Multi-Disciplinary University Research Initiative
(MURI) Active Projects (2006-2011)

This data is a provided to highligiht some of the key fundamental research being carried out by the DoD
For more information about a specific MURI, please contact the Principal Investigator or the Program Manager for that project.

Fiscal Year	Agency	MURI Title	Program Officer	Principal Investigator	Institute	Abstract
FY06	ARO	Bio-integrating Structural and Neural Prosthetic Materials	Elmar Schmeisser	David Martin	University of Michigan	This MURI effort seeks to create structural and interconnective bio-integrating materials for a future limb prosthetic that users could intuitively control using natural intent with real time sensory and proprioceptive feedback via normal neural pathways
FY06	ARO	Spatial-Temporal Nonlinear Filtering with Applications to Information Assurance and Counter Terrorism	Harry Chang	Boris Rozovsky	Brown University	This MURI seeks to develop a general and systematic foundation and algorithms for spatial-temporal statistical inference and for fusion of heterogeneous information from multi-source, multi-sensor distributed sensor networks.
FY06	ARO	Superatoms as Building Blocks of New Materials	William Mullins	A. Welford Castleman	Pennsylvania State University	Small clusters of atoms have been predicted to exhibit atomic-like electronic structure and to form stable atomic-like bonds with large atoms and other clusters. The objective of this MURI is to establish the feasibility for assembling clusters into new materials with selected properties
FY06	ARO	Tunable and Reconfigurable Optical Negative-Index Materials with Low Losses	Richard Hammond	Vladimir Shalaev	Purdue University	The objective of this MURI is to develop optical materials that exhibit a negative index of refraction in the visible and near IR region of the spectrum.

FY06	ARO	Growth, Characterization, and Modeling of Monolithic Silicon Microbolometer Materials for Uncooled Infrared Detectors	William Clark	Mark Horn	Pennsylvania State University	This MURI seeks to target four areas for increased impact and technology transition: Spectroscopic ellipsometry for microbolometer material optimization and control; pulsed DC magnetron sputtering of VOx for improved process control and reduced cost; increased support for a-Si:H microbolometer material optimization industrial transition; and low-resolution ZnO pyroelectric thin film transistor microbolometer array demonstration.
FY06	ARO	Engineered Multifunctional Nanophotonic Materials for Ultrafast Optical Switching	Douglas Kiserow	Eric Van Stryland	University of Central Florida	This MURI focuses on basic science and engineering to explore a new approach to nanophotonic materials, material structures, and devices, that exhibit large, high-speed nonlinear optical adsorption and refractive index changes. The long-term goal is to generate the fundamental science base to enable new capabilities in all-optical switching without the need for focusing optics.
FY06	ARO	Ultrafast Laser Interaction Processes for Libs and Other Sensing Technologies	Ralph Anthenien	Martin Richardson	University of Central Florida	The objective of this MURI project is to assemble a fundamental theoretical understanding of femtosecond laser and materials interaction expressed in combined physical and chemical models, rigorously grounded by experimental characterization and detailed physical and chemical observations relevant to laser induced breakdown spectroscopy and other spectroscopic sensing techniques.
FY06	ARO	Heterogeneous Sensor Webs for Automated Target Recognition and Tracking in Urban Terrain	John Lavery	Shankar Shastry	University of California, Berkeley	This MURI effort works to achieve improved data compression by fusing different imaging modalities. In particular, the work focuses on improving 3D LIDAR compression using hyper-spectral images.

FY07	ARO	Biologically Assembled Quantum Electronic Arrays	Marc Ulrich	Richard Kiehl	University of California, Davis	The objective of this MURI is to provide a biological route to the precision assembly of nanostructure-based quantum electronic systems functional at room temperature and to utilize the pathway for the systematic study of many-body quantum effects.
FY07	ARO	Attosecond Optical Technology Based on Recollision and Gating	Richard Hammond	Zenghu Chang	Kansas State University	The objective of this research is the development of attosecond science directed towards finding methods for resolving ever faster phenomena.
FY07	ARO	Situation Understanding Bot through Language and Environment	Joe Myers	Mitchell Marcus	University of Pennsylvania	This MURI develops a broad range of concepts, a formal computational specification of a significant empirically determined subset of natural language (English), and a testbed system which will ultimately enable military designers to develop powerful communication methods between bots and humans, enabling humans to communicate goals and intentions as well as direct commands to bots in a natural, effective way. At the heart of this MURI is fundamental research to develop methods for constructing a computationally tractable end-to-end system for a habitable subset of English, one that takes us from utterances all the way to the understanding of them, including both a formal representation of the implicit meaning of utterances and the generation of control programs for a robot platform.
FY07	ARO	Ionic Liquids in Electro-active Devices (ILED)	David Stepp	Timothy Long	Virginia Polytechnic Institute and State University	The goal of this MURI is to use ionic liquids in novel ways to prepare new and potentially useful polymeric materials and devices. The research focuses on synthesizing polymers using ionic liquids as the reaction medium, synthesizing polymers with ionic liquids as a polymerizable component, characterizing material properties, and preparing actuators and membranes to evaluate device properties.

FY07	ARO	Mechanochemically-Active Polymer Composites	Doug Kiserow	Jeffrey S. Moore	University of Illinois	This MURI pursues new types of self-sensing and self-healing polymer composites based on molecular-level mechanochemical transduction.
FY07	ARO	Materials on the Brink: Unprecedented Transforming Materials	John Prater	Kaushik Bhattacharya	California Institute of Technology	The purpose of this MURI is to develop a fundamental understanding and establish the engineering expertise needed to tailor the electrical, optical, or magnetic (EMO) properties of phase transforming materials through the design and implementation of highly reversible, phase-transformations.
FY07	ARO	ARSENAL: A cross layer Architecture for Secure Resilient Tactical Mobile Ad-hoc Networks	Cliff Wang	Prasant Mohapatra	University of California, Davis	This MURI works from the thesis that in order to achieve its objectives, it is essential to have a holistic view of the behaviors at the various layers of a network stack i.e., cross-layer effects. To pursue this idea, it undertakes a systematic effort towards the design of a cross layer architecture that effectively distinguishes between environmental factors and adversarial threats and invokes the right mechanisms at the various layers both proactively to prevent and reactively to cope with disruptions.
FY07	ARO	Designing Reliable and Secure Tactical MANETS	Cliff Wang	Virgil Gligor	University of Maryland, College Park	This MURI seeks to develop the analytical models, tools, and mathematical representations for assessing, prescribing, analyzing, and predicting the behavior of robust and resilient mobile ad hoc networks.
FY07	ARO	Engineering of Sensor Network Structure for Dependable Fusion	Liyi Dai	Shashi Phoha	Pennsylvania State University	The objective of this MURI is to develop theoretical foundations for the design and operation of flexible sensor network topologies that utilize constrained resources effectively to support dynamic needs for data fusion. The effort is focused on engineering network structure for operation dependability and performance predictability under known and unknown perturbations by effectively organizing diverse resources of sensing, communications, and computational capabilities.

FY07	ARO	Model Classes, Approximation, and Metrics for Dynamic Processing of Urban Terrain Data	John Lavery	Ronald DeVore	University of South Carolina	This MURI seeks to develop an analytical framework and accurate and efficient computational procedures consistent with modeling the 3D geometry and topology of large regions (1 to 10,000 sq km) of urban terrain
FY08	ARO	Dynamic Models of the Effect of Culture on Collaboration and Negotiation	Jeff Johnson - PU,PV	Michele Gelfand	University of Maryland, College Park	This MURI team includes leading scholars from anthropology, psychology, computer science, political science, economics, and communication, and seeks to develop a model that offers a dynamic, multilevel, and contextualized understanding of culture and negotiation and collaboration. It is the first research program of its kind to deliver knowledge about negotiation and collaboration processes across a wide range of contexts.
FY08	ARO	Modeling Cultural Factors in Collaboration and Negotiation	Jeff Johnson - PU	Katia Sycara	Carnegie Mellon University	This MURI works to develop a comprehensive approach to develop and validate theory and derive and transition products to significantly advance our understanding of multi-cultural collaboration and negotiations.
FY08	ARO	The Analysis and Classification of Brain Signals for Covert Speech Communication	Elmar Schmeisser Liyi Dai	Michael D'Zmura	University of California, Irvine	The objective of this application is to develop the fundamental research needed in order to design a system for verbal communication and monitoring of attentional orientation that uses brain signals to provide, in real time, an accurate assessment of the user’s intentional focus, eye movements, and imagined speech. The proposal focuses on the electrocorticograms in epilepsy patients as the initial test bed, leveraging a similarly focused single investigator award, and will use that data to inform the development of the algorithms needed to perform the task via non-invasive EEG only.

FY08	ARO	A Brain-Based Communication and Orientation System	Liyi Dai, Elmar Schmeisser	Gerwin Schalk	Albany Medical College	The objective of this MURI is to develop the fundamental research needed in order to design a system for verbal communication and monitoring of attentional orientation that uses brain signals to provide, in real time, an accurate assessment of the user's intentional focus, eye movements, and imagined speech.
FY08	ARO	A Unified Approach to Abductive Inference	Purush Iyer	Pedro Domingos	University of Washington	This MURI seeks to develop a unified framework for carrying out abduction – the process of explaining potential causes for an observed phenomenon – based on information obtained from multiple sources, with the possibility that the data could contain noise and be of uncertain nature.
FY08	ARO	Electrical Control of Magnetic Dynamics in Hybrid Metal-Semiconductor Systems	John Prater	Daneil Ralph	Cornell University	This MURI investigates fundamental phenomena enabling the all-electrical manipulation of magnetic behavior (both static and dynamic properties) in hybrid structures incorporating magnetic metals, multi-ferric oxides and semiconductors.
FY08	ARO	Room Temperature Spin-Mediated Coupling in Hybrid Magnetic, Organic and Oxide Structures and Devices	John Prater	Michael Flatte	University of Iowa	This program will investigate the fundamental properties of novel hybrid structures incorporating magnetic metals, multiferroic oxides and organic semiconductors. The goal is to establish the underlying physics and identify potential new approaches to room-temperature spintronics - a new approach to electronics that is based on spin-mediated (rather than electrical charge) manipulation of the magnetic state of the basic elements.
FY08	ARO	Tools for the Analysis and Design of Complex Multi-scale Networks	Harry Chang	Jean Walrand	University of California, Berkeley	This MURI seeks to develop a unified framework to understand and exploit the complex behaviors of the network resulting from this spatial and temporal heterogeneity and the interaction of network algorithms with traffic characteristics.

FY08	ARO	Stochastic Control of Multi-scale Networks: Modeling, Analysis and Algorithms	Harry Chang	Ness Shroff	The Ohio State University	The overarching objective of this MURI effort is to develop a theory for modeling, analysis, and control of military networks to achieve high network performance. The theory will unify stochastic control, statistics, queuing theory, complexity theory, and distributed algorithms, which is necessary for the development of radically new strategies for controlling increasingly complex military networks.
FY08	ARO	Spray and Combustion of Gelled Hypergolic Propellants for Future Rocket and Missile Engines	Ralph Anthenien	Stefan Thynell	The Pennsylvania State University	This MURI effort represents an integrated research program comprising material science, chemistry, physics, and engineering to address various fundamental issues critical to the development of gelled hypergolic propellant spray and combustion technologies for future rocket and missile propulsion systems.
FY08	ARO	Spray and Combustion of Gelled Hypergolic Propellants	Ralph Anthenien	Stephen Heister	Purdue University	The objective of this effort is to develop a fundamental understanding of the processes and mechanisms that control droplet formation, droplet collision and mixing, ignition, and energy release in gelled hypergolic propellants
FY09	ARO	Multiscale Design and Manufacturing of Hybrid DWCNT-Polymer Fibers	Doug Kiserow	Horacio Espinosa	Northwestern University	This MURI team is engaged in a multidisciplinary effort in the chemical design of precursors, development of novel fiber fabrication methods, and Multiscale modeling and characterization methods. Specifically, they seek to develop CVD-based fabrication methods for highly aligned double-walled carbon nanotube mats possessing optimized density and surface chemistry as precursors for fiber formation.
FY09	ARO	Unified Research on Network-Based Hard/Soft Information Fusion	John Lavery	James Llinas	University at Buffalo, The State University of New York	This MURI team investigates the nature of "soft" sensing and the data that results from human-based observation by analytical source characterization. Methods for normalizing/referencing and associating soft data with both other such soft data streams and data from hard or physics-based sensing modalities are being developed.

FY09	ARO	Design of Adaptive Load Mitigating Materials Using Nonlinear Stress Wave Tailoring	David Stepp	John Lambros	University of Illinois	The objective of this work is to develop a new class of material systems that have the ability to mitigate adverse effects of stress wave propagation through them in a much more controllable and beneficial manner than is currently possible.
FY09	ARO	Quantum-Optical Circuits of Hybrid Quantum Memories	T.R. Govindan	Christopher Monroe	University of Maryland, College Park	The MURI program objective is to investigate and demonstrate optically-coupled hybrid quantum circuitry, with an aim of exploiting particular features of various quantum platforms for enhanced quantum information capabilities. Quantum optical interfaces between (a) atomic systems having excellent coherence and memory properties, (b) solid state systems with high-speed operations and scalable architectures, and (c) optical photonic systems with long-distance communication
FY09	ARO	Innovative Design and Processing of Multi-Functional Adaptive Structural Materials	David Stepp	Ilhan A. Aksay	Princeton University	The central focus of this MURI is on sensing stress variations on the struts of cellular or porous structures to enhance mass deposition at those sites to negate the weakening effect of increased stress with the view to the use of cellular or porous structures similar to bone as an essential structural feature, necessary to rapidly transport mass to weakening regions, using a fluid phase rather than the slow solid state transport processes of fully dense structures.
FY09	ARO	Transformation Optical Metamaterials	Richard Hammond	David Smith	Duke University	This MURI balances transformation optics theory, metamaterials design, and advanced fabrication to ensure that device concepts will transition to actuality.

FY09	ARO	Emergent Phenomena at Mott Interfaces	Marc Ulrich	Susanne Stemmer	University of California, Santa Barbara	The effort works to establish fundamentally new approaches to predict, understand and control the wealth of electronic, spin and collective mode excitations associated with Mott metal-insulator transitions at complex oxide interfaces. Interfaces between thin (a few monolayers) Mott materials and conventional band insulators are being synthesized using oxide molecular beam epitaxy. In particular, the project focus is on Mott materials, such as rare earth nickelates, titanates and vanadates, and band insulators with the perovskite structure.
FY09	ARO	Signaling Network Interactions Controlling Mouse and Salamander Limb Regeneration	Micheline Strand	Ken Muneoka	Tulane University	The focus of this work is to establish the molecular a genetic foundation necessary for the eventual regeneration of a human limb. Advances in the field of regenerative medicine are moving at a rapid pace with our ability to reprogram adult cells for use in regeneration therapies paving the way
FY09	ARO	Mechanism of Bacterial Spore Germination and its Heterogeneity	Wallach Buchholz -PS, Virigina Pasour, MG	Peter Setlow	University of Connecticut Health Center	The overall goal of the work outlined in this MURI effort is a detailed understanding of the germination of spores of bacteria of Bacillus species, as well as similar understanding of germination of spores of Clostridium species. A particular goal is to understand the reasons for heterogeneity in spore germination
FY09	ARO	Opportunistic Sensing for Object and Activity Recognition from Multi-Modal, Multi-Platform Data	Liyi Dai	Richard Baraniuk	William Marsh Rice University	This MURI project seeks to develop a principled theory that provides predictable, optimal performance for a range of different problems through the effective utilization of the available network of resources. The multidisciplinary team of researchers from sensor physical modeling, statistical image processing, computer vision, optimization, game theory, robotics, control, and compressive sensing work to make OS a practical reality.

FY09	ARO	A Cyber Awareness Framework for Attack Analysis, Prediction, and Visualization	Cliff Wang	Richard Kemmerer	University of California, Santa Barbara	This effort seeks to develop novel situation awareness theories and techniques to obtain an accurate view of the available cyber-assets and to automatically determine the assets required to carry out mission tasks.
FY09	ARO	Computer-aided Human Centric Cyber Situation Awareness	Cliff Wang	Peng Liu	The Pennsylvania State University	This MURI takes an interdisciplinary computer-aided human centric cyber situation awareness approach to fill the gap between machine information processing and analysts' mental processes. Innovations include adding the "missing links" between the analysts' mental processes and machine-level intrusion analysis tools, between human-comprehensible situation representation and algorithmic data structures, and between brain-side decision making and machine-side information fusion.
FY10	ARO	Blast Induced Thresholds for Neuronal Networks (BITNeT)	Elmar Schmeisser Bruce LaMattina	David F. Meaney	University of Pennsylvania	This MURI examines circuits constructed in vitro and in vivo, and assess the effect of blast-induced circuit changes on subsequent function and physiology of the organism.
FY10	ARO	Prokaryotic Genomic Instability	Micheline Strand Janet Spoonamore	Pat Foster	Indiana University	This effort combines recent technological advances that facilitate high-throughput sequencing of complete microbial genomes from mutation-accumulation experiments with a rigorous statistical framework for determining mutational rate and the spectra of mutational change. The interdisciplinary research team is unique, combining expertise in microbial genetics, evolutionary genomics, population-genetic modeling, and bioinformatics. The completion of this project will provide the experimental and theoretical basis for a complete understanding of prokaryotic genomic instability.

FY10	ARO	Measuring, Understanding, and Responding to Covert Social Networks	John Lavery	Patrick Wolfe	Harvard University	This MURI addresses the difficult yet important problem of automatically analyzing heterogeneous, noisy, and incomplete multi-source data sets to infer information about individuals of interest and covert groups. To do so require both passive network observation and inference from traditional sources, as well as active sensing in a way that does not perturb the network as it evolves dynamically over time. These new methodologies enable new operational capabilities, yielding as an end goal the ability to discover, monitor, and modulate dynamic networks of actors based on fully automated analysis techniques.
FY10	ARO	Neuro-Inspired Adaptive Perception and Control for Agile Mobility of Autonomous Vehicles in Uncertain and Hostile Environments	Randy Zachery	Panagiotis Tsiotras	Georgia Institute of Technology	This effort seeks to enable radically new capabilities of autonomous and semiautonomous ground vehicles in the battlefield. It will enhance many fold the maneuverability and mission impact of these vehicles by allowing them to move at high speed, over rough terrain while operating in hostile environments. To achieve this, the MURI team develops insights from human-like perception mechanisms, capable of providing cues derived from attention and/or saliency of the scene and explores hierarchical and multi-resolution approaches to vision and processing, inspired by the human visual cortex.

FY10	ARO	The Linguistic-Core Approach to Structured Translation and Analysis of Low-Resource Languages	Joseph Myers	Jaime Carbonell	Carnegie Mellon University	Whereas statistical approaches for machine translation (MT) and text analysis (TA) successfully harvested the low-hanging fruit for large data-rich languages, they prove insufficient for quality among typologically-diverse languages and, worse yet, inapplicable for very low-resource languages. This effort seeks to venture much further and turn the process on its head, i.e. start with a true linguistic core and add lexical coverage and corpus-based extensions as data availability permits. This linguistic core would comprise an enriched feature representation (morphology, syntax, functional semantics), a suite of core linguistic rules that operate on these features via powerful operators (tree-to-tree transduction, adjunction, unification, etc.), and prototype MT and TA engines to evaluate their accuracy and phenomenological coverage.
FY10	ARO	Reconfigurable Matter from Programmable Colloids	John Prater (EX) Douglas Kiserow	Sharon Glotzer	University of Michigan	This MURI effort seeks to develop the scientific foundation and technical know-how to create an entirely new class of self-assembled, reconfigurable colloidal materials with radically increased complexity and functionality. Multicomponent, programmable, addressable, shape-changing colloidal building blocks with reconfigurable elements on multiple scales are being designed, fabricated and assembled via stages into new architectures with tunable properties made possible by reconfigurability.
FY10	ARO	Atomtronics: Material and Device Physics of Quantum Gases	Marc Ulrich	Ian Spielman	University of Maryland, College Park	This MURI brings together a diverse group of scientists, both experimental and theoretical, experts in fields from atomic and condensed matter physics to electrical engineering. Their goal is to start from the fundamental physics already revealed with cold atoms systems and move to an understanding of the functional materials science required for practical device applications.

FY10	ARO	Near and Far-Field Interfaces to DNA-Guided Nanostructures from RF to Lightwave: Exploiting the	Dwight Woolard	Peter Burke	University of California, Irvine	This research center focuses on the electromagnetic interrogation and interface to nanostructures (including DNA tiles, nanotubes, and nanowires), their assembly into complex structures using DNA nanotechnology, and the properties of signals, and spectral signatures of various chemical species attached to and probed by the electric fields generated and guided by nanowires and nanotubes.
FY10	ARO	An Integrated Multi-Scale Approach for Understanding Ion Transport in Complex Heterogeneous Organic Materials	Robert Mantz	Andrew Herring	Colorado School of Mines	This MURI seeks to synergistically develop new polymer architectures with standard and novel cations. The synthetic work iteratively prepares stable cations, varies modes of attachment to polymer backbones, and generates controlled morphologies. Synthesis and characterization is closely tied to theory through model validation, firstly by the study of aqueous solutions of representative cations and secondly by the study of well-defined polymer
FY10	ARO	Fundamental Study of Defects and Their Reduction in Type-II Superlattice Materials	William Clark John Prater	Shun Lien Chuang	University of Illinois at Urbana Champaign	This program involves investigators at four institutions with a broad and relevant range of technical backgrounds, including physics, materials science, and electrical engineering, investigating the defect formation in Antimony-based type-II superlattices materials so as to ultimately improve the performance of lasers and detectors.

FY11	ARO	Understaning the Interaction of Peptides and Proteins with Abiotic Surfaces: Towards Water-Free Biologics	Becker	Zhan Chen	University of Michigan	This effort includes groups with expertise in surface spectroscopy, computational modeling of biological molecules, protein engineering and fabrication of biocomposite materials, to investigate and control abiotic/biotic interfaces. They apply a combination of state-of-the-art experimental techniques and advanced theoretical simulation methods to investigate molecular structures at abiotic/biotic interfaces in water and in air with different humidity levels. Three classes of surfaces are being studied: self-assembled monolayers, liquid crystals and vapor-deposited polymers, onto which biologically active peptides and enzymes will be covalently immobilized.
FY11	ARO	Control of Quantum Open Systems: Theory and Experiment	Chang	Daniel Lidar	University of Southern California	To address the MURI goal of a mathematical theory unifying quantum probability and quantum physics, this MURI studies unifying features of controlled quantum phenomena. The means for achieving quantum control is generally categorized as either open loop control (OLC), adaptive open-loop control (AFC), realtime feedback control (RTFC), or coherent real-time feedback control (CFC). This linkage is expected to be significant to draw out the best features for meeting new control challenges and overcoming inevitable laboratory constraints, in particular in the context of our proposed meso-scale laser and atomic Rb experiments.
FY11	ARO	Multi-Qubit Enhanced Sensing & Metrology	Govindan	Paola Cappellaro	Massachusetts Institute of Technology	Multi-partical quantum coherence and entanglement can be used as a powerful resource to improve imaging, sensing and metrology beyond the classical limit by exploiting multi-qubit systems. The goal of this MURI is to address the major roadblocks that currently hinder quantum sensors from reaching their full potential: the fragility of entangled states and the low fidelity of the control and readout of multi-qubit quantum systems.

FY11	ARO	Stress-Controlled Catalysis via Engineering Nanostructures	Stepp	William Curtin	Brown University	This project brings together a multidisciplinary team of scientists spanning chemistry, physics, materials science, and applied mechanics, to develop a scientific basis for controlling chemical reactions using applied stress, with particular application to catalytic processes. Enhanced control of chemical reactions has enormous and broad implications for energy generation and conversion, chemical synthesis, sensing, and material degradation. The use of mechanical stress or strain to augment traditional alloying methods provides an avenue both for fine-tuning reaction specificity and/or selective and active control
FY11	ARO	Scalable, Stochastic and Spatiotemporal Game Theory for Real-World Human Adversarial Behavior	Iyer	Milind Tambe	University of Southern California	This MURI seeks to produce fundamental advances in game theory and key scalable algorithms that are necessary for the next generation of solutions for adversarial games. Its three thrusts are scalable behavioral game theory, stochastic coalitional game theory, and spatiotemporal game theory.
FY11	ARO	Light Filamentation Science	Hammond	Martin Richardson	University of Central Florida	The objective of this MURI is to gain a qualitative and quantitative understanding of all the physical phenomena that are associated with light filaments.
FY11	ARO	Atomic Layers of Nitrides, Oxides, and Sulfides (ALNOS)	Varanasi	Pulickel Ajayan	William Marsh Rice University	The main objective of this MURI is to explore innovative top-down and bottom-up routes for the synthesis or isolation of high quality uni-lamellar sheets and ribbons of nitrides (e.g., hexagonal BN), oxides (ZnO, V2O5, TiO2 etc.), and sulfides (e.g., MoS2). The synthetic approaches will span from simple mechanical/chemical exfoliation techniques to controlled chemical vapor deposition. It is envisioned that several synthetic approaches that can be generically used to create atomic layers routinely from bulk layered structures as well as chemical precursors will result.

FY11	ARO	Value-centered Information Theory for Adaptive Learning, Inference, Tracking, and Exploitation	Dai	Alfred Hero III	University of Michigan	This effort seeks to provide theoretical and empirical methods for analysis and accurate prediction of performance using a new class of information measures that account for both quality and value of information. In particular, it seeks a foundational systems theory for active information gathering that uses new measures and derives a theory to develop highly adaptive and learning-based sensing strategies with significantly enhanced performance while not requiring user tuning. Finally, it applies these strategies to sensor signal processing, information fusion, and sensor platform control for next-generation sensing systems.
FY07	ONR	Exploiting Nonlinear Dynamics for Novel Sensor Networks (Topic: Exploiting Nonlinear Dynamics for Novel Devices)	Michael Shlesinger	Edward Ott	University of Maryland, College Park	This research is exploiting the extreme sensitivity of chaos, and the power of synchronization within a network, to design and build prototype detectors that are sensitive to change and have the following attributes: low power, jam resistant, compact and rugged. These nonlinear dynamical detectors can find application to sensing through walls, acquiring targets, sensing traffic movement, and for intrusion detection. The electromagnetic sensing involves RF frequencies employing a network of chaotic solid state devices, millimeter wave frequencies using a network of chaotic microwave time delay traveling wave tubes, optical frequencies using vertical cavity surface wave emitting lasers, and then low power acoustic detection (based on wave chaos concepts).

FY07	ONR	Chemical Discrimination and Localization Using Biologically Based Olfactory Processing (Topic: Exploiting Nonlinear Dynamics for Novel Devices)	Michael Shlesinger	H. Abarbanel	University of California, San Diego	This research effort will design, build and test a prototype device to sense odors, discriminate among odors, and locate their source. The odors of interest include explosive materials, toxic or corrosive chemicals, and bio-hazards. The classification of odors will employ a neuro-biologically inspired nonlinear dynamical system. The classification will depend on nonlinear signal processing. The tracking of an odor will depend upon nonlinear control mechanisms.
FY07	ONR	Foundational and Systems Support for Quantitative Trust Management (Topic: towards Trust Management in Service Oriented Architectures)	Ralph Wachter	Sampath Kannan	University of Pennsylvania	The project aims to obtain fundamental understanding of dynamic trust management in service-oriented architectures.
FY07	ONR	A Framework for Analyzing and Ensuring Trust in Service-Oriented Architectures (Topic: towards Trust Management in Service Oriented Architectures)	Ralph Wachter	Scott D. Stoller	State University of New York at Stony Brook	This project will develop languages, techniques, and tools for trust management in service-oriented systems.

FY07	ONR	From Individuals to Populations: Biologically-Informed Multi-Modal Situation Understanding with Sensor Networks (Topic: Disparate Sensor Based Situation	Behzad Kamgar-Parsi	Andrew Y. Ng	Leland Stanford Junior University	MURI team will develop a biologically-informed unified mathematical foundation for multi-modal scene understanding. This involves 4 main tasks: 1) developing algorithms for automatically learning succinct representations, 2) probabilistic information fusion, 3) developing robust, distributed probabilistic algorithms, and 4) perform testbed evaluation of methods.
FY07	ONR	Underwater Acoustic Propagation and Communications: A Coupled Research Program (Topic: Underwater Acoustic Communications)	Robert Headrick	J.C. Preisig	Woods Hole Oceanographic Institution	Using a team approach under the MURI program, the PI will: 1) Study and analyze small scale, upper ocean processes with respect to their temporal and spatial evolution and statistics, their predictability, and their impact on acoustic propagation; 2) Evaluate the Shannon capacity of the underwater acoustic channel under simplifying assumptions, and develop strategies for adapting signal modulation and coding parameters to maximize communications system performance with varying levels of channel state information (CSI); 3) Develop new adaptive temporal and space-time coding techniques and spatial and temporal modulation techniques to account for the characteristics of the underwater acoustic channel and the exploitation of CSI; 4) Execute field experiments to gather the data necessary to support the above objectives.

FY07	ONR	Impact of Oceanographic Variability on Acoustic Communications (Topic: Underwater Acoustic Communications)	Robert Headrick	W.S. Hodgkiss	Scripps Institution of Oceanography	Using a team approach under the MURI program, the PI will couple together analytical and numerical modeling of oceanographic and surface wave processes, acoustic propagation modeling, statistical descriptions of the waveguide impulse response between multiple sources and receivers, and the design and performance characterization of underwater acoustic digital data communication systems in shallow water. These models and statistical descriptions will be validated with experimental data and will enable the definition of a set of benchmark cases for use in exploring transmitter/receiver design and performance characterization in the deployment of diversity exploiting, digital data telemetry systems (point to-point and networked). Both fixed fixed (stationary) and moving source and/or receiver scenarios will be considered across bands of frequencies in the range 1 50 kHz.
FY07	ONR	Fundamental Physics Issues on Radiation Belt Dynamics and Remediation (Topic: Radiation Belt Dynamics and Energetics)	Robert McCoy	Dennis Papadopoulos	University of Maryland, College Park	A consortium under the aegis of the U. of Maryland will undertake an interdisciplinary investigation of the physics of energetic particles in the inner magnetosphere under natural and artificially enhanced conditions. Areas to be addressed include: a) particle losses in the inner magnetosphere; b) space and ground-base injection and amplification of ELF/VLF waves; c) natural and artificial duct formation; d) the transition from quasi-linear to monochromatic wave-particle interactions; e) contollled precipitation from ground-based ELF/VLF waves; f) artificial modification of energetic particle pitch angles; and g) enhanced ion precipitation by stimulation and enhancement of natural PcI pulsations.

FY07	ONR	System-Level Approach for Multi-Phase, Nanotechnology-Enhanced Cooling of High-Power Microelectronic Systems (Topic: Thermal Management for Advanced Electrical Systems)	Mark Spector	P.M. Norris	University of Virginia	This MURI effort will develop an integrated approach to reducing chip temperatures in large-scale and high heat flux, complex electronic systems using microfabrication, nanotechnology, and modern systems control strategies that will be applied for the first time to heat conduction and multi-phase heat transfer problems. The four primary thermal resistances, at solid/solid interfaces and three solid/fluid interfaces, in the overall system thermal circuit will be reduced through a combination of fundamental advances in thermal bonding technologies and enhanced boiling and condensation heat transfer at the nano and microscale in controlled refrigeration systems.
FY07	ONR	An Integrated Cellular Materials Approach to Force Protection (Topic: Light Cellular Structures for Force Protection)	David Shifler	H. Wadley	University of Virginia	These are for a MURI team: Dr. Haydn Wadley, University of Virginia, PI. The MURI task will investigate new lightweight volumetrically efficient concepts that will enhance both projectile impenetrability and blast resistance. These new concepts and design tools provide for passive and active protective protection from detrimental kinectic energy events by combining the attributes of cellular materials and high strength constituents. The fundamental interactions between air blast created shock waves and structures will be established, as well as the principles underlying penetration of optimized topologies by projectiles in topologically configured systems.

FY07	ONR	Cognitively Compatible and Collaboratively Balanced Human-Robot Teaming in Urban Military Domains (Topic: Human-Robot Interaction in Littoral and Urban Military Domains: Human-Unmanned Systems Interactions)	Thomas McKenna	Cynthia Breazeal	Massachusetts Institute of Technology	Funding is provided to develop the underlying principles, methodologies, and technologies necessary to engineer human-centric robot teammates that participate in a balanced collaboration with people in order to achieve a dramatic improvement in the flexibiility, robustness, and scalability of human-robot teams in dynamic and uncertain environments.
FY07	ONR	Effective Human-Robot Interaction under Time Pressure through Robust Natural Language Dialogue and Dynamic Autonomy (Topic: Human-Robot Interaction in Littoral and Urban Military Domains: Human-Unmanned Systems Interactions)	Thomas McKenna	Matthias Scheutz	University of Notre Dame	Funds are provided to design, implement and evaluate computational mechanisms that dramtically improve human-robot interactions in natural language under time pressure. It will build robotic systems of unprecedented interaction capabilities by integrating a robust lanuage processing system into the robots's cognitive architecture, and augmenting it with novel goal representations and planning algorithms and integrating instruction-based learning, using non-linguistic indicators to facilitate interactions and advance robot autonomy.

FY07	ONR	Capitalizing on Research on Animal and Human Brain Plasticity to Enhance Warfighter Training and Performance (Topic: Exploiting the Documented Plasticity of the Adult Brain to Create Superior Warfighters In Fast-Paced Close Quarters Combat)	Harold Hawkins	A. F. Kramer	University of Illinois	The specific tasks that will be performed to implement the research goals include: - Study to examine the efficacy of variable priority training as a means to enhance domain general training and transfer of executive control skills; - Study to examine single versus multiple game training as a means of enhancing domain general and domain specific transfer of training; - Study to examine the relative benefits of single versus multiple player game training as a means to enhance learning and domain general transfer of training; - Study to examine variable communications training in multi-player games as a means of enhancing team-based transfer of training; - Conduct non-human primate studies of training and transfer of attentional and exeutive control skills; - Develop computational models on the basis of non-human primate and humand psychophysical and neuroimaging data, of learning and transfer of domain-general and domain-specific skills of relevanct to the military.

FY07	ONR	Complex Learning and Skill Transfer with Video Games (Topic: Exploiting the Documented Plasticity of the Adult Brain to Create Superior Warfighters In Fast-Paced Close Quarters Combat)	Ray Perez	D. Bavelier	University of Rochester	This research effort consists of three major phases with each phase of this effort made up of specific areas of experimentation. These are: 1) Phase 1, to identify skills and brain systems that can be trained during this phase research will be conducted to document in detail which aspects of sensory, motor, attention, pattern learning, and recognition, working memory, and decision making process are modified by training. Associated neural changes will be characterized using human brain imaging; 2) Phase2, Investigation of task factors that optimize learning and learning transfer. This phase consist of analysis of expert game players using cognitive task analysis techniques, conducting studies of factors hypothesize to control learning including individual differences, and the development of a more general computational theory of complex learning; 3) Phase 3, development of a new approach to hybrid models of complex learning that include optimal principles of statistical learning, inference, planning and decisions-making under uncertainty, with hierarchically structured and symbolic forms of
FY07	ONR	Tailoring Multiscale Processes and Mechanisms to Control Energy Release of Energetic Materials (Topic: Reactive Material Dynamic Response and Energy Release for Mout Applications)	Clifford Bedford	Vitali Nesterenko	University of California, San Diego	Develop a fundamental understanding of the processes and mechanisms that control energy release for reactive material systems subject to dynamic stimulation. Demonstrate that and quantify how the mechanical properties, survivability, and reactivity of high density metal based compositions can be controlled based on microstructural design so that reactive material systems can be designed with properties tailored to specific applications.

FY07	ONR	Materials and Manufacturing Science and Engineering of Direct Methanol Fuel Cells (Topic: Processing and Production Science for Next Generation Fuel Cells)	Khershed P. Cooper	Arumugam Manthiram	University of Texas at Austin	This MURI project will develop high energy density direct methanol fuel cells at low cost utilizing novel materials and advanced manufacturing technologies.
FY08	ONR	DRIFT: Design-for-Reliability Initiative for Future Technologies (Topic: A 21st Century Approach to Electronic Device Reliability)	Paul Maki	Umesh Mishra	University of California, Santa Barbara	Funds are provided to develop new methods and physical models of assessing device lifetimes in semiconductor devices. This is a new start MURI for FY08, Entitled "Design-for-Reliability Initiative for Future Technologies (DRIFT)." The lead PI is Professor Umesh Mishra, the lead performer is the University of California, Santa Barbara.
FY08	ONR	Scalable Methods for the Analysis of Network-Based Data (Topic: Real-Time Methods for the Analysis of Networks)	Martin Kruger	Padhraic Smyth	University of California, Irvine	The proposed research will produce new statistical estimation techniques for network data as well as new algorithmic techniques that will extend statistical network estimation methods to much larger data sets than can currently be handled. In addition, new statistical network models to handle heterogeneous combinations of dynamic, spatial, textual, and attribute/covariate data will be developed and applied to large realistic network data sets. The algorithms and methods developed as part of this research will be deployed in open source network modeling software packages such as R, leveraging the past experience of the team in software development.

FY08	ONR	Next Generation Network Science (Topic: Real-Time Methods for the Analysis of Networks)	Donald Wager	Michael Kearns	University of Pennsylvania	PIs will develop a broad-based, cross-disciplinary research program focused on rigorous, scalable, and provably correct analysis of networks and network data.
FY08	ONR	Towards a Mission Configurable Stealth Underwater Batoid (Topic: Biologically-Inspired Autonomous Sea Vehicles)	Robert Brizzolara	Hilary Bart-Smith	University of Virginia	Task I: A Biological Study of the Batoid Ray will be carried out to determine the key features that influence its propulsive and maneuvering capabilities, specifically, the swimming motions, three dimensional geometry and anatomy, and material properties. Task II: Structures and Control Strategies will learn from and utilize the biological findings to develop an artificial morphing wing, which will be used as a test bed in the hydrodynamic and hydroacoustic study of the manta ray. Task III: Hydrodynamics of Flapping and Undulating Propulsion will study, experimentally and numerically, a flexible fin actuated in a traveling wave motion (undulation) and flapping (oscillation), and establish the key requirements on gait and frequency for efficient swimming. Task IV: The Hydroacoustic Signature of the pectoral fin will be analyzed and strategies developed to maximize the stealth capabilities of the vehicle. Task V: Integration of these components to produce BAUV will be carried out to produce a first generation batoid-like AUV.

FY08	ONR	Jelly Fish Autonomous Node and Colonies: Modeling Biological Structure and Behavior, System Architecture Design and Implementation (Topic: Biologically-Inspired Autonomous Sea Vehicles)	Robert Brizzolara	Shashank Priya	Virginia Polytechnic Institute and State University	(1) Modeling of the bio-mechanics, hydrodynamics by incorporating micro-fluidics and jellyfish locomotion. Emphasis will be placed on: (i) developing a mechanics of motion that is energy efficient, so that persistence as a platform can be achieved; (ii) trading off size with power restrictions; and (iii) developing means of moving both vertically and horizontally. (2) Developing polymer composites (IPMC's, and PPy/PVDF/PPy) based muscles with appropriate trade-offs of force and displacement, and of fuel powered nanotube yarns for some minimal skeletal support. Fabricate nanocomposites based acoustic encapsulants. (3) Incorporating sensors into the jellyfish tentacles including pressure and acoustic, shear, velocity, chemical, and magnetic. These will enable maneuvering, positioning, and detection functions that will be necessary for a mobile platform of sensors that is autonomous. (4) Incorporation of energy harvesting functions. This is critical to persistence, and thus to the overall mission. In considerations of the energy restrictions of the undersea environment, it will be necessary to incorporate numerous mechanisms including mechanical, thermo-mechanical, acoustic, and chemical/biological. (5) Incorporating (limited) digital logistics, so that the sensorial perceptions can be forwarded by communications, when triggered by alarm.

FY08	ONR	A Structural Approach to the Incorporation of Cultural Knowledge in Adaptive Adversary Models (Topic: Socio-Cultural Modeling for Understanding Asymmetric Threat Environment)	Rebecca Goolsby	Kathleen Carley	Carnegie Mellon University	The overall goal of this multidisciplinary research is to develop grounded context-sensitive theories of adaptive adversarial behavior; theoretically-based, flexible, robust & scalable computational techniques for assessing, modeling & predicting the adaptive behavior of adversaries in asymmetric threat environments; & to enable a leap in social theorizing about adversarial adaptation by creating a context-sensitive strategic dynamic network perspective that is sensitive to issues of deception & uncertainty. By context we mean the cultural, ecological, economic, social, political, infrastructural, military & historical factors in the situation. The initial domain of study will be Sudan, with a secondary focus on Darfur & the sub-group & resource-based conflict in that area & associated instances of deception & strategic behavior that may serve as tipping points to/away from stability. From there we will move to other types of conflicts in Sudan, & then Afghanistan. Possible extensions include conflict assessment in Korea, Indonesia, Iraq, & Somalia.
FY08	ONR	Multidisciplinary Agent-Based Modeling of a Conflict Region Using Socio-cultural and Evolutionary Dynamics (Topic: Socio-Cultural Modeling for Understanding Asymmetric Threat Environment)	Rebecca Goolsby	Richard Cioffi-Revilla	George Mason University	The team will adapt and extend agent based models and cellular automata simulations to address problems posed by the civil strife problems in Sudan.

FY08	ONR	Remote Multi-Model Biometrics for Maritime Domain (Topic: Biometrics in the Maritime Domain)	Thomas McKenna	Ramalingam Chellappa	University of Maryland, College Park	Image processing and biometric matching algorithms will be developed to create the ability to extract biometric information from people in the maritime domain, and at a distance.
FY08	ONR	HUNT: Heterogeneous Unmanned Networked Teams (Topic: Biologically-Inspired Approaches for Team and Coalition Adaptation of Heterogeneous Unmanned Systems for Surveillance over Large and Complex Areas)	Mark Steinberg	George Pappas	University of Pennsylvania	FY08 funds are provided for research in biologically-inspired team and coalition formation for Intelligence, Surveillance, and Reconnaissance (ISR) of complex areas. 1. Cataloging, modeling, and analysis of biological behaviors - Cataloging group behaviors in biology involving cooperation among different species or the allocation of tasks and differentiated role assignments in groups of intelligent animals. Mathematically modeling cooperative behaviors for various animals with an emphasis on heterogeneous cooperation and cross-species cooperation modeling abstractions 2. Biologically-inspired heterogeneous cooperation - Coalition formation models as the basis for the cognitive coordination of teams of heterogeneous robots coalescing to solve difficult surveillance problems. Biologically-inspired and distributed auction-based algorithms for differentiated role, target, and task allocation. Bio-mimetic approaches for addressing complex multi-player, multi-objective games with groups of heterogeneous vehicles using not only static but also dynamic strategies employed by social animals. 3. Cooperative behaviors in communications degraded environments - Distributed methods for maintaining robustness to communications limitations among teams and coalitions of unmanned systems. 4. Optimization based approaches for complex spatio-temporal specifications - Optimization-based approaches for control and planning of heterogeneous unmanned vehicles with spatio-temporal

FY08	ONR	Modular Social Intelligence for Teaming and Coalition Adaptation of Heterogeneous Autonomous Cooperative Agents (Topic: Biologically-Inspired Approaches for Team and Coalition Adaptation of Heterogeneous Unmanned Systems for Surveillance over Large and Complex Areas)	Mark Steinberg	Richard Granger	Dartmouth College	FY08 funds are provided for research in biologically-inspired team and coalition formation for Intelligence, Surveillance, and Reconnaissance (ISR) of complex areas. Development of dynamic teaming and coalition forming theories rooted in modular social intelligence exhibited by high-functioning mammals. Identification of relevant social intelligence models - Develop and embody relevant concepts from biological systems of high-functioning mammals within Autonomous Cooperative Agents (ACA) such as cooperation strategies, social hierarchies, selective recruitment and teaming, stable first-order coalitions, and innate knowledge of roles and responsibilities of others. Mathematical modeling in support of satisficing algorithms for dynamic teaming and coalition forming. Mathematical models of systems of ACAs and individual ACA subsystems - Develop models of systems of ACAs, and subsystems of appropriate complexity and level of abstraction abstract while allowing individual behavior that results in the emergence of unique and useful teaming behaviors. Subsystems to be modeled include mobility/vehicle dynamics, sensor dynamics, and communication dynamics. Begin development of a simulation-based evaluation approach that allows evaluation of sensitivity and performance of surveillance tasks.

FY09	ONR	How Unsupervised Learning Impacts Training: From Brain to Behavior (Topic: Cellular, Molecular, Correlates of Training)	Ray Perez	Howard Poizner	University of California, San Diego	The proposed research project consists of seven major tasks (projects). These are: (1) Mapping memory of synaptic changes that occur in rostral hippocampus of rats during unsupervised learning and then expand the mapping process to the entire hippocampus and frontal association region; (2) Develop unsupervised learning algorithms and modeling of the cortical circuits and synaptic plasticity that account for unsupervised learning; (3) Conduct training studies to determine the trade-off between unsupervised learning and supervised learning and determine the effects of various training strategies such as temporal spacing and interleaving of different categories (e.g., colored shapes); (4) Investigate the underlying brain dynamics of unsupervised spatial learning in a large scale immersive virtual environment using high density EEG and spectral analysis; (5) Conduct studies on unsupervised learning of category learning, the studies will combine simultaneous fMRI-EEG with imaging genetics to investigate the neurophysiological substrates and dynamics of unsupervised category learning and their modulation by training; (6) Conduct studies on unsupervised spatial learning using a virtual environment as their experimental test bed measures EEG-fMIR of human subjects will be used while subjects are receiving unsupervised training. These studies are designed to parallel those studies described in task 1 with rodents; and (7) Conduct studies on the genetic control of dopaminergic-dependent learning in drosophila, leveraging on the shared

FY09	ONR	From Attentive to Automated Performance: A Multi-Scale, Multi-Species, and Multi-Modal Investigation of Spatial Learning (Topic: Cellular, Molecular, Correlates of Training)	Roy Stripling	Giorgio Ascoli	George Mason University	Continuous training in both humans and rodents produces a first transition from naive to expert attentive performance (requiring conscious effort, but modulable by variable cues), and a later shift to automatic performance (effortless but more fixed motor sequence). Acquisition of attentive and automatic skills occurs in distinct brain regions, namely hippocampus and striatum, overseen by neocortex. However, their complex dynamics in the attentive to automatic shift, the underlying network & cellular mechanisms, and the molecular correlates of the large intersubject variability, are poorly understood. We propose a unique multi-scale, multi-species, and multi-modal investigation to quantify these factors. This will enable the development and assessment of training protocols to enhance the operational performance of warfighters. We will use a technical approach integrated across levels, from molecular, through cellular, to systems, in rodent & human studies of spatial navigation learning, complemented by computational modeling. For clarity of exposition, the work is organized according to three tasks (T1-T3). Deliverables: Purchase equipment, train graduate student and postdocs to perform experiments and simulations. Neuronal activation (rats): electrodes implant surgery, recovery, maze testing. Sacrifice animals, section, label for Arc and Homer. Computational modeling: program LTD in striatum and hippocampus. Implement SPN-FSN neuron network using temporary spike based learning rule. Develop and
FY09	ONR	Infiltration of Botnet Command-&-Control and Support Ecosystems (Topic: Removing the Botnet Threat)	Ralph Wachter	Stefan Savage	University of California, San Diego	The proposed research addresses fundamental aspects of malicious overlay networks and practical approaches to the removal of botnets as a strategic threat.

FY09	ONR	COVERT: Botnet Attribution and Removal: from Axioms to Theories to Practice (Topic: Removing the Botnet Threat	Ralph Wachter	Wenke Lee	Georgia Institute of Technology	The proposed research addresses fundamental aspects of malicious overlay networks (i.e., the kinds that botnets represent) with developing comprehensive, practical approaches to the removal of botnets as a strategic threat.

FY09	ONR	ANTIDOTE: Adaptive Networks for Threat and Intrusion Detection or Termination (Topic: Highly Decentralized Autonomous Systems for Force Protection and Damage Control)	Mark Steinberg	Gaurav Sukhatme	University of Southern California	FY09 funds are provided for research in Highly Decentralized Autonomous Systems for Force Protection and Damage Control. FY09 funding is provided to begin research in: Biological Inspiration and Modular Enginering Design - Catalog and study frequent important relationships in nature as relevant to robust, adapative systems for force protection and damage control. Bottom-up Synthesis of Intelligent Autonomous Behavior - Study modular design via the paradigm of sequential, parallel, and hierarchichal composition to develop formalism for such complex tasks as perimeter defense, vulnerability assessment and detection/pursuit of intruders. Coverage for Perimeter Defense and Repair (Choset, Ghrist, Rus, Sukhatme) - Develop a two-pronged approach to a broad class of coverage problems, entailing distributed methods for (1) rigorous certification of coverage, defense, and non-invasion, robustness to intelligent adversarial decoys; (2) optimal probabilistic coverage. The latter will draw from multi-vehicle navigation, Bayesian inference and hybrid control. The former draws on topological methods for generating certificates, and is intended to operate in the regime of abundant resources and/or heightened need for guaranteed security. Agent-centered Heuristic Search - Design agent-centered search methods for each robot to allow it to plan in real-time. Multi-agent Planning under Uncertainty with Repeated Searches - Investigate how planning with repeated searches can apply to the problems

FY09	ONR	Figure-Ground Processing, Saliency and Guided Attention for Analysis of Large Natural Scenes (Topic: Bio-inspired Autonomous Agile Sensing and Exploitation of Regions of Interest within Wide Complex Scenes)	Thomas McKenna	Ernst Niebur	The Johns Hopkins University	Psychophysical and neurophysiological studies of visual attention will inform development of novel cognitive saliency maps. 1. The neurophysiological basis of border ownership and figure-ground segregation in realistic and dynamic scenes will be studied. 2. A model of auditory cortical processing will be expanded to include formation of auditory objects. An explicit formulation will be made of attentional mechanism in auditory stream segregation. 3. Computational models will be developed to incorporate border-ownership rules of early cortex to determine proto-objects within visual and auditory domains. Psychophysical experiments will be conducted to distinguish the extent to which figure-ground information and spatio-temporal adaptation mechanisms are part of saliency based attentional selection. Software modules will be developed to integrate visual proto-objects and auditory cues. 4. The psychophysical influence of attention on auditory pop-out will be examined. 5. Visual psychophysical experiments to explore high-dimensional guidance in both artificial and realistic displays will be conducted. 6. Bottom-up saliency driven and top-down attentional selection will be incorporated into a single set of algorithms for efficiently searching natural scenes. 7. Concepts from prior tasks will be integrated into software and hardware architecture and tested in real-time surveillance tasks. 8. Engineering design criteria for the limitations of hybrid human-computer surveillance systems will be developed.

FY09	ONR	Decentralized Reasoning in Reduced Information Spaces (Topic: Computational Intelligence for Decentralized Teams of Autonomous Agents)	Behzad Kamgar-Parsi	James Bagnell	Carnegie Mellon University	Develop theory and computational methods for building decentralized teams of autonomous systems.
FY09	ONR	SMART Adaptive Reliable Teams for Persustent Surveillance (SMARTS) (Topic: Computational Intelligence for Decentralized Teams of Autonomous Agents)	Behzad Kamgar-Parsi	Daniela Rus	Massachusetts Institute of Technology	Develop hierarchical intelligence architecture and supporting algorithms for single agents as well as groups of agents. Perception, reasoning, learning, control, and human interaction map to this architecture.

FY09	ONR	Dynamic Camouflage in Benthic and Pelagic Cephalopods: An interdisciplinary approach to crypsis based on color, reflection, and bioluminescence (Topic: Dynamic Biological Adaptations to the Undersea Light Field)	Joan Cleveland	Sonke Johnsen	Duke University	Marine animal responses to the time-dependent, underwater light field will be investigated as it relates to camouflage and signaling.
FY09	ONR	Biological Response to the Dynamic Spectral-Polarized Underwater Light Field (Topic: Dynamic Biological Adaptations to the Undersea Light Field)	Joan Cleveland	Molly Cummings	University of Texas at Austin	Marine animal responses to the time-dependent, underwater light field will be investigated as it relates to camouflage and signaling.

FY09	ONR	Unified Theories of Language and Cognition (Topic: Grounding Language Understanding in Cognitive Architecture)	Paul Bello	Nicholas Cassimatis	Rensselaer Polytechnic Institute	Year 1: Team meetings at RPI (after 6 months), ASU (after 12 months). Design representational formalism for knowledge and beliefs for new architecture. Design and implement focused inference mechanism for these structures. Use the architectural formalism to encode syntax, semantic, and pragmatic knowledge. Use architectural formalism to encode dialogue-level concepts, constraints, and skills about extended dialogue, including knowledge about joint activities and shared goals. Develop and extend tools for constructing and organizing large-scale domain and linguistic knowledge bases. Do cognitive task analysis of domains where language supports joint activities. Collect, analyze, and annotate natural dialogues that arise in these domains. Produce reports on architectural design, knowledge bases, cognitive task analysis, and dialogue analyses. Year 2: Team meetings at UMBC (after 6 months), USC (after 12 months). Adapt inference mechanism to abduction, skill execution and problem solving. Use abduction mechanism to comprehend challenging utterances. Utilize the abductive reasoning mechanism to understand the meaning and flow of extended dialogues, including inference of common ground. Translate OntoSem knowledge for sentence processing into the architectural formalism. Demonstrate that the unified architecture, given relevant knowledge, qualitatively addresses aspects of language identified as challenges. Produce first documentation for new

FY09	ONR	Functionalized Nanoscale Graphene: A Platform for Integrated Nanodevices (Topic: Tailoring Electronic Bandgap of Nanostructured Graphene)	Chagaan Baatar	Michael Crommie	University of California, Berkeley	Funding is provided to the MURI team to carry out a series of investigations designed to understand and utilize bandgap in graphene. Specifically, the research consists of three main activities: 1) Nanodevice Architecture: Combine theoretical and experimental expertise to develop and fabricate new electromechanical-based, conductivity-based, optics-based, and spin-based nanodevice schemes involving graphene monolayers, bilayers, nanoribbons, and nanoplatelets; 2) Graphene Chemical Functionalization and Synthesis: Develop new techniques for engineering graphene structure, bandgap behavior, mechanical response, magneto-electronic behavior, and optical properties through chemical routes based on molecular functionalization of graphene sheets and ribbons, and reactive processing; 3) Microscopic Characterization: Develop new "interactive microscopy" techniques that allow both characterization and modification of functioning nanodevices at the atomic scale.

FY09	ONR	Tailoring Electronic Properties of Graphene at the Nanoscale (Topic: Tailoring Electronic Bandgap of Nanostructured Graphene)	Chagaan Baatar	Michael Fuhrer	University of Maryland, College Park	Funding is provided to the MURI team to carry out a series of investigations designed to understand and utilize bandgap in graphene. Specifically, the research consists of three main thrusts: 1) Thrust 1: Theoretical understanding of graphene nanoribbons. The theoretical approach will be comprehensive, ranging from first-principles modeling of GNRs with edge disorder and chemical modification, to understanding interacting electrons in disordered GNRs. The activities in Thrust 1 will be closely coordinated with the work in other thrusts to obtain experimental input into the theoretical models; 2) Thrust 2: Control of graphene nanoribbon structure and properties. GNRs will be fabricated using both top-down (lithographic) and bottom-up (chemical) approaches. Since an eventual practical technology will likely be based on a top-down approach, we will focus on methods of preparing clean edges in lithographically-defined GNRs through chemical etching or chemical modification. GNR electronic properties will also be controlled by edge termination using controlled reaction at the low-coordination edge sites. The MURI goal will be to develop a top-down approach capable of producing GNRs of ~5 nm width (bandgap >250 meV) with chemical control of edge disorder; 3) Thrust 3. Characterization of graphene nanoribbons. Techniques will be developed to characterize the bandgap of GNRs using optical and THz spectroscopy, scanned probe techniques, as well as transport measurements. The atomic-scale structure of GNR

FY09	ONR	Graphene Approaches to Terahertz Electronics (GATE) (Topic: Tailoring Electronic Bandgap of Nanostructured Graphene)	Chagaan Baatar	Michael Strano	Massachusetts Institute of Technology	Funding is provided to the MURI team to carry out a series of investigations designed to understand and utilize the small bandgap in graphene. The key research tasks include: Development of the CVD growth of large-area graphene wafers. This task will be combined with an important characterization effort by Raman spectroscopy and electrical measurements. A detailed study of the microscopic disorder in the graphene devices will be performed using scanning single electron transistor microscopy. Graphene crystallographic and nanoribbon etching using Ni-nanoparticles. Bandgap engineering through e-beam and He-ion lithography, where graphene nanoribbons as narrow as 4 nm will be demonstrated. Use of electron transfer chemistries to passivate and sort graphene edges. In addition Joule thermal treatments will be used to improve the graphene crystallinitsy and edge quality. Simulations will be performed to determinf the effects of edge, Coulomb and phonon scattering in arbitrarily-shaped graphene nanoribbons. The team will develop a two-dimensional graphene device simulator, which will be integrated into a circuit level CAD tool.

FY10	ONR	Large-Area 3D Optical Metamaterials with Tunability and Low Loss (Topic: Optical Metamaterials)	Mark Spector	Nader Engheta	University of Pennsylvania	The MURI team will develop and put forward novel schemes and revolutionary concepts to design, analyze, fabricate and characterize optical metamaterials with low-loss, full three-dimensionality, tunability, broader bandwidth and large physical area, operating at IR and visible wavelengths. They will develop a variety of optimized designs for subwavelength inclusions forming optical metamaterials, exploring novel optimized geometries, such as nanorings, nanoblocks, and layered structures, particularly suitable for scalable configurations. They will apply sophisticated nanofabrication techniques suitable for 3D multimaterial construction of large-scale optical metamaterials. Finally, they will develop novel theoretical schemes, including various analytical and multi-scale computational methods, to better model the optical wave interaction in large-area 3D optical metamaterials.
FY10	ONR	Grid Cells and Cognitive Maps for Autonomous Systems (Topic: Adaptive Cognitive Maps for Autonomous Systems)	Thomas McKenna	Michael Hasselmo	Boston University	Research will be conducted on biologically-inspired mechanisms to enhance self-localization and mapping for autonomous vehicles and enhance interaction with human operators with improved spatial representations. The research consists of 4 projects: 1) Nonlinear dynamic models of grid cells for navigation including how sensory features can update grid cell firing; 2) Linking sensory input to spatial representations, developing models linking spatial location to landmarks and cues; 3) Biologically inspired algorithms for navigation. This includes 3D navigation for microflyers and UUVs; 4) Linking spatial representations and communication.

FY10	ONR	Sound and Electromagnetic Interacting Waves (Topic: Non-linear Mediums Converting Frequencies of Propagating E/M and Pressure Waves)	Daniel Prono	Michael Steer	North Carolina State University	The performer will develop a solid understanding of acousto-electromagnetic (EM) phenomena. The purpose of this research is to begin developing acousto-EM sensors. Investigations of conversion between EM energy and acoustic energy will be explored as a solution to high atmospheric losses of ultrasound and millimeter wave signals, as well as absorptive and photoconductive effects.

FY10	ONR	Fundamental Research on the Biological Stability of Future Naval Fuels and Implications for the Biocorrosion of Metallic Surfaces (Topic: Biofuels: Microbial Communities, Biogeochemistry and Surface Interactions)	David Shifler, Linda Chrisey	Joseph Suflita	The University of Oklahoma	This is FY2010 MURI. Funds are Dr. Joseph Suflita. The MURI team seeks to explore the fundamental mechanisms of fuel- and biofuel-induced corrosion. An interdisciplinary investigative team from four universities will work to elucidate the connections between the chemical composition of the fuel and its propensity to undergo biodegradation and thereby accelerate biocorrosion. The work is designed to understand the physical, chemical, and biological nature of the underling processes so that diagnosis and mitigation efforts can be effectively targeted. The project is divided into 8 Technical Approaches (TAs), each of which has a series of objectives. The specific research work to be performed includes the following: following biodegradation pathways of fuel and biofuel components using 13C-labeled starting materials; modelling biodegradation kinetics; obtaining mechanistic correlations between fuel composition, extent of fuel degradation and biocorrosion; identifying problematic fuel components; developing predictive models for biomass growth and metal corrosion; molecular characterization of important microbial assemblages, chemical characterization of fuel and associated metabolites, microscopy and surface analytical characterization of corroded steel and of bioorganic minerals produced by biofilm assemblages to determine their inherent corrosivity. Collectively the research work will provide a scientifically defensible basis for assessing the biological stability of alternate fuels and

FY10	ONR	Rational Design of Advanced Polymeric Capacitor Films (Topic: Design, Synthesis, and Characterization of Electro-Active Polymers for Dielectric Energy Storage)	Paul Armistead	Rampi Ramprasad	University of Connecticut	ONR FY2010 MURI Topic 5: Rational Design of Advanced Polymeric Capacitor Films (Armistead, Lipkowitz topic authors): Professor Ramprasad and collaborators propose an approach that integrates DFT, molecular dynamics and Monte Carlo techniques through continuum breakdown modeling with the discovery approach of quantitative structure-property relationships to help define synthetic polymer targets among selected classes of polymers. They choose to start with silicon containing polymers to get higher permittivities than carbon-based polymers and will make block copolymers with and without conjugation. They propose to work on modified polyolefins as well as high temperature materials such as polyimides.
FY10	ONR	Rich Representations with Exposed Semantics for Deep Visual Reasonings (Topic: Reasoning for Image Understanding in Uncertain Environments)	Behzad Kamgar-Parsi	Martial Hebert	Carnegie Mellon University	Develop robust image understanding methods for building image/video-based surveillance systems.
FY10	ONR	Knowledge Representation, Reasoning and Learning for Understanding Scenes and Events (Topic: Reasoning for Image Understanding in Uncertain	Behzad Kamgar-Parsi	Song-Chun Zhu	University of California, Los Angeles	Develop the methods for building versatile and robust image/video-based surveillance systems.

FY10	ONR	Dielectric Enhancements for Innovative Electronics (DEFINE) (Topic: Fundamental Study of High- and Low-K Dielectrics for III-V Electronic Devices)	Daniel Green, Paul Maki	Umesh K. Mishra	University of California, Santa Barbara	Funds are provided to characterize and develop new dielectric materials for III-V/dielectric integration. This is a new start MURI for FY10, Entitled "Dielectric Enhancements for INnovative Electronics (DEFINE)" The lead PI is Professor Umesh Mishra, the lead performer is the University of California, Santa Barbara.

FY10	ONR	Animal Inspired Robust Flight with Outer and Inner Loop Strategies (Topic: Provably-Safe Perception-Based Control of Autonomous UAS Operations around Complex, Unstructured Terrain)	Mark Steinberg	Kristi Morgansen	University of Washington	This proposal was received and evaluated in accordance with {MURI BAA}. Award is recommended based on evaluation of the proposal (provided separately) in accordance with criteria stated in the announcement/solicitation. FY10 funding is provided to begin research in: Sensing, actuation and robust flight in biology - Begin tethered flight experiments to extend modeling, mechanosensing, and flight response to perturbations in animal organisms to more complex flow environments and to animal species spanning a range of body sizes and sensory modalities. Optimal sensing for near-field estimation - Using animal capabilities as models; create a link between the data collection features of a given type of sensing, the locations of those sensors on the flight vehicle, and the extent to which they enable the vehicle to realize a particular goal or task. A key point regarding sensor effectiveness in the applications at hand is that observability will generally be coupled to the flight dynamics that will be executed by the engineered vehicle. Bio-inspired reactive deconfliction, obstacle avoidance, and stabilization- Combine the biological models and data with the observability results to capture sensing and actuation capabilities and encode those basic principles into engineering algorithms for deconfliction and obstacle avoidance with probabilistic bounds on guaranteed performance. Initially, hybrid and potential field methods will be considered. Live animal tracking for deliberative

FY10	ONR	Provably-Stable Vision-Based Control of High-Speed Flight through Forests and Urban Environments (Topic: Provably-Safe Perception-Based Control of Autonomous UAS Operations around Complex, Unstructured Terrain)	Mark Steinberg	Russ Tedrake	Massachusetts Institute of Technology	This proposal was received and evaluated in accordance with {MURI BAA}. Award is recommended based on evaluation of the proposal (provided separately) in accordance with criteria stated in the announcement/solicitation. FY10 funding is provided to begin research in: Experiments with Birds Flying in Cluttered Environments including (a) Flight through an artificial forest with variable luminance and (b) Visually guided control of flight through cluttered environments. Robust, Adaptive, Resource-Limited Vision - Estimate egomotion, optical flow, depth, traversability labels and controls for reactive obstacle avoidance. Real-time, Provably-Stable, Nonlinear Control - Extend rigorous algebraic verification techniques to efficiently handle the nonlinearities in aerodynamic models with geometric obstacles. Deep Integration of Perception and Control - Develop theory to extend probably-approximately correct (PAC) analysis to provide aggressive probabilistic bounds on stability. Tight Coupling between Biology and Engineering - Biologically-motivated, learning and adaptive computer vision and Bootstrap engineering solutions of biology's problems.

FY10	ONR	Dynamical Systems Theory and Lagrangian Data Assimilation in 4D Geophysical Fluid Dynamics (Topic: Dynamical Systems Theory in 4D Geophysical Fluid Dynamics)	Scott Harper	Larry Pratt	Woods Hole Oceanographic Institution	Funding is provided under the Multidisciplinary University Research Initiative (MURI) to support advances in the development of Dynamical Systems Theory and Lagrangian Data Assimilation in 4D Geophysical Fluid Dynamics. The objective of this effort is to provide the Navy with precise predictions of advective pathways throughout the water column which impact a number of Navy operations. The team consists of mathematicians, fluid dynamicists, physical oceanographers and operational modelers from 8 institutions. The work will be coordinated by the Principal Investigator, Dr. Larry Pratt, from the Woods Hole Oceanographic Institution. He has 15 years of experience applying dynamical systems techniques to fluid dynamics problems of oceanographic significance.
FY10	ONR	Remote Sensing and Data-Assimilative Modeling in the Littorals (Topic: Hyperspectral, Radar and EO/IR Signatures in the Littorals)	Thomas Drake, David Han	Andrew Jessup	University of Washington	Jessup will direct a team of investigators to study the remote sensing signatures of a number of littoral processes, including wave breaking, wave-current interaction, and sediment transport using radar, infrared and EO imaging modalities in concert with detailed groundtruth measurements. The observations will be assimilated into a physical model for waves, currents and morphology.

FY11	ONR	An Integrated Experimental and Computational Multiscale Immersed Particle-Continuum Approach to Modeling and Simulation of Multiphase Soil Failure Mechanics Under Buried Explosive Loading (Topic: Soil Blast Modeling and Simulation)	Billy Short	Richard A. Regueiro	University of Colorado Boulder	Program Title: An Integrated Experimental and Computational Multiscale Immersed Particle-Continuum Lagrangian-Eulerian Approach to Modeling and Simulation of Multiphase Soil Failure Mechanics under Explosive Loading Short statement of work: Funds are provided to UC Boulder to conduct scientific research involving experimental mechanics and computational modeling in soil blasts. The research program will result in a validated, computationally efficient, multiscale multiphase hybrid Lagrangian particle-continuum computational approach to predict blast wave propagation and soil ejecta motion resulting from buried explosives in natural soils, usable for simulating IED-vehicular interaction and design. This includes numerically predicting (i) the propagation of blast waves in soil (accounting for physics at grain to- application-blast length-and-time-scales); (ii) explosive device fragment interaction with soil; and (iii) the triphasic soil deformation, fracture, fragmentation and ejecta resulting from the detonation of a buried explosive device in various soil types (cohesive and cohesionless soils, dry to partially saturated and fully saturated). For the solid and liquid constituents, a Lagrangian multiscale particle-continuum computational approach naturally provides the transition from solid-like to fluid-like material state upon blast loading. The gas (i.e., air) constituent can most efficiently be modeled as a background Eulerian grid. The overall multiscale multiphase computational assembly will be validated by means of a

FY11	ONR	Nonparametric Bayesian Models to Represent Knowledge and Uncertainty for Decentralized Planning (Topic: Knowledge Representation and Reasoning for Decentralized	Behzad Kamgar-Parsi	Jonathan P. How	Massachusetts Institute of Technology	Develop decentralized planning methods for teams of autonmous agents operating in open environments; in particular develop nonparametric Bayesian approaches.

FY11	ONR	III-N Devices and Architectures for Terahertz Electronics (Topic: III-Nitride Terahertz Electronics - Scaling Strategies Beyond Silicon)	Paul Maki	Patrick Fay	University of Notre Dame	Funds are provided to develop new methods and physical models of assessing device lifetimes in semiconductor devices. This is a new start MURI for FY11, Entitled "III-N Devices and Architectures for Terahertz Electronics." The lead PI is Professor Patrick Fay; the lead performer is the University of Notre Dame. The MURI team will investigate the problem of providing significant gain and power at THz frequencies by all electronic means, through a multi-faceted, multi-disciplinary effort. An integrated program of research in materials, devices, electromagnetics, and characterization forms the core of the proposed effort. The device concepts around which this effort will revolve are based in the exploitation of gated tunneling, hot-electron injection, and resonant traveling-wave plasma amplification. Exploration of the relevant physics, engineering of physically-realizable implementations exploiting these physical mechanisms (including material growth, fabrication processing, and fully integrating the effects of electromagnetic propagation and interactions on the extrinsic device performance), and enhancement of the performance of devices through phonon engineering, in conjunction with a comprehensive program of characterization of the resulting devices and structures, form the basis for the proposed work plan.

FY11	ONR	Conductive DNA Systems and Molecular Devices (Topic: Charge Transport in DNA Molecular Wire)	Chagaan Baatar	Mark Ratner	Northwestern University	The MURI team will carry out the following tasks: Year 1: Build molecules for On-Wire Lithography (OWL) and break junction measurement. Construct robust, quantitative NEGF/DFT transport code. Begin quality comparisons with different levels of theory in the DFT. Compare to measurements using OWL, break junction. Begin pulling/transport calculations on simple duplexes. Ultrafast Raman and TREPR measurements on structure and relaxation of polarons. Build linker groups onto extended DNA structures (DX, PX, and TX). Build duplex structures that include GGG and other stoppers for transport at both ends (for capacitance applications). Year 2: Synthesize zA (replacement for A)-containing duplexes. Compare measured conductance to calculations and optimize zA/A ratio. Utilize OWL structures with differing metallic layers (e.g. Au/Ag) to construct directionallybiased junctions by orthogonal self-assembly. Complete break junction measurements on standard duplexes (with or without A). Compare with computations, construct able of conductance as determined by structural parameters. Ultrafast Raman and TREPR experiments on modified duplexes to determine polaron structure. Calculate fluctuation-induced broadening of duplex conductance; compare with break junction statistics. Dielectric spectroscopy on endstopped duplexes. Measure leakage currents, dielectric failure; Weibull analysis. Measure conductances of extended DNA structures including PX, DX, and TX motifs. Build PX-DNA

FY11	ONR	Environmental stress and human migration in a low-lying developing nation: A comparison of co-evolving natural and human landscapes in the physically and culturally diverse context of Bangladesh (Topic: Coupled Human-Landscape Interaction in Low-lying Coastal Environments)	Thomas Drake	Steven Goodbred, Jr.	Vanderbilt University	Goodbred and collaborators will collect and analyze new and existing data about environment-migration relations in Bangladesh, the world's 7th most populous nation. Specifically, the team will seek (1) to understand environmental factors that affect migration decisions; (2) to determine how these factors differ within and across particularly vulnerable social and environmental landscapes of Bangladesh; and (3) perhaps most importantly, to assess how these variables interact and co-evolve to define the continually changing relationship between humans and their environment.
FY11	ONR	Integrated Modeling and Analysis of Physical Oceanographic and Acoustic Processes (Topic: Integrated Oceanographic, Atmospheric, and Acoustic Physics)	Robert Headrick	Timothy F. Duda	Woods Hole Oceanographic Institution	Using a team approach under the MURI program, the PI will conduct an integrated ocean fluid physics and acoustics study with the goal of creating a broadly applicable and portable continental shelf-area acoustic prediction capability that includes the effects of internal and surface gravity waves as well as effects of the more commonly handled subtidal-frequency large-scale processes. The team will integrate acoustics and ocean physics and increase the predictive capability for coupled 4D NIW and acoustics fields. Major technical developments will be the nesting of nonhydrostatic pressure (NHP) models inside HP models, improved 4D acoustic modeling, and improved tools for quantifying means and variances of tidally and subtidally determined flow fields and sound fields.

FY11	ONR	Mountain Terrain Atmospheric Modeling and Observations (MATERHORN) Program (Topic: Improved Meteorological Modeling in Mountainous Terrain)	Ronald Ferek	H. J. S. Fernando	University of Notre Dame	Funds are provided to conduct research to improve the understanding of winds, moisture, turbulence, subgrid processes and their variability in mountainous terrain utilizing a combination of observations, modeling, and theoretical analysis. A multidisciplinary team has been assembled that includes atmospheric scientists, geophysicists, numerical/theoretical analysts, engineers and applied mathematicians from five academic institutions and three Army and Navy laboratories (DPG, NRL and ARL). Field work will be conducted at the Dugway Proving Ground (DPG) instrumented test range in order to leverage the extensive observation network available there.

FY11	ONR	Utilizing Synthetic Biology to Create Programmable Micro-Bio-Robots (Topic: Bacterial or Cellular Controllers for Device Autonomy)	Linda Chrisey	James Collins	Boston University	This effort proposes to develop a generalizable platform for the two-way interfacing of synthetic biological systems with non-living systems. Environmental signals such as explosives toxins, metals, salinity, pH, temperature and light, will be detected by synthetic biosensors and bioprpocessors that function in living cells that are located in hybrid micro-bio-robots (MBRs). These MBRs, 10-100 micronometers in length, will be composed of microbes associated with non-living substrates and will be designed to function in teams which can interrogate and modify their environment as well as coordinate their behavior with each other and with larger chaperone robots, 10-100 cm in length. Two-way communication between MBRs and chaperone robots will enable complex tasks to be executed at different physical and time scales. Finally, the chaperone robots will be capable of receiving external signals or instructions and passing this information via electrical, chemical, optical or mechanical signals onto the MBRs.

FY11	ONR	Roll-to-Roll High Speed Printing of Multi-functional Distributed Sensor Networks for Enhancing Brain-Machine Interface (Topic: NanoScience−based High-Speed Fabrication of Full Function Hybrid Flexible Electronic Systems)	Khershed Cooper	C. Daniel Frisbie	University of Minnesota	The integration of electronic circuits into flexible, stretchable, conformal, impact resistant and large area formats will greatly expand the application space for microelectronics and deliver new functional capabilities in areas relevant to both national security and the US economy, e.g., radiation detection, health diagnostics, distributed sensing, information display, identification tagging, inventory tracking, robotics, and human-machine interfacing. The proposed research will develop the fundamental knowledge base for high-rate nanomanufacturing of full-function hybrid flexible electronic systems and the basic science needed for building high speed, power efficient, high-density devices on flexible substrates for a variety of applications.

FY11	ONR	Tailoring of Atomic-scale Interphase Complexions for Mechanism-Informed Materials Designs (Topic: Atomic-Scale Interphases: Exploring New Material States)	David Shifler	Martin Harmer	Lehigh University	These funds are for Dr. Martin Harmer for FY 2011 MURI. To meet these ambitious goals, a highly integrated experimental and computational program employing multiscale computations combining density functional theory, molecular dynamics, phase field, Potts model, and thermodynamic models will be correlated with multiscale materials characterization. Interphase structure and chemistry will be characterized via atomic-scale aberration corrected electron microscopy, and related to microstructures characterized using advanced three-dimensional orientation mapping techniques. The stability of these interphases will be probed as a function of relevant thermodynamic variables, and their mechanical, electrical, thermal, and diffusional properties will be measured explicitly. These experimental and computational data will be correlated to optimize strategic engineering materials, develop processing strategies for bulk nanomaterials, and develop new classes of materials with unique properties. The effort will develop interphase complexion diagrams analogous to phase diagrams, together with processing maps and property maps essential for engineering the types of materials developed in the program. Three major thrusts make up the proposed hypothesis-driven effort, which include: 1) the creation of entirely new classes of materials with tailored properties; 2) the exploitation of interphase complexions (ICs) in the processing of bulk nanograined materials; and 3) the use of ICs for controlling

FY06	AFOSR	Fundamentals and Bioengineering of Enzyamtic Fuel Cells	Walter Kozumbo	Plamen Atanassov	The University Of New Mexico	In a pioneering effort that bridges bio-electrochemistry and synthetic biology, the MURI team has developed protocols for fabrication of bio-electrodes with multi-enzyme cascades and methods for characterization of multi-enzyme cascades for complete oxidation of pyruvate and ethanol through the employment of Krebs cycle enzymes, immobilized on a biofuel cell electrode. For a first time, a biomimetic Krebs cycle oxidative pathway has been demonstrated. Two strategies for incorporation of dehydrogenases were explored: one based on developing catalyst for NADH oxidation and a second one based on synthetic engineered NAD analog for stability. The team has developed hierarchically-structured materials based on conductive 3D chitosan CNT scaffolds, which were used for a broad range of biomaterial applications, including those that immobilize enzyme catalysts or whole microorganisms and biofuel cell approaches. The materials were used in preparing 3D flow-through anodes that utilize the catalysts for NADH oxidation. In a parallel effort enzyme electrodes for oxygen reduction were developed as self-standing air-breathing cathodes. They were integrated with the flow-through anodes to demonstrate the operation of a complete biofuel cells. This allows to both evaluate the power source performance and to extrapolate the trends for the future design of a new generation of energy harvesting devices.

FY06	AFOSR	Three-Dimensional Approaches to Assembling Negative Index Metamedia	Harold Weinstock	Roberto Merlin	University Of Michigan	Progress has been achieved in the following areas: (i) the design of plasmonic near-field plates for visible operation and corrugated near-field plates for point focusing; (ii) synthesis of gold nanoparticle patterns; (iii) persistent tuning of metamaterials properties; (iv) experimental demonstration of the magnetic moment of a self-assembled cluster of plasmonic nanoparticles; (v) focused-ion-beam synthesis of nanostructure ar-rays; (vi) search for negative index in chiral molecule composites; (vii) experimental demonstration of negative-index waves in indefinite-permittivity media; (viii) sub-wavelength mid-IR superlensing; and (ix) experimental demonstration of negative-index propagation in sub-wavelength plasmonic metamaterials. We also describe advances in the homogenization theory of arbitrary plasmonic and RF metamaterials and the understanding of bulk properties of low-loss periodic negative index structures, as well as results revealing a close relationship between the dynamic magnetic properties of metamaterials and the permittivity of the inclusions, which impose stringent limits to high-frequency magnetism.

FY06	AFOSR	Bioengineered Fuel Cells: Optimization via Genetic Approaches and Multi-Scale Modeling	Robert Hearn	Kenneth Nealson	University Of Southern California	This MURI aims to understand and optimize the microbial mechanisms involved with current production. The approach to this effort is three-fold: 1) identification and regulation of the molecular machines responsible for current production, 2) modeling and bioengineering microbial fuel cells, and 3) development and exploitation of microbial consortia with the ability to utilize a wide range of energy sources and operate over a wide range of environmental conditions. The first major accomplishment was the identification of the genes involved with catalysis of the cathode reaction. While these genes have not been completely identified, it is now clear that under different conditions, different genes are used, and that the pathway of electron uptake is, under all conditions so far tested, different from the pathway of electron donation.

FY06	AFOSR	Specification, Design and Verification of Distributed Embedded Systems	Fariba Fahroo	Richard Murray	California Institute Of Technology	This project is aimed at developing a common framework and the requisite theory for formal analysis and reasoning about continuous controllers, dynamical systems and concurrent, loosely synchronized supervisory control structures. The objective of this research is to investigate the specification, design and verification of distributed systems that combine communications, computation and control in dynamic, uncertain and adversarial environments. The goal is to develop methods and tools for designing control policies, specifying the properties of the resulting distributed embedded system and the physical environment, and proving that the specifications are met. So the problem is partitioned into three parts: 1) Specification: how does the user specify continuous and discrete control policies, communication protocols and environment models? Graph grammars and Sum Of Squares techniques will be used; 2) Design and reasoning: how can engineers reason that their designs satisfy the specifications? Automated proof techniques will be used; and 3) Implementation: what are the best ways of mapping detailed designs to hardware artifacts, running on specific operating systems? What languages are suitable for specifying systems so that the specifications can be verified more easily? These methods will be tested on two testbeds developed at Caltech: the multi-vehicle wireless testbed (MVWT) and "Alice", an autonomous vehicle that competed in the 2005 DARPA Grand Challenge

FY06	AFOSR	A Multidisciplinary Approach to Health Monitoring and Materials Damage Prognosis	David Stargel	Aditi Chattopadhy	Arizona State University	This project aims to produce a major advance in the ability to provide reliable life cycle estimates for current and future aircraft systems. The current states of structural health monitoring (SHM), damage diagnosis and prognosis will be transformed by the introduction of a hierarchical framework of sensor data, information, models and algorithms that span and integrate scales from microstructure to structural level. Sustainment and life-cycle engineering of aircraft and propulsion systems represent major and growing challenges for the Air Force. The aging of the legacy aircraft fleet threatens to drive maintenance costs to unprecedented levels and to consume budget that would otherwise be available for operation and modernization. This research seeks to enable state awareness and physics-based lifetime prediction for aircraft systems, thus enabling more efficient fleet sustainment management.
FY06	AFOSR	Frameworks and Tools for High-Confidence Design of Adaptive, Distributed Emdedded Control Systems	Robert Herklotz	Janos Sztipanovits	Vanderbilt University	The objective of this research is to develop a comprehensive approach to the design of high-confidence complex embedded systems, that is, systems that are correct-by-construction, fault tolerant, secure and degrade gracefully under fault conditions or information attack. The approach integrates verification, validation and test procedures throughout the complete design, development and maintenance cycle for high-confidence complex embedded systems. The research areas are (1) hybrid and embedded systems theory, (2) model-based software design and verification, (3) composable tool architectures, and (4) testing and experimental validation.

FY06	AFOSR	Integrated Fusion, Performance Prediction, and Sensor Management for Automatic Target Expolitation	Hugh Delong	Randolph Moses	The Ohio State University	This effort supports research aimed at basic understanding of complex systems involved with aspects of automatic target exploitation, including signal processing and conditioning, information fusion, and pattern learning, and control for dynamic sensor arrays and moving platforms. This effort involves a multi-disciplinary approach to model single mode sensor data streams for detection and recognition, to integrate these models in an innovative hierarchical graphical model, and to use this model to estimate current states used for statistical state estimation for control of sensors, their modes, and orientations. This multi-disciplinary approach is expected to provide principled understanding of the credit assignment problem inherent in complex, multi-layered systems involved. Future Air Force systems for detecting, identifying, and tracking difficult targets in complex environments will rely on managed suites of sensor information and other information combined and managed to maximize actionable information available for effective targeting. This effort contributes by developing the algorithms that such systems will require to manage and control the interacting systems involved.

FY06	AFOSR	Energy Harvesting and Storage System and Their Integration to AF Aero Vehicles	Les Lee	Minoru Taya	University Of Washington	This project aims to accomplish the following: (a) To develop a scientific foundation for the design and manufacture of "self-powered" load-bearing structures with integrated energy harvest/storage capabilities; and (b) to establish new multi-functional design rules of interdisciplinary nature for structural integration of various means of energy harvesting or their combinations. Self-powered load-bearing structures with integrated energy harvest/storage capabilities will be developed for both manned (MAV) and unmanned aerovehicles (UAV). A new design paradigm will be formulated to optimally integrate (i) energy harvesting systems including thermoelectric power generators and polymer solar cells and (ii) energy storage system including polymer battery cells and state-of-the-art supercapacitors. The Air Force will require aerospace vehicles and weapon systems with performance superior to those of any potential adversary. The establishment of "self-powered" structures with integrated energy harvest/storage capabilities along with adequate load-bearing capability will fulfill a key requirement for the improvement of structural performance and reliability of Air Force systems.

FY06	AFOSR	Self-Assembled Soft Optical NIMS	Les Lee	Peter Palffy-Muho	Kent State University	The goal of the MURI is the development of 3D bulk optical metamaterials, produced via self-assembly, for negative index, hyperbolic dispersion and other optical applications. Advances were made in the areas of synthesis & processing, characterization and theory and modeling. It was established that samples of aligned nanorods samples with high volume fractions are required to achieve the goals in optical performance. Samples with high loading are difficult to achieve; 90wt% corresponds to 33% by volume. Au NRs stabilized with thiolated polystyrene surfactants were suspended in both cyclic and linear polymer solvents. Samples with high loading were prepared, which showed an aligned liquid crystal phase. This is the first observation of a nematic phase of surface stabilized metallic NPs; the bulk samples retain the charactgeristic plasmon resonance signatures of the individual NRs. Such samples can be aligned by electric fields, as well as shear. Due to their switchability with fields, a new application of these materials may be for inexpensive displays and wavelengths which can be tuned by the aspect ratio of the NRs. Samples with high density of aligned Ag NRs were realized, whose optical transmittance shows negative index in the visible. Strategies for achieving chiral materials and for extracting their optical properties were developed. New chiral and achiral resonator structures were developed with huge optical susceptibilities. New results were obtained on dense packings of tetrahedra, which are promising isotropic

FY06	AFOSR	CARA: Cognitive Architecture for Reasoning About Adversaries	Terrence Lyons	Dana Nau	University of Maryland, College Park	This effort attempts to discover new theory and algorithms to estimate adversarial behaviors, learn based on observed behaviors, and maintain those models for strategy formation and evaluation. A theory of hybrid qualitative-quantitative probability rules will be developed and used as a framework for inferring likely adversarial behaviors based on past behavior and obtained estimates of attitude and intention. This framework will be examined via a new cognitive architecture based on game-tree search algorithms for an ability to explain, predict, and develop strategies based on existing data and new data obtained from an adversarial game test bed. Future Air Force operations will combine delivery of kinetic and non-kinetic influences on adversarial capability and intent in model-dependent ways that are currently understood to limited degrees. This effort contributes by developing theory and associated algorithms needed to inform commanders' decisions about best combinations of forces.
FY06	AFOSR	Infrared and Terahertz Lasers on Silicon Using Novel Group-IV Alloys	Gernot Pomrenke	Jose Menendez	Arizona State University	The objectives of this program are to develop new direct gap group IV materials and new families of lasers based on group-IV materials. The first family of lasers will consist of Ge(1-y)Sn(y) or Ge active layers, emitting light in the 1.9 – 3.0 microns range. The second family consists of intersubband quantum cascade lasers containing Ge(1-x-y)Sn(y)Si(x) and Ge(1-x)Si(x) layers and operating in the

FY06	AFOSR	Electrically-Pumped, Silicon-Based Lasers for Chip-Scale Nanophotonics Systems	Gernot Pomrenke	Lionel Kimerling	Massachusetts Institute of Technology	The objective is to investigate, design and develop a nanophotonic, silicon-based laser for monolithic, CMOS-compatible integration with electronic and photonic chip-level circuits. The aim will be to have a silicon-based laser that will be electrically pumped; have a high wall-plug-efficiency and low heat dissipation; have a long operating lifetime; and emit at a carrier frequency and output power that meet the expectation of a >10 Gbit/s optical communications link, operating at a Bit-Error Rate tolerance <10^-12. Two principal challenges will be high lasing efficiency cavities and high gain efficiency media.
FY07	AFOSR	Quantum Simulations of Condensed Matter Systems Using Ultra-Cold Atomic Gases	Tatjana Curcic	Markus Greiner	Harvard University	This project aims to build quantum simulators to perform analog simulations of strongly correlated many-body quantum systems. The approach selected is to use ultra-cold atoms in optical lattices to simulate Hamiltonians that are thought to be important for high temperature superconductors and other novel electronic and magnetic materials. These Hamiltonians are intractable mathematically but can be simluated exactly in the optical lattice system. In the first phase, they will simulate basic fermionic and bosonic Hubbard Hamiltonians, validate, and verify the results by comparison to theory. In parallel efforts, they will develop a set of new and advanced tools and methods to simulate more complex lattice systems. In the second phase, they will combine the results of phase one and the newly developed tools and methods to simulate d-wave superfluid states and quantum magnets. Both are at present not well understood by theory. The experimental results will be used to guide development of new theoretical models, and ultimately to identify new materials with desirable electronic and magnetic properties.

FY07	AFOSR	Generation of Comprehensive Surrogate Kinetic Models and Validation Databases for Simulating Large Molecular Weight Hydrocarbon Fuels	Chiping Li	Frederick Dryer	Princeton University	The objective of research is to generate a surrogate fuel model, cross-validated experimental data, detailed and reduced kinetic mechanisms, analytical tools, and experimental methods to predict accurately the complex gas-phase combustion behavior of real fuels using a limited number of chemical components. Based on a new principle to control kinetic and transport timescales of aliphatic and aromatic fuel mixtures, a small number of surrogate components will be selected that can match gas-phase combustion properties of real fuels. A cross-validated and comprehensive experimental database will be generated consisting of ignition delay, speciation, flame speed, ignition and extinction limits, and sooting characteristics for each component, mixtures of components, and real fuels. Single pulse shock tube and variable pressure flow reactor experiments will produce data for highly dilute reaction conditions, while rapid compression machine, laminar premixed and non-premixed flames, and turbulent combustor experiments will yield data for higher fuel-oxidizer ratios approaching those in real systems. Detailed kinetic models will be developed and validated based on computational theory and comprehensive hierarchical mechanism development approaches, guided by computational mechanism construction and utilizing in-house codes for mechanism behavior analysis. New kinetic reduction tools, including diffusion and temperature coupling, will be developed and used, together with

FY07	AFOSR	Autonomic Recovery of Enterprise-Wide Systems After Attack or Failure with Forward Correction	Robert Herklotz	Anup Ghosh	George Mason University	The objective of this project is to develop autonomic recovery and reconstitution techniques, which together is called self-regeneration, for enterprise systems, clients and servers, for both incidental failures and deliberate attack. Enterprise computing systems need to be not only highly available, but also highly resistant to attack. It is known that enterprise computing systems will fail due to software flaws, attacks, or hardware device failures. As a result, it is not adequate to assume that these systems will be able to always provide critical network services without building mechanisms that account for and handle these failures and reconstitution of service. This research directly supports the Air Force vision of information dominance and the development of effective, secure large information systems like the Joint Battlespace Infosphere, GIG and future airborne networks for C2 support to the warfighters.
FY07	AFOSR	Behavioral Dynamics in the Cooperative Control of Mixed Human/Robot Teams	Fariba Fahroo	John Baillieul	Boston University	The goal of the research is to develop new methods to capture, model, represent, and ultimately understand human behavior in military tactical scenarios involving autonomous and semi-autonomous vehicles.The research focuses on four interrelated thrusts: 1) a systematic study of psychological aspects of decision making under adverse conditions; 2) human-in-the-loop control and psycho-kinetics of motion control; 3) information flow and data fusion for human-in-the-loop; and 4) enhancements to testbeds and the design of supporting experiments.

FY07	AFOSR	Helix: A Self-Regenerative Architecture for the Incorruptible Enterprise	Robert Herklotz	John Knight	University of Virginia	The objective is aimed at understanding key aspects of cooperative distributed decision making, coordination, and distributed control of groups of humans and autonomous machines. Models will be developed of human relationships in organization, command, and social structures and in human-machine interactions in tactical operations. The goal of the research is to develop new methods to capture, model, represent, and ultimately understand human behavior in military tactical scenarios involving autonomous and semiautonomous vehicles. Recent research is reported on new methods to capture, model, represent, and ultimately understand human behavior in complex and even adversarial scenarios involving autonomous and semiautonomous machine agents. Principles and models of cognitive and social psychology play a major role in the work. A particular objective is to develop a fundamental understanding of how humans and autonomous machine agents can operate as teams to efficiently accomplish mission objectives. The research is focused on conditions in human-machine interactions in which humans may not perform well because of excessive worklload, inability to assimilate information, and various types of cognitive fatigue such as boredom and decreased attentiveness due to task repetitiveness. An equally important focus of the research is on how human behavior differs from ideal decision makers due to social factors includling pressure to conform, competitiveness

FY07	AFOSR	Bioinspired Supramolecular Enzymatic Systems	Hugh Delong	Chad Mirkin	Northwestern University	The Mirkin group has continued to develop new and powerful concepts in amplified chemical detection based on the idea that a small molecule recognition event can trigger the formation of a catalytic structure that can turn over a large amount of a chemical signaling agent. Indeed, new and sensitive detection systems reminiscent of the Polymerase Chain Reaction (PCR) for elemental anion (acetate) have been developed based upon Weak-Link Approach chemistry. Additionally, the Mirkin group has started to address a fundamental selectivity limitation with analyte detection and signal amplification using allosteric catalysts. Thus far, studies aimed at understanding small molecule binding with model Pt(II) complexes have been conducted, and a library of potential organic ligand effectors has been established. In the area of chemical detection the Mirkin group developed a new assay for the detection of elemental anions based on DNA-functionalized infinite coordination polymer particles, which avoids the use of previously utilized gold-based nanoparticles.
FY07	AFOSR	Dynamic Decision Making in Complex Task Environments: Principles and Neural Mechanisms	Jay Myung	James McClelland	Leland Stanford Junior University	The ability to optimize behavior in the face of uncertainty and competing goals is of crucial importance to national defense. Theoretical and experimental investigation of the dynamic processes underlying human decisions should increase understanding of human decision making abilities, how these abilities can be optimized, and what the limits are of these abilities. This project develops a neurodynamic theory of decision making, using a combination of computational and experimental approaches.

FY07	AFOSR	Biologically-Inspired Flight for Micro Air Vehicles	Douglas Smith	Kenneth Breuer	Brown University	The objectives of this work are to categorize the unique systems that bats employ to achieve their unparalleled flight capabilities, to develop quantitative models to describe those features and then to develop and validate model systems and design tools (both physical and computational) to mimic those systems.
FY07	AFOSR	Biologically-Inspired, Anisotropic Flexible Wing for Optimal Flappling Flight	Douglas Smith	Louis Bernal	University of Michigan	The goals of this work are to conduct coordinated theoretical, computational and experimental pursuits that will lead to the development and validation of new computational and modeling approaches for understanding and predicting the coupled fluid and structural dynamic response in the unsteady, low Reynolds number environment
FY07	AFOSR	Neutral Atmosphere Density Interdisciplinary Research (NADIR)	Cassandra Fesen	Jeffrey Forbes	University of Colorado Boulder	The objective of NADIR is to significantly advance understanding of drag forces on satellites, including density, winds, and factors affecting the drag coefficient. The project aims for a deeper understanding of the internal and external physical processes driving neutral density variability so that empirical models of neutral density will significantly improve. The research will also lay the foundation for a next generation hybrid physical/empirical
FY08	AFOSR	A 21St Century Approach to Electronics Device Reliability	Kitt Reinhardt	Mark Law	University of Florida	Predicting electronic device lifetime and failure mechanisms is notoriously difficult and the physics is not well understood. Yet, these predictive capabilities are critical to the success of all DOD systems. The goal of the proposed research is to develop tools and methods for accurate prediction of electronic device lifetime and failure mechanisms. The approach will be to develop comprehensive predictive capabilities using physics-based simulation, empirical measurements, and new characterization techniques. The program will develop design tools and protocols for predicting reliability of future electronic devices and create a library of established

FY08	AFOSR	A Framework for Managing the Assured Information Sharing Lifecycle	Robert Herklotz	Timothy Finin	University of Maryland, Baltimore County	This research will be framed by a set of AIS requirements relevant to applications found in the DoD, Government and industry. The significant research contributions of this project will include the definition of an AIS lifecycle (AISL) that is driven by the 4Vs (volume, veracity, velocity, vector) as well as cross-cutting requirements and the development of (1) a framework based on a secure semantic event-based service oriented architecture to realize the life cycle, (2) novel policy languages, reasoning engines and negotiation strategies, (3) techniques for information integration, analysis and quality, (4) secure knowledge management for AISL based on risk and incentives, and (5) techniques to exploit social networks to enhance AISL. For each of these areas, this research will make contributions to the underlying theory and algorithms as well as build prototypes of software components and systems. This project will design, develop and prototype feasibility demonstrations built on a common evolving testbed during the three year base period. The feasibility demonstrations will be used to ensure software interoperability and system compatibility and to provide an environment for testing, experimentation and evaluation. A revised testbed will be developed in the two year optional period based on an analysis of the strengths, weaknesses and relevance of the base testbed. The end result will be concepts, algorithms and technologies that will significantly enhance the DoD's ability to implement and deploy systems that will share
FY08	AFOSR	Nanocatalysts for Propulsion Applications	Michael Berman	Lisa Pfefferle	Yale University	In this MURI, new non–precious metal nanocatalysts soluble in hydrocarbon fuels are developed and tested to facilitate combustion in high-speed jet engines. Fundamental calculations and in-situ characterization provide an understanding of nanocatalyst interactions with fuel components and guide new catalyst designs and

FY08	AFOSR	Atomic-Scale Principles of Combustion Nanocatalysis	Michael Berman	Uzi Landman	Georgia Tech Research Corporation	The research program focuses on the development, implementation and use of theoretical methodologies to establish atomic-scale design principles of individual and integrated nanocatalytic materials systems of basic significance. Investigations address combustion processes important for progress in practical systems, including low temperature combustion, the design of more efficient catalysts capable of complete and rapid fuel combustion, and increasing the durability and poison-resistance of combustion catalysts.
FY08	AFOSR	Adaptive Intelligent Photonic/Electronic Systems Based on Silicon Nanomembranes	Gernot Pomrenke	Max Lagally	University of Wisconsin	The objective is to investigate in a comprehensive and multidisciplinary effort, the processing, properties, and application of silicon nanomembranes (SiNMs) to achieve novel functions in adaptive intelligent photonic/electronic systems (AIPES). The tunable dielectric, electronic, optoelectronic, and mechanical properties of SiNMs enable unprecedented 3-D integration of photonics, electronics, optoelectronics, thermoelectronics, and MEMS/NEMS, all based on Si, but not realizable with bulk Si. The Si-AIPES platform combines different features of SiNMs (flexible, strain-engineered single crystalmembranes that are stackable, transferable, bondable, and readily processable) to introduce intelligent and adaptive function. The focus is to establish the foundation for the application of SiNMs to Si-based nanophotonic/electronic platforms.

FY08	AFOSR	Dynamics of Thermal Transport at Interfaces Between Dissimilar Materials	Kumar Jata	Kevin Pipe	University of Michigan	The work aims to provide a comprehensive investigation of the fundamental mechanisms of thermal transport at interfaces. It will develop a new time-resolved X-ray and laser capability for measuring atomic structure dynamics at interfaces with a 1000-fold improvement in temporal resolution (100 fsec) and a 100-fold improvement in signal to noise, which will create a one-of-a-kind, state-of-the-art facility. Interfaces will be fabricated to examine new phenomena such as switchable thermal conductivity, non-linear thermoelectric effects, and evanescent near field thermal radiation. The possibility of engineering the spectral emissivity of materials at high temperature may offer unique technological advantages for military systems ranging from compact power for the dismounted soldier to microelectronics to satellite systems. The fundamental knowledge gained, and the new chemical and physical means developed, to prepare novel materials and structures for improved thermal management will result in enhanced performance, reliability, and thermal-signature control of a variety of military power, weapons, and electronic systems.
FY08	AFOSR	Collaborative Policies and Assured Information Sharing	Robert Herklotz	John Mitchell	Leland Stanford Junior University	The Presidio Project is developing methods for assured information sharing, with specific attention to confidentiality, privacy, trust, data quality and provenance. We have made progress on formal policy specification languages, theory and algorithms for the design of incentive-compatible sharing policies, and policy enforcement using cryptographic methods. While initial discussions centered on healthcare as a motivating application, the project broadened its technical scope in year two, with increasing discussion at meetings last year on cloud computing and associated assurance concerns.

FY08	AFOSR	Modeling Synergies in Large Human-Machine Networked Systems	Robert Herklotz	Katia Sycara	Carnegie Mellon University	This work aims to provide validated theories grounded in human experiments that allow descriptive and predictive characterization of complex human-machine systems. It will develop multi-level modeling methodology that includes four levels of increasing abstraction: humans-in-the-loop, high-fidelity cognitive models, large-scale simulation, and high level abstractoins. This will introduce new approaches for design of future complex systems and deployment/employment of current and future systems that will increase the situational awareness and overall effectiveness of warfighters and the military systems they inhabit at all levels. The goal is to have a better means of optimizing our Air Force systems, allowing the Air Force to more effectively operate within the cyberspace domain. Warfighters at all levels will have the information necessary to accomplish their mission in all three domains of air, space, and cyberspace.
FY08	AFOSR	Membrane Technology and 3D Photonic-Crystal Devices	Gernot Pomrenke	Henry Smith	Massachusetts Institute of Technology	To develop a wide range of semiconductor membrane technologies, and apply them to demonstrate a silicon chip containing an array of femtosecond lasers with low-threshold (zero in principle) and extremely high-repetition rate (> 100GHz for the fundamental mode). A focus is to demonstrate waveguides of extraordinarily large dispersion. By tuning the wavelength, accurate true-time delays up to 100 ns may be achieved on a silicon chip. A major focus is to achieve this with 3D photonic crystals. The work could lead to board-level, portable phased-array antennas (PAA) that can significantly improve the RF communications among all military units, including jet fighters, other aircrafts, vehicles and even individual soldiers.

FY08	AFOSR	Three Dimensionally Interconnected Silicon Nanomembrances for Optical Phased Array (OPA) and Optical True Time Delay (TTD) Applications	Gernot Pomrenke	Ray Chen	University of Texas at Austin	The objective is to conduct basic research on three-dimensionally integrated silicon nano-membranes involving nano-wires, photonic crystal waveguides and plasmonic structures which provide the building blocks for a myriad of dual-use applications such as optical phased arrays, true-time-delay lines for phased array antenna and biosensors. The more specific focus is to explore (1) an ultra-compact tunable MHz 8x8 optical phased array (OPA) with steering angles to ±70o without side lobe effect, and (2) a 16-element sparse array of optical true time delay (TTD) lines with tunable delay from 0 to 32 nano-seconds for X-band (8 to 12.5 GHz) phased array antennas suitable for an array with 1000 elements.
FY08	AFOSR	Nanocatalysts in Propulsion: Mechanisms and Optimization	Michael Berman	Scott Anderson	University of Utah	The objective of this MURI is to use combined experimental and theoretical approaches to understand and exploit the basic chemistry of propulsion nanocatalysts. The program spans a wide range of phenomena and length scales, from the very basic molecular level structure of catalytic centers and catalyst surface science to more complex processes of catalytic ignition and combustion kinetics, liquid phase cracking catalysis, and in situ growth of catalytic nanoparticles. Development and experimental validation of both microscopic and global kinetic models as well as high level electronic structure calculations provide insight into mechanisms and input for highly accurate propulsion models.

FY08	AFOSR	Rotorcraft Brownout: Advanced Understanding, Control, and Mitigation	Douglas Smith	John Leishman	University of Maryland, College Park	This research program has been designed to accelerate the understanding and mitigation of the problem of brownout during rotorcraft operations in austere environments. A multidisciplinary approach is being undertaken to provide advances in the state-of-the-art of understanding brownout problems and in the development of a rational methodology to predict the fluid dynamic and other effects of brownout.
FY08	AFOSR	Passive and Active Control of Heat Transfer At Interfaces	Kumar Jata	David Cahill	University of Illinois	The work aims to provide a comprehensive investigation of the fundamental mechanisms of thermal transport at interfaces. The possibility of engineering the spectral emissivity of materials at high temperature may offer unique technological advantages for military systems ranging from compact power for the dismounted soldier to microelectronics to satellite systems. The fundamental knowledge gained, and the new chemical and physical means developed, to prepare novel materials and structures for improved thermal management will result in enhanced performance, reliability, and thermal-signature control of a variety of military power, weapons, and electronic systems.

FY09	AFOSR	Distributed Learning and Information Dynamics in Networked Autonomous Systems	Fariba Fahroo	Jeff Shamma	Georgia Tech Research Corporation	This project is motivated by the future need to enable advanced operations of teams of autonomous vehicles to learn and adapt to uncertain and hostile environments under effective utilization of communications resources. Of particular interest is the interplay between distributed learning and information dynamics. Distributed learning refers to a collection of interacting agents with limited local processing, information, and communications, all seeking to achieve a global objective in an uncertain and possibly hostile environment. Information dynamics refers to the architecture, either inherited or designed, of information flow among the distributed agents. The interplay of distributed learning algorithms and information dynamics can have dramatic effects on the efficiency of the collective.
FY09	AFOSR	Hardware, Languages, and Architectures for Defense Against Hostile Operating Systems	Robert Herklotz	David Wagner	University of California, Berkeley	This work will enable development of an integrated suite of techniques for protecting applications from a hostile OS, with the goal of enabling a range of protections to be applied to both legacy and new applications. This research directly supports the Air Force vision of information dominance and the development of effective, secure large information systems like the Joint Battlespace Infosphere, GIG and future airborne networks for C2 support to the warfighters.

FY09	AFOSR	Search for New Superconductors for Energy and Power Applications	Harold Weinstock	Ivan Schuller	University of California, San Diego	This project is dedicated to the development of new techniques and to implement the search for new superconductors. The search for new materials is akin to finding a "needle in a haystack", in which most of the material is irrelevant. Therefore, it is important to develop an efficient method to discard most of the uninteresting materials. This was implemented using two crucial ingredients: 1) Synthesis by many preparation methods, and 2) fast, sensitive and efficient methods that allow discarding large parts of the uninteresting parts of the phase diagram.
FY09	AFOSR	Towards New and Better High Temperature Superconductors	Harold Weinstock	Malcolm Beasley	Leland Stanford Junior University	This program is focused on the search for new superconductors in material systems with potential for higher temperature superconductivity through electronic interactions (charge and spin). We also are examining a few critically selected apparent observations of very high temperature superconducting anomalies. In the long run, we seek materials that have strong attractive pairing interactions and that are isotropic and have relatively high carrier densities, as these are necessary to mitigate the effects of macroscopic quantum phase fluctuations in destroying superconductivity at high temperatures.

FY09	AFOSR	Production, Manipulation, and Applications of Ultracold Polar Molecules	Tatjana Curcic	Susanne Yelin	University of Connecticut	This comprehensive experimental and theoretical program will address the production and characterization of cold and ultracold polar molecules, and a variety of scientific explorations using these systems. The scientific goals range from the study and control of collisional and chemical processes at low temperatures, to the engineering of many-body quantum systems with novel interactions, to the development of new technologies for quantum information processing, precision measurement, sensing, etc. The experimental approaches to produce cold polar molecules include assembly from ultracold atoms using magneto- and photoassociation, evaporative and sympathetic cooling, buffer-gas cooling, Stark deceleration, laser-cooling, ion trapping, and combinations thereof. New, sensitive methods for detecting and characterizing cold molecular systems will be developed. Experiments will be conducted with both neutral and ionized polar molecules; both molecular beams and a variety of different trapping techniques (ion traps, electric traps, magnetic traps, optical traps, chip-based traps) will be employed. Precision spectroscopy will be used to enable optimized production and cooling schemes, and as development towards new types of precision measurement and sensing applications.

FY09	AFOSR	Fundamental Mechanisms, Predictive Modeling, and Novel Aerospace Applications of Plasma Assisted Combustion	Chiping Li	Walter Lempert	The Ohio State University	The Air Force will require aerospace vehicles and weapon systems with performances superior to those of any potential adversary. Many of these vehicles and weapons will use chemical propulsion systems. Plasma enhancement offers the possiblity to achieve optimized, stable performance over a broader range of combustion conditions and to utilize alternative fuels with properties unlike those of conventional fuels. The proposed research seeks to achieve an understanding of the relationship between plasma chemistry and combustion chemistry that will be essential to exploit the potential advantages of plasma enhancement
FY09	AFOSR	Broad-Based Search for New and Practical Superconductors	Harold Weinstock	Richard Greene	University of Maryland, College Park	This work aims to develop a large-scale program targeted toward the discovery and synthesis of new superconducting materials with unprecedented isotropic properties, large upper critical fields and high transition temperatures. The approach is built upon the expertise of three leading centers of superconducting materials synthesis and is designed to search for new compounds that will dramatically improve the performance of superconducting devices and reduce the cost of their production. By focusing the resources of the three institutions, each with a well-recognized reputation for new materials exploration and research, it is envisioned that entirely new classes of superconductors with exceptional promise for technological applications will be discovered.

FY09	AFOSR	Multi-Scale Fusion of Information for Uncertainty Quantification and Management in Large-Scale Simulations	Fariba Fahroo	George Em Karnia	Brown University	Uncertainty quantification (UQ) cuts across many areas of interest to the USAF including electro-magnetic scattering, materials, fluid mechanics and aeroacoustics. We aim to develop an integrated methodology that proceeds from initial problem definition to engineering applications. Towards this goal, we are working on five research areas: (1) Mathematical analysis of SPDEs and multiscale formulation; (2) Numerical solution of SPDEs; (3) Reduced-Order modeling; (4) Estimation/Inverse problems; and (5) Robust optimization and control.
FY09	AFOSR	Ultracold Polar Molecules: New Phases of Matter for Quantum Information and Quantum Control	Tatjana Curcic	Paul Julienne	University of Maryland, College Park	The goal of this MURI is to understand and exploit the formation, collisions and ultracold chemistry, and the electric, magnetic and electromagnetic field control of weakly and strongly bound states of ultracold molecules and to use the novel control features of these systems to produce and characterize new phases of quantum matter and to find ways of realizing scalable quantum logic and

FY09	AFOSR	Information Dynamics as Foundation for Network Management	Robert Bonneau	Robert Calderbank	Princeton University	The Princeton team wishes to develop strategies for estimation of parameters of dynamic information content and exchange in networks that are computationally efficient and require low overhead. These estimations should result in metrics of performance both in the exchange of information between individuals and of protocols and policies of the overall network. These metrics should then result in management approaches and policies that are provably stable and reliable under difficult conditions such as high mobility or flooding and compromise of networks. Approaches in dynamical analysis and modeling on information topological structure are of interest as well as mathematical approaches drawn from diverse fields such as theoretical physics, decision theory, bio-molecular processes, and social inference. The intent is to develop methods that can follow the structure of information exchanged and manage new network behavior and performance before and during its occurrence rather than pre-configuring an approach that does not adapt to variable conditions.
FY09	AFOSR	Bio-Inspired Optics: Offering Physical and Technological Insights in Color and Structure (BioOptics)	Hugh Delong	Joanna Aizenberg	Harvard University	Study of structural color and dynamic camouflage systems in biology and their potential impact on DoD optical technologies. This multifaceted, highly-interactive program balances exploratory research to describe and characterize biological and bio-inspired optical structures, with applied research to design and prototype components, and with theory and modeling to guide and rationalize these efforts. The team consists of a unique blend of expertise in biochemistry, materials science, biomimetics, biophotonics, optics, nanofabrication and optical engineering.

FY09	AFOSR	Bio-Inspired Intelligent Sensing Materials for Fly-By-Feel Autonomous Vehicle	Les Lee	Fu Kuo Chang	Leland Stanford Junior University	The goal of the proposed research is to design the next generation of intelligent sensing materials inspired by the parallelism, fault tolerance, and adaptability of neurobiological systems. Multi-scale design, synthesis, and fabrication techniques will be employed to create lightweight, intelligent aerospace materials that can sense their state automatically with high resolution and can communicate important high-level information to control

FY09	AFOSR	Synthesis, Characterization and Modeling of Functionally Graded Multifunctional Hybrid Composites for Extreme Environments	David Stargel	Dimitris Lagoudas	Texas Engineering Experiment Station	The goal of this work is to achieve an integrated holistic multidisciplinary approach to the analysis, predictive modeling, and design of hybrid material structures coupling the thermal-acoustic-mechanical flight loads with the design of functionally graded multifunctional hybrid material systems. This highly qualified MURI team is willing to take a significant research risk in order to achieve something more than just an incremental improvement in current capabilities. It will develop the science for a novel functionally graded hybrid composite (FGHC) composed of multiple layers, starting from an external ceramic thermal barrier layer, through a graded ceramic/metallic composite (GCMeC) layer and then transition to a polymer matrix composite (PMC) substructure. The proposal clearly identifies the target temperature range (250-1000C) and durability (1000 hrs/550C/300 thermal cycles). The thermal barrier layer and graded ceramic/metallic composite will provide thermal protection, the metallic layer will provide damage tolerance and vibration isolation/mechanical damping through SMA effect, and the PMC layer will fulfill primarily the load-bearing structural function. The proposal has a strong and aggressive focus on bringing together disparate materials classes to achieve a common functionality, which is the true nature of hybrids. Four major thrust areas are proposed: (1) development and fabrication of novel functionally graded hybrid material systems; (2) multiscale characterization of these novel hybrid materials;

FY09	AFOSR	Robust and Complex On-Chip Nanophotonics	Gernot Pomrenke	Shanhui Fan	Leland Stanford Junior University	The objective is to conduct research on fundamental theory, numerical simulation, experimental demonstration, and applications and integrations, of robust devices based on onchip non-periodic nanophotonic structures. The program is motivated by the urgent need to solve some of the most important chip-scale photonics challenges of the 21st century, including compact and robust components for wavelength division multiplexing, multi-spectral sensing, photovoltaics, optical switching, and low-loss nano-scale localization of light. The program proposes to overcome these challenges through fundamental scientific advances for understanding, designing, optimizing, and applying complex non-periodic nano-photonic structures.
FY09	AFOSR	New Materials Approaches for Future Graphene-Based Devices	Harold Weinstock	Richard Osgood Jr	Columbia University	The MURI goal is to develop new growth and fabrication technologies for graphene-related materials that, when coupled with improved understanding of grapheme underlying physical properties, will enable novel device concepts. The proposed research has the potential to improve the design, development and fabrication of novel advanced electronic and nanoscale electromechanical devices. Graphene-based FETs possess the capability to surpass conventional high-frequency electronics that are currently in use which will allow for superior signal processing. Graphene and graphene-related materials represent the future of electronics to be implemented within the next generation of war fighter aircraft.

FY10	AFOSR	Quantum Piston: Quantum Preservation, Simulation and Transfer in Oxide Nanostructures	Harold Weinstock	Jeremy Levy	University of Pittsburgh	The central goal of this MURI project is to exploit materials that incorporate the useful properties of both superconductors and semiconductors to create novel quantum devices. These devices will rely on near-atomic-scale control over semiconducting properties as well as existing and newly predicted properties of superconductors to create functionality that will be as transformative as a superconducting quantum interference device (SQUID).
FY10	AFOSR	Cryogenic Peltier Cooling	Harold Weinstock	Joseph Heremans	The Ohio State University	The team aims to develop new, breakthrough thermoelectric materials that will make cooling possible in the cryogenic temperature range using the Peltier effect, starting from 170 K and aiming down to 10K. It breaks into 2 goals: first by using Bi-based semiconductors in the range 40K<T<170K, and second by using highly-correlated systems in the range 10K<T<40K. The specific systems for the latter (more challenging) range will include transition-metal pnictides and chalcogenides, as well as metallic alloys or intermetallic compounds containing rare-earth or transition metals with hybridized d or f levels.

FY10	AFOSR	BIOPAINTS: Bio-Enabled Particle Adherents for Interrogative Spectroscopy	Hugh Delong	Carson Meredith	Georgia Tech Research Corporation	The objectives and key research questions of the BioPAINTS MURI are as follows: 1) Thrust 1. Fundamental attachment mechanisms of pollen and diatom model bioparticles. How does microstructure affect static and dynamic aspects of pollen and diatom adhesion? What biomolecules do diatoms secrete to enable chemical adhesion to surfaces? How can genetic engineering be used to generate diatoms with desired adhesive properties? 2) Thrust 2. Synthesis of artificial or bio-hybrid microparticles with tailored adhesion. What controls deposition of thin, conformal inorganic coatings on bio-inspired templates? How do synthetic nano- and micro-patterned structures, and functionalization with bioadhesives, drive tailorability of particle adhesion? 3) Thrust 3. Incorporate tailored chromophores into microparticle resonators for remote detection. What are the advantages and limitations for utilizing optical resonances in biologically derived and synthetic particles to enhance the signal-to-noise ratio for detection? How do methods for surface functionalization, surface deposition, and thermal treatments affect nanostructure/chemistry and optical behavior of inorganic or organic/inorganic coatings?

FY10	AFOSR	Center for Organic Materials for All Optical Switching	Charles Lee	Seth Marder	Georgia Tech Research Corporation	The objective of Center for Organic Materials for All-Optical Switching, COMAS, is the development of new organic materials that will lead to unprecedented utility for all-optical switching applications. COMAS will build on recent very promising results indicating that certain polymethine cyanine dyes exhibit very large negative real part of the third-order polarizability low linear and nonlinear loss at certain wavelengths. We will design and synthesize various classes of chromophores with improved molecular nonlinearities and develop methods for successfully translating solution properties into high chromophore-density films that retain large nonlinearities, using a tight feedback loop of theory, synthesis, and characterization.
FY10	AFOSR	Mathematical Modeling and Experimental Validation of Ultrafast Nonlinear Light-Matter Coupling Associated with Filamentation in Transparent Media	Arje Nachman	Jerome Moloney	The University of Arizona	This MURI will undertake theory/experiment regarding the novel behavior of laser pulses of ultrashort duration (<100femtoseconds), but with substantial power (exceeding 10^12W), as they propagate through transparent media such as air. Fundamental understanding of nonlinear light/matter interaction at these extremes of duration/power are required in order to explain behavior such as the following: 1) these pulses propagate with significantly reduced diffraction for kilometers (up to 10k), 2) are believed to pass through clouds/obscurants with relative ease, and 3) are accompanied by a plasma channel which possibly can serve as a waveguide for other electromagnetic fields.

FY10	AFOSR	Fundamental Processes in High-Temperature Hypersonic Flows	John Schmisseur	Graham Candler	University of Minnesota	Progress towards the identification, accurate simulation and exploitation of critical high-temperature gas kinetic phenomena will create new design options for efficient high-speed air platforms. This MURI will develop and validate new models for energy transfer in high-temperature gases and gas-surface interactions utilizing multi-scale simulations ranging from quantum mechanics calculations to molecular dynamics simulations, monte carlo methods and continuum models. High-fidelity companion experiments are integrated with leading-edge numerical methods in each appropriate range of physical scales to discover the dominant processes and characterize the resultant influence on larger scales.
FY10	AFOSR	CHASE: Control of Heterogeneous Autonomous Sensors for Situational Awareness	Robert Bonneau	Daniel Koditschek	University of Pennsylvania	Understanding and controlling cyber-physical systems or hybrid systems are scientific disciplines that aim at studying system with multiple interacting components. The modular components exchange their physical or computational states that constitute systems with complex behaviors. In this direction, the MURI topic further explores "information states", which are derived either from physical or computational processes, and their roles in systems and

FY10	AFOSR	Inferring Structure and Forecasting Dynamics on Evolving Networks	Terrence Lyons	Jeffrey Brantinghar	University of California	The aim of this project is to generate network data from diverse sources, to test models against these data, to develop stable metrics for analyzing the data, to forecast the network dynamics, and to explore network intervention. Three major research tasks are identified: (1) development of stable metrics for inferring latent properties of networks, (2) forecasting dynamical processes operating on evolving networks, and (3) planning and predicting outcomes of interventions on network structure and function. The research is data driven, with an explicit goal of testing models and metrics against diverse empirical data sets on human social networks from field, laboratory and web-based settings. Technical approach includes empirical data collection, developing metrics for static and evolving networks, error and robustness measurement, models for local-global coupling of and dynamical processes on evolving networks, and forecasting trends and events on networks
FY10	AFOSR	Novel Catalytic Mechanisms for the Chemical Reduction of Carbon Dioxide to Energy-Dense Liquids	Michael Berman	Clifford Kubiak	University of California, San Diego	This MURI explores new approaches and materials for solar fuel generation by developing efficient catalysts for the production of liquid fuels from CO2, water and sunlight as well as determining molecular mechanisms for the catalytic chemical reduction of CO2 to energy-dense liquids. The program combines high level theory with experimental investigations that employ in situ spectroscopic studies of catalysts using synchrotron radiation, metal electrochemical and semiconductor photoelectrochemical reduction of CO2, and catalyst discovery.

FY10	AFOSR	Multi-Layer and Multi-Resolution Networks of Interacting Agents in Adversarial Environments	Fariba Fahroo	Tamer Basar	University of Illinois	The overall goal is to develop a comprehensive multi-layer multi-resolution (MLMR) framework, with associated theory, computational algorithms and experimental testbeds, for dynamic games played on multiple scales by spatially distributed teams of human and automated decision makers, who communicate and interact over a network and
FY11	AFOSR	Synthesis and Characterization of 3D Carbon Nanotube Solid Networks	Joycelyn Harrison	Ajayan	William Marsh Rice University	Guided by theory and experiment, the goal of this MURI research is to create solid materials by the controlled assembly and atomic-scale bonding of nanoscale elements, thereby leading to network solids with remarkably improved thermo-electro-mechanical properties as compared to randomly assembled nanostructures. These novel, multi-functional, three-dimensional nanotube-based structures will provide properties required for critically needed applications such as thermal management platforms, energy storage electrode scaffolds, and lightweight, mechanically durable nanocomposite structures. The 3D nanotube structures envisioned are hierarchical and will be designed with the focus of creating covalent bonding junctions between individual nanoscale elements so that the macroscopic properties will be seamlessly extended in all three dimensions rather than dissipated as when nanoscale elements are interfaced via only weak van der Waals interactions.

FY11	AFOSR	Nanofabrication of Tunable 3D Nanotube Architectures	Joycelyn Harrison	Dai	Case Western Reserve University	The goal of this MURI research to develop 3D nanotube-graphene-based architectures that are inherently nanoporous and allow for tunable thermal, mechanical, and electrical properties. The utilization of such 1D and 2D carbon-based nanostructures (i.e., CNTs and graphene) in the development of tunable 3D nanotube architectures provides a potential for a quantum leap in material performance in a variety of critical mission-specific DoD applications. Such novel 3D material architectures are envisioned to exploit the synergistic effects by extending their unique electrical and thermal transport and mechanical properties to the critical third dimension through rational integration of CNTs and graphene.
FY11	AFOSR	Quantum Memories in Photon-Atomic Solid State Systems (QuMPASS)	Tatjana Curcic	David Awschalom	University of California, Santa Barbara	The team will implement scalable quantum circuits by integrating micro- and nanoscopic optical networks with emitters (atomic or solid-state) to achieve quantum functionality. QuMPASS will develop the systems architecture and engineer the light-matter interactions for a hybrid quantum memory incorporating both atoms and NV centers as the stationary qubits, linked by high quality solid state optical cavities that will transduce the quantum information from stationary qubits to photons in a compact, on-chip footprint.
FY11	AFOSR	Multi-Functional Light-Matter Interfaces Based On Neutral Atoms and Solids	Tatjana Curcic	Alex Kuzmich	Georgia Institute of Technology	The objective is to create a new generation of capabilities for quantum information processing and communication. Work will be performed to develop and experimentally implement multi-functional quantum memories that combine efficient coupling to light, long storage times, multi-qubit storage capacity, high-fidelity deterministic quantum gate operations, as well as efficient interfacing of quantum memory nodes with the telecom band.

FY11	AFOSR	Bioprogrammable One-, Two-, and Three-Dimensional Materials	Hugh Delong	Chad Mirkin	Northwestern University	This work has four primary goals: 1) Goal 1. Development of Design Rules for Biomolecule based Assembly, 2) Goal 2. Integration of biomolecule directed-assembly and nanolithographic techniques, 3) Goal 3. Establish theoretical models, 4) Goal 4. Evaluate emergent physical properties. The results of this effort will have significant long term implications for the DoD in the construction of useful devices, including electronic and optoelectronic circuitry, chemical sensors, data storage and manipulation, energy harvesting and storage. The fundamental methodologies developed will provide an entirely new means of, and knowledge base for, creating designer materials with physical and chemical phenomena that cannot be realized through traditional atomic- or bulk-scale syntheses.
FY11	AFOSR	Control of Thermal and Electrical Transport in Organic and Composite Materials Through Molecular and Nanoscale Structure	Charles Lee	Rachel Segalman	University of California, Berkeley	none
FY11	AFOSR	3D Hybrid Circuits for Advanced Information Processing	Harold Weinstock	Cheng	University of California, Santa Barbara	none
FY11	AFOSR	Science of Cyber Security: Modeling, Composition, and Measurement	Robert Herklotz	Mitchell	Stanford University	none

FY11	AFOSR	Integrated Hybrid Nanophotonic Circuits	Gernot Pomrenke	Mark Brongersma	Stanford University	Hybrid nanophotonics presents an entirely new device technology with many unknown opportunities and scientific challenges. In hybrid nanophotonic devices and circuits nanoscale metallic and semiconductor components will be brought together in new and creative ways to enhance the function of the other component. In these unique structures, the metals and semiconductors will also for the first time perform simultaneous electrical and optical functions. In hybrid nanophotonics, the traditional spatial boundaries between electronic and photonic components will disappear and new opportunities for ultra-dense integration will naturally emerge. The operation of the proposed nanodevices will rely on two valuable physical phenomena that naturally become available at very small size scales: room temperature quantum effects and strong-light matter interaction down to the few photon level. The effort will also take advantage of the recent explosion in the range of materials that can perform valuable optical functions in the realization of hybrid nanophotonic circuitry on a Si platform.