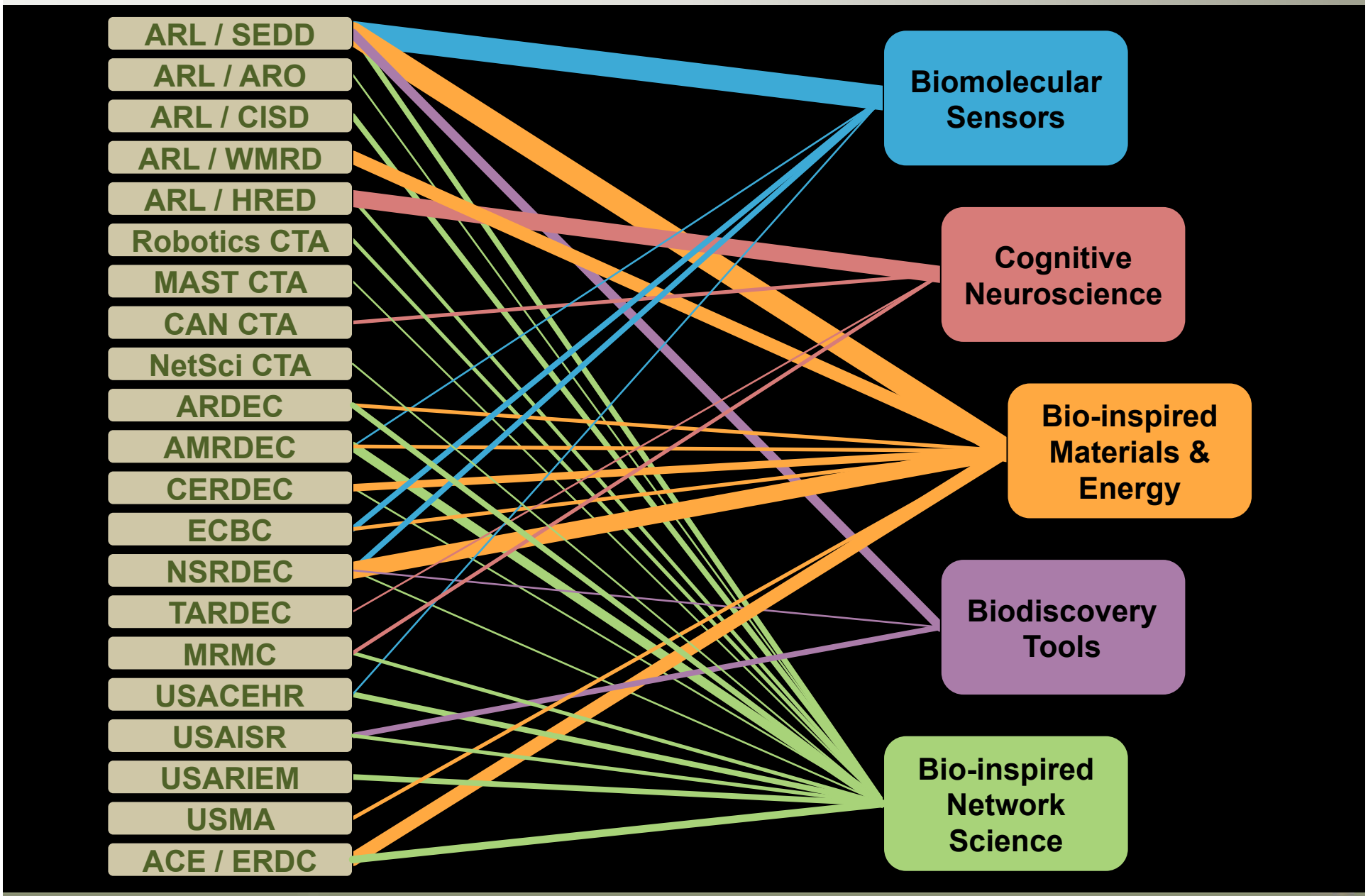
Dr. Nancy Spruill
USD(ATL)

Mr. Mark Krzysko
USD(ATL)

Dr. John Parmentola
ASA(ALT)

Mr. John Miller
ARL

2012 Army-ICB Collaboration Network



2011-12 Army-ICB Joint Patents and Publications

ARL 10-36 Nonprovisional Patent Application, "Agents for Enhanced Charge Transport Across Microbial Membranes" (UC ref 2010-542). **J. Sumner (ARL/SEDD), S. Harvey(ECBC), G. Bazan**

A. Duarte, **M. Slutsky (NSRDEC)**, G. Hanrahan, **C. Mello (NSRDEC)**, and **G. Bazan**, "Supramolecular electrostatic nanoassemblies for bacterial forensics," *Chemistry: A European Journal*, vol. 18, no. 3, pp. 756–759, Dec. 2011.

F. Nunez, Y.Q. Wang, **S. Desai (ARL/SEDD)**, **G. Cakiades (ARDEC)** and **F.J. Doyle, III**, "Bio-inspired synchronization of wireless sensor networks for acoustic event detection systems," in *Proceedings of IEEE Symposium on Precision Clock Synchronization for Measurement, Control and Communication*, 2012.

M. Rodriguez-Fernandez, B. Grosman, T. Yuraszeck, B. Helwig, **L. Leon (USARIEM)**, and **F.J. Doyle III**, "Modeling the Intra- and Extracellular Cytokine Signaling Pathway under Heat Stroke", *PLoS Comp Biol*, submitted, 2012.

D. Oh, X. Dang, H. Yi, M. Allen, **K. Xu (ARL/SEDD),** Y. Lee, and **A. Belcher**, "Graphene sheets stabilized on genetically engineered M13 viral templates as conducting frameworks for hybrid energy−storage materials," *Small*, vol. 8, no. 7, pp. 1006–1011, Apr. 2012.

K. Xu (ARL/SEDD), D. Oh, H. Yi, J. Qi, A. Xu, J. Snyder, and **A. Belcher**, "Genetically programming interfaces between active materials, conductive pathway and current collector in li-ion batteries," *ECS Transactions*, vol. 41, no. 41, pp. 55–64, May 2012.

J. Kogot (ARL/SEDD), Y. Zhang, S. Moore, P. Pagano, **D. Stratis-Cullum (ARL/SEDD)**, D. Chang-Yen, M. Turewicz, **P. Pellegrino (ARL/SEDD)**, A. de Fusco, **H. Soh**, and N. Stagliano, "Screening of peptide libraries against protective antigen of Bacillus anthracis in a disposable microfluidic cartridge," *PLoS ONE*, vol. 6, no. 11, e. 26925, Nov. 2011.

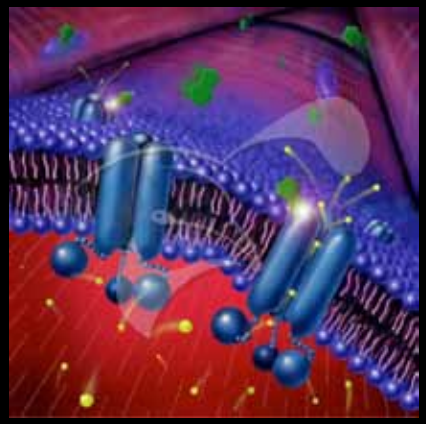
A. Wadhwa, **U. Madhow, J. Hespanha**, and **B. Sadler (ARL/CISD)**, "Following an RF trail to its source," in *Proceedings of the Communication, Control, and Computing 49th Annual Allerton Conference*, pp. 580–587, 2011.

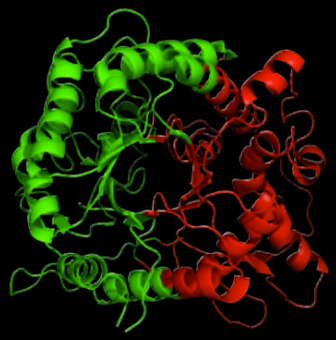
H. Cecotti, **A. Ries (ARL/HRED), M. Eckstein, B. Giesbrecht,** "Multiclass classification of single trial evoked EEG responses," in *Proceedings of the IEEE Engineering in Medicine and Biology Society,* 2012.

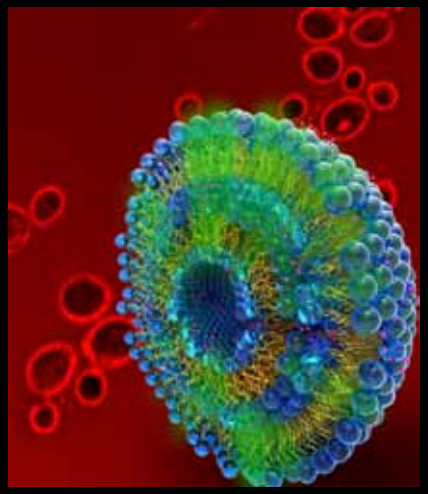
L. Gibson, J. Touryan, **A. Ries (ARL/HRED),** H. Cecotti, and **B. Giesbrecht,** "Adaptive integration and optimization of automated and neural processing systems: Establishing neural and behavioral benchmarks of optimized performance," *ARL Technical Report ARL-TR-6055, 2012.*

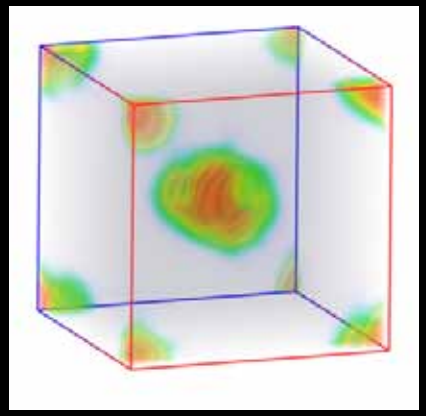
R. Kraft (ARL/WMRD), P. Mckee, A. Dagro, **S. Grafton**, "Combining the Finite Element Method with Structural Connectome-based Analysis for Modeling Neurotrauma: Connectome Neurotrauma Mechanics," *PLoS Comput Biol,* 2012, in press.

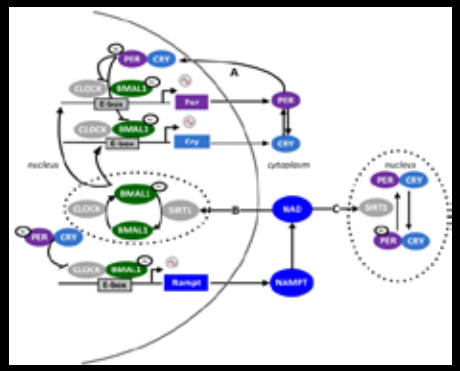
Overview and Highlights











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