



# 2010 ONR Naval S&T Partnership Conference

Next Generation Technologies for Today's Warfighter



# ONR

Revolutionary Research . . . Relevant Results

**Naval Warfighter Performance**  
**Dr. Terry Allard, ONR34 Department Head**

O F F I C E O F N A V A L R E S E A R C H

Total Ownership Cost

Unmanned Systems



Human Systems and Decision Support

Network-Centric Systems

Network-Centric

Manpower, Personnel Training and Education

Warfighter Health and Survivability

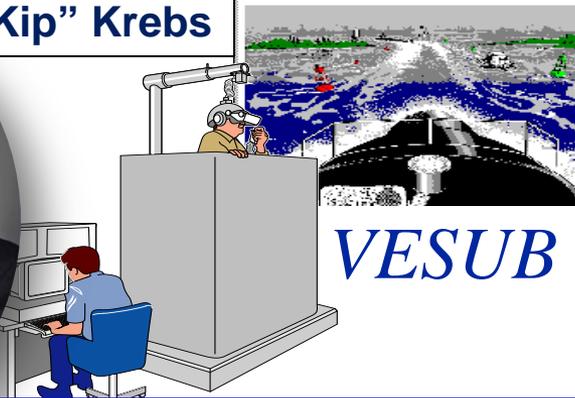
Irregular Warfare

Seabasing

# Naval Warfighter Performance

# Scenario-Based Training: *Classroom-Pierside-Shipboard*

Dr. William "Kip" Krebs



**Bridge/ Control Room Team Training  
Submarine Piloting & Navigation**

- ✓ Realistic, Simulation Training
- ✓ Tailored to skill gaps
- ✓ Individuals & Teams
- ✓ Reduced Instructor Workload
  - Automated Readiness Assessment
  - Automated Scenario Generation

## ASW / TAO Sandbox at SWOS

- ✓ Interactive simulation for solving surface ASW problems
- ✓ Instructor (authoring) and Student (problem-solving)
- ✓ Record and Replay solutions



Dr. Ray Perez

# Scenario-Based Training: Virtual Maintenance Performance Aid for the Littoral Combat Ship

VMPPA Instructor

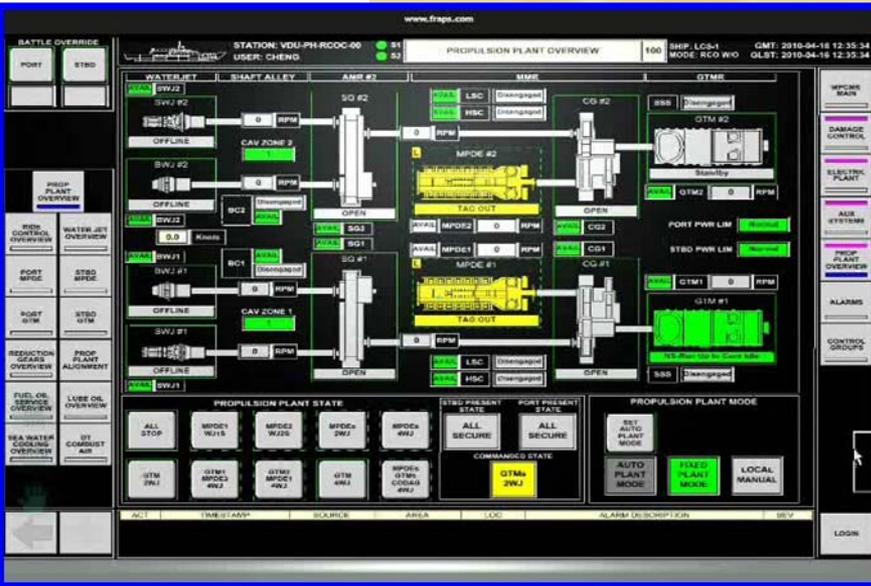
EPT "Rover"



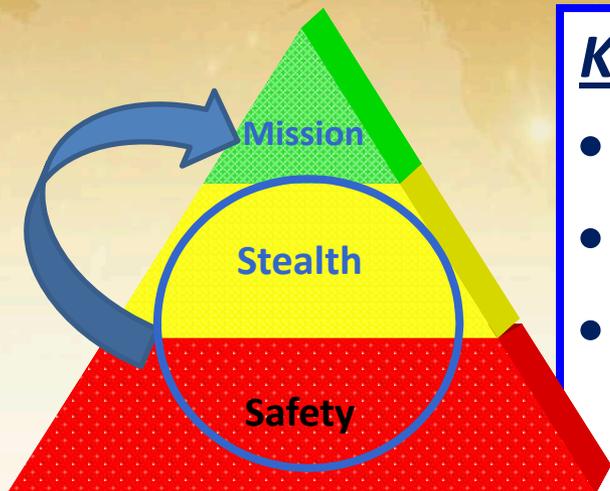
Dr. Harold Hawkins



Readiness Control Officer (RCO) trainee using the Machinery Plant Control & Monitoring System (MPCMS) on the virtual bridge of LCS-1 Freedom



# Command & Control Center Concepts for Ohio-class Replacement Program

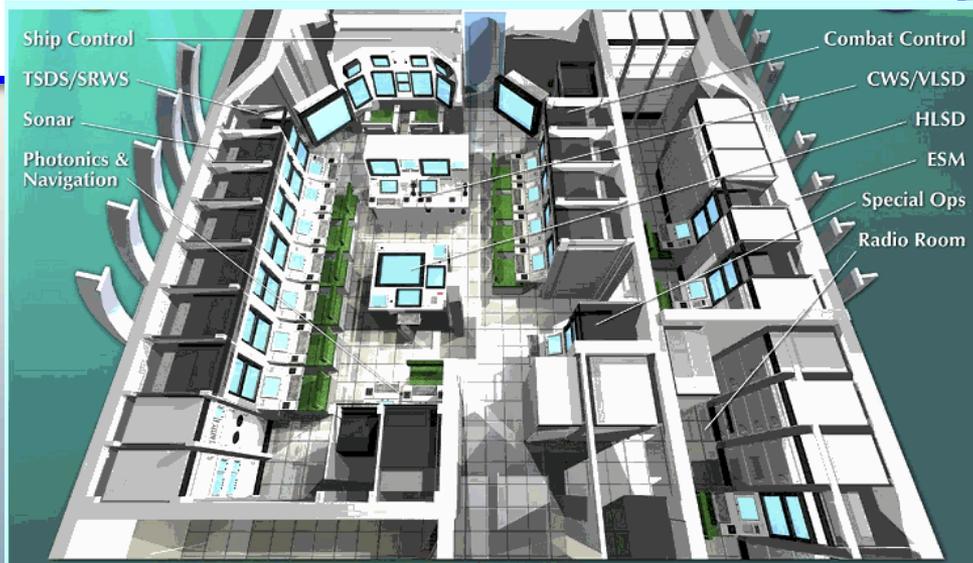


## Keep the Focus on the Mission

- Spatial Arrangement of C2 Center
- Decision-centric information architecture
- Reduced cognitive effort to integrate tactical picture



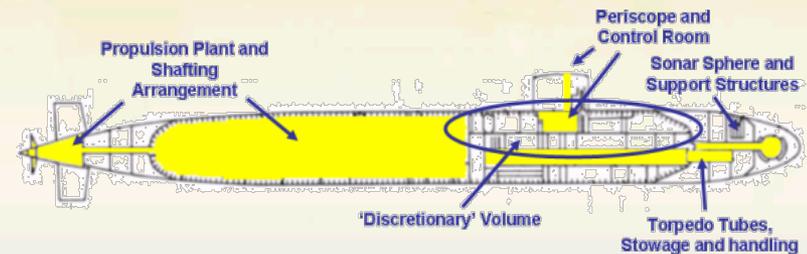
Dr. William "Kip" Krebs



Spatial Arrangement of Workstations & Personnel

# Engineering Tools : Human Systems Integration Design

**Cost-effective ORP Design optimized for  
Crew Size, Automation, Operability, Military Effectiveness**



- Merge Full Spectrum of Human Systems Engineering into Navy Integrated Product Data Environment (IPDE)
- Evaluate engineering trade space and acquisition costs

**Bridging to Total Ownership Cost of Manning**



**Dr. William "Kip" Krebs**

# Noise-Induced Hearing Loss

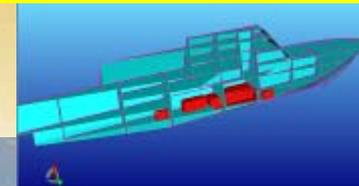
## Standards: 24/7 Operations & Impulse Noise

**Evaluate  
Hearing Risk**



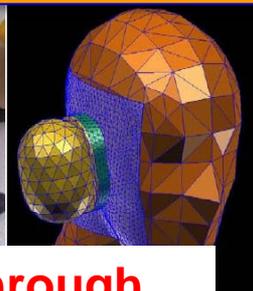
**Dosimetry**

**Reduce  
Noise at  
the Source**



**Jet Engines**

**Hearing  
Protection**



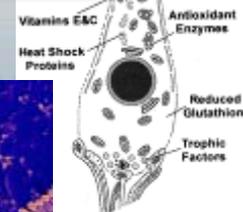
**Talk-through  
Communications**



**Treatment**



**Mr. Kurt Yankaskas**



# New Directions in Warfighter Health & Survivability

LCDR Matt Swiergosz PhD

## *Undersea Medicine: a National Naval Responsibility*

- ✓ Decompression Illness (DCI)
- ✓ Hyperbaric Oxygen Toxicity (HBOT)

## *Combat Casualty Care*

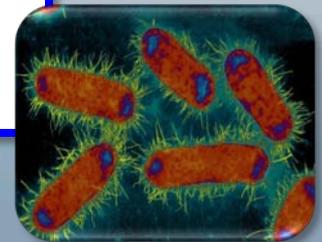
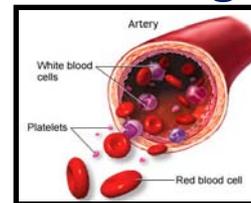
- ✓ Hemorrhage Control – Internal Bleeding
- ✓ Automated Casualty Care
- ✓ Field Diagnostics

## *Synthetic Biology*

- ✓ Engineered Sentinel Cells / Wound Infection



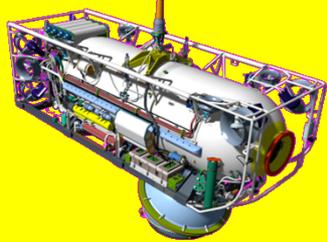
Dr. Mike Given



Dr. Linda Chrisey

# Non-Recompression Treatment for Decompression Illness (DCI)

**Today**



**Decompression Chambers**

**Tomorrow ?**



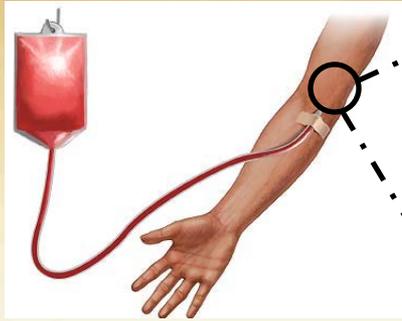
**Pharmacological therapies to mitigate DCI**

- Disabled Submarines (DISSUB)
- Diving / Spec Ops

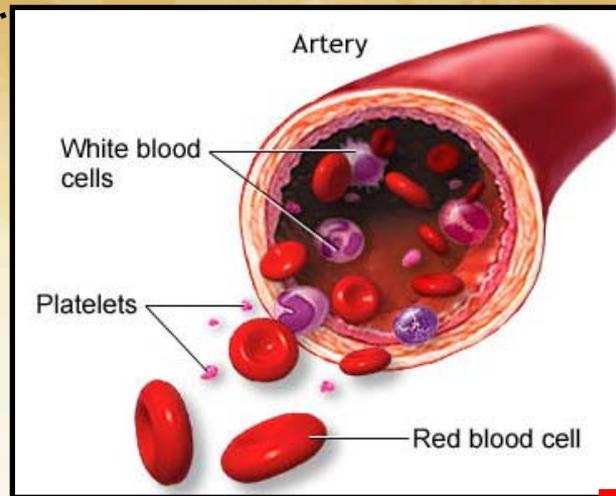


**LCDR Matthew Swiergosz PhD**

# Treating Battlefield Hemorrhage with Blood Substitutes



**Whole Blood**



**Dr. Michael Given**

**Blood Substitute**

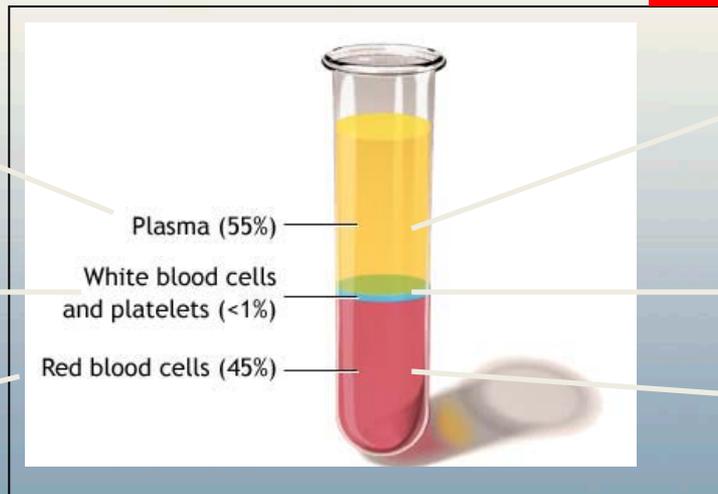
**Requires Refrigeration**

**No Refrigeration Necessary!**

**Plasma**  
Volume (water)  
Ions  
Coagulation factors

**Platelets**  
Control Bleeding

**Red Blood Cells**  
Carry Oxygen



**Dried Plasma**  
Volume (water + colloid)  
Ions  
Coagulation factors

**Dried Platelets**  
Control Bleeding

**PFCs / HBOCs**  
Carry Oxygen

PFC = Perfluorocarbon /  
HBOC = Hemoglobin-Based Oxygen Carrier



# Automated Critical Care System

***“Over the horizon force projection with operational reach approaching 200nm will ... increase the risk of in-transit clinical degradation of severely wounded casualties.”***

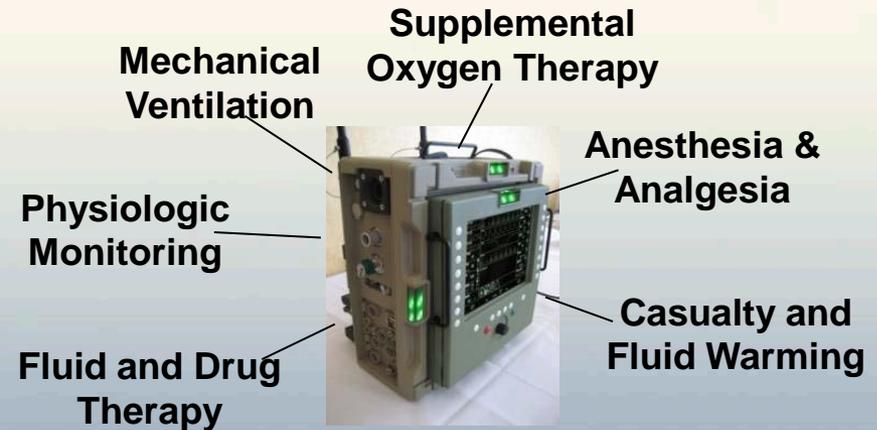
**USMC ORD for The En Route Care System**



***Continuous Monitoring***

***Closed-Loop Interventions***

***Reduces CASEVAC Risk***



**Dr. Michael Given**

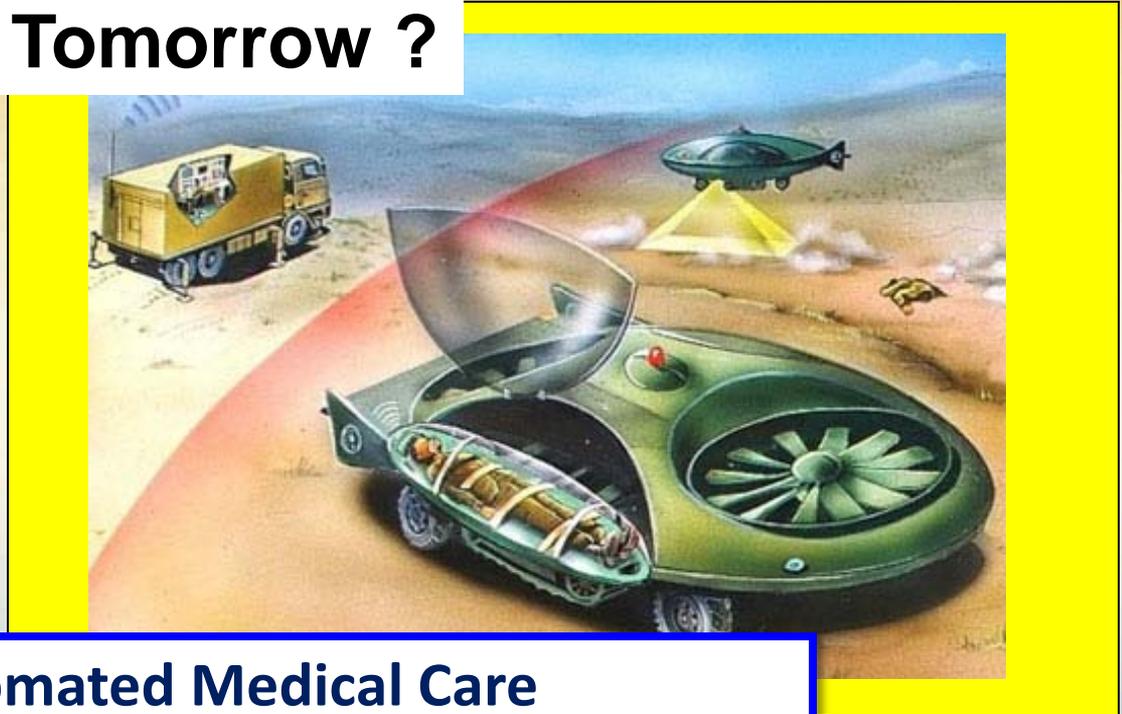
***Force Multiplier: Integrated medical management of individual casualties without continuous human oversight***

# Automated Medical Care during Unmanned Casualty Evacuation

**Today**



**Tomorrow ?**

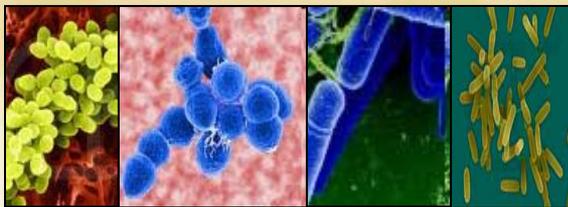


- **Titrated, Tailored, Automated Medical Care**
- **Compact, Mobile systems for Austere Environments**
- **Applies to Military and Civilian trauma care**

# Engineered Sentinel Cells to Combat Wound Infection

**Search & Destroy:** Detect pathogens and destroy them with local antibiotics

*Pathogenic Bacteria (Gram + and - Species)*



Pathogen-specific  
signal molecules

Pathogen-specific  
antibiotics produced



Dr. Linda Chrisey



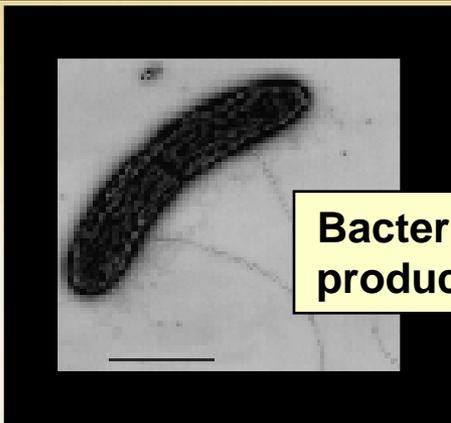
Sentinel Cells

**FAILSAFE approaches:**

- ✓ **“Smart” bandages** localize Sentinels and prevent release throughout body
- ✓ **Engineered “Suicide” circuits** trigger programmed cell death on demand

## Exploiting Nature's Design Principles

Genetically engineered organisms for biosensing or bio-manufacturing (e.g. bacteria, diatoms, plants)



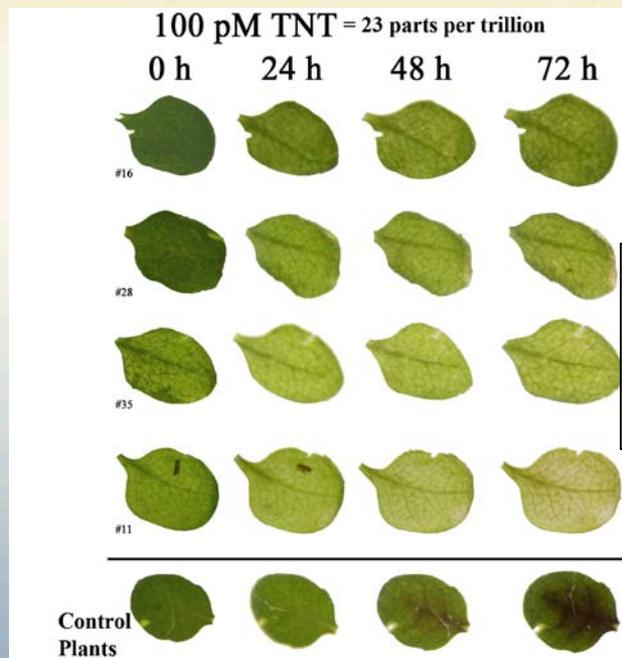
**Bacteria in seabed produce electricity**

Microbial physiology and electron transfer mechanisms for microbial "batteries"

- Persistent "Green" Power

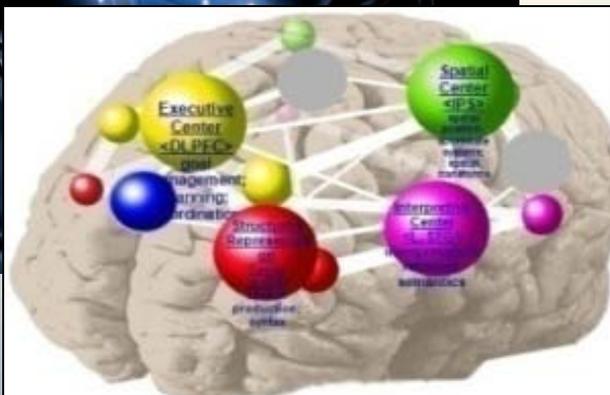
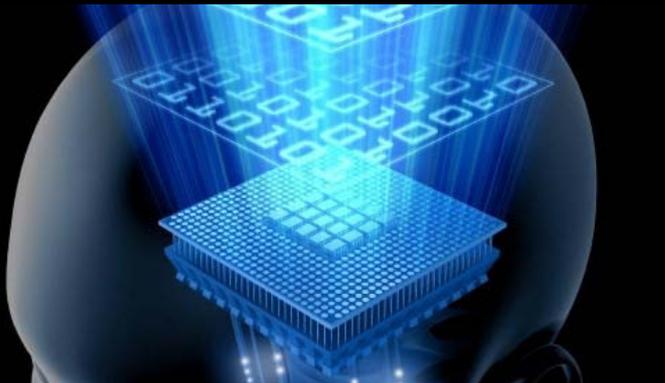


**Dr. Linda Chrisey**



**TNT Biosensor**  
Plant's leaves turn white in presence of TNT

## Exploiting Nature's Design Principles



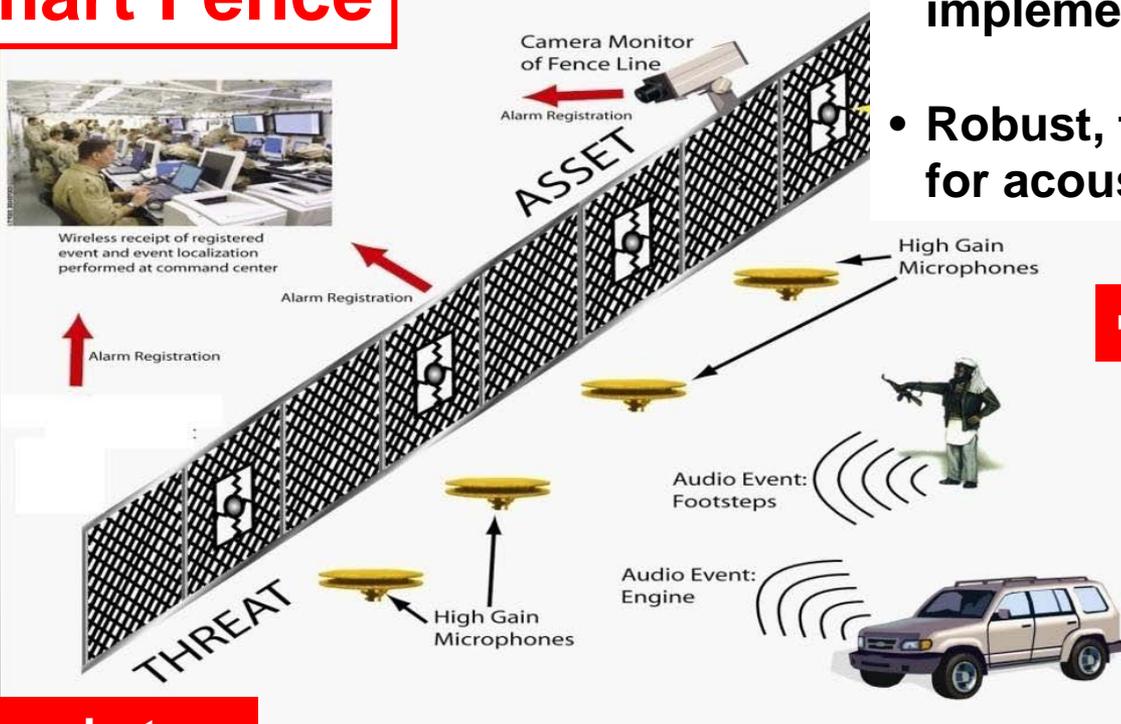
- ✓ Smart sensors
- ✓ Unmanned vehicle control
- ✓ Intelligent Training Systems
- ✓ Engineering models of Individual & Team Performance
- ✓ Decision Support/ Interface Design
- ✓ Synthetic Forces/ Artificial Intelligence

25 years of research inspired fields of Cognitive Science, Computational Neuroscience, Human-Systems M&S, Organizational Design / Social Network Analysis

# Bio-Computation: Acoustic / Seismic Sensing

## Exploiting Nature's Design Principles

### Smart Fence



- Hippocampal synapse model implemented in VLSI circuits
- Robust, trainable pattern recognition for acoustic and seismic signals

▪ Fence climbing



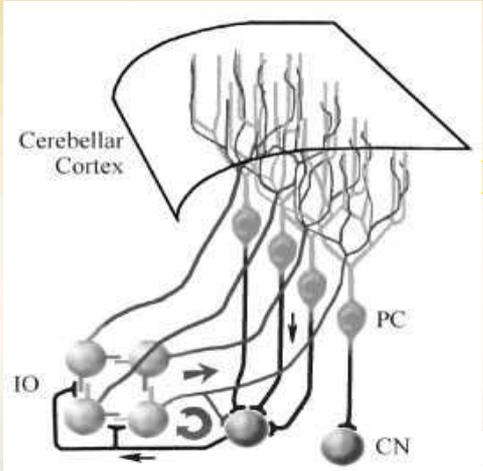
Dr. Thomas McKenna

▪ Gunshots  
▪ Footsteps

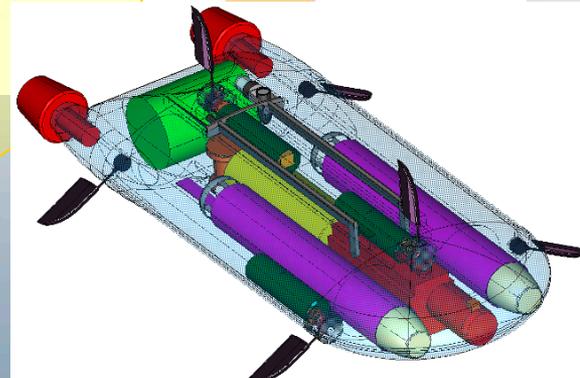
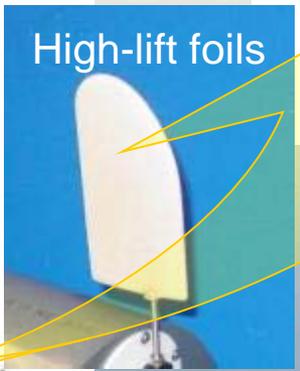
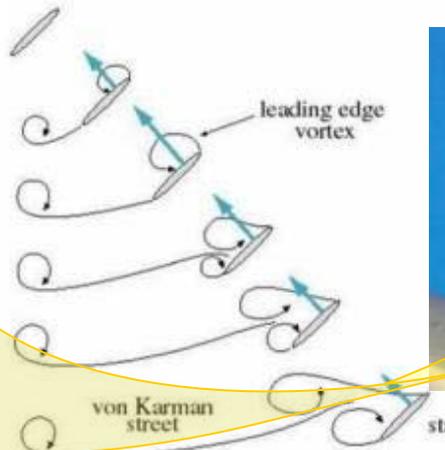
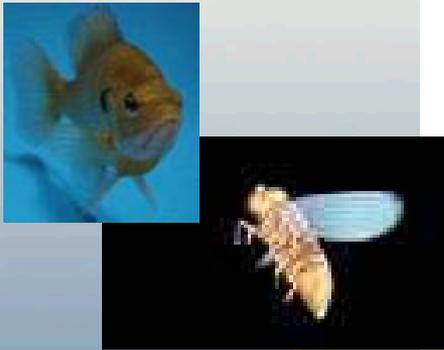
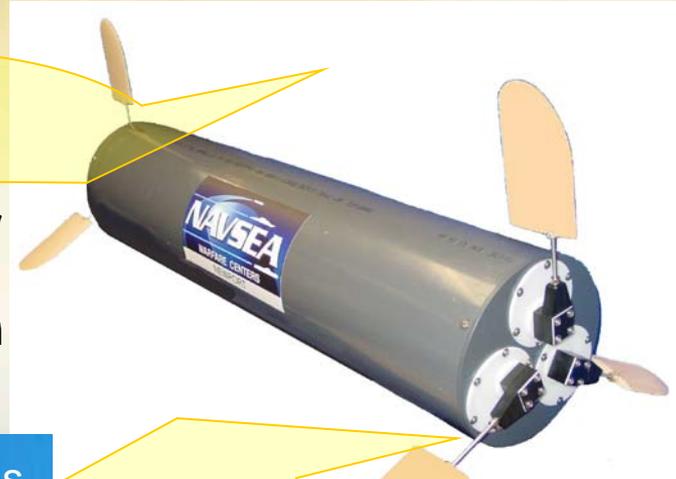
▪ Vehicle engines

# Bio-Inspired Autonomous Undersea Vehicles

**Efficient, exceptionally Quiet, highly Maneuverable AUVs**



- Brain-based controller
- Biomechanics for high-lift propulsion

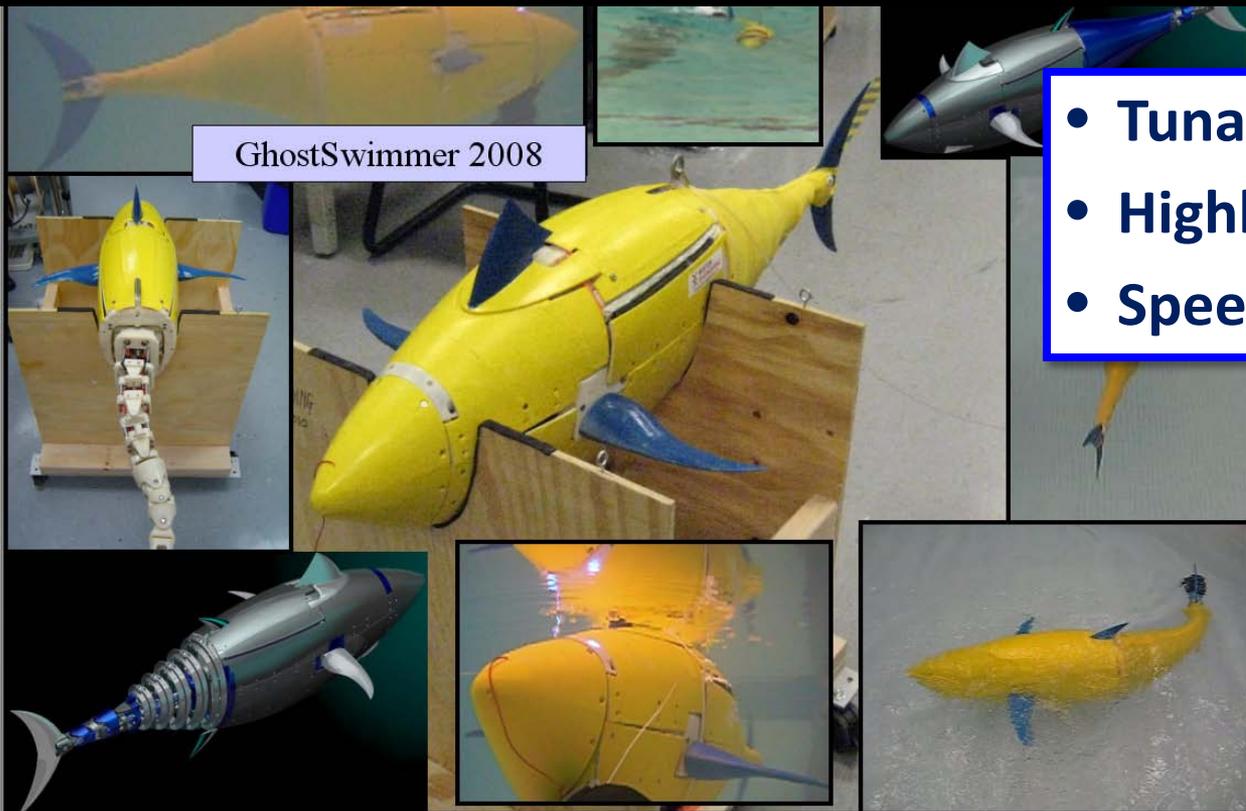


**Dr. Thomas McKenna**

**Dr. Promode Bandyopadhyay at NUWC Newport**

# GhostSwimmer

## Exploiting Nature's Design Principles



- Tuna –Inspired Vehicle
- Highly Maneuverable !
- Speed goal is 10-20 Knotts

STTR  
Boston Engineering



Dr. Thomas McKenna

# GhostSwimmer

## Exploiting Nature's Design Principles



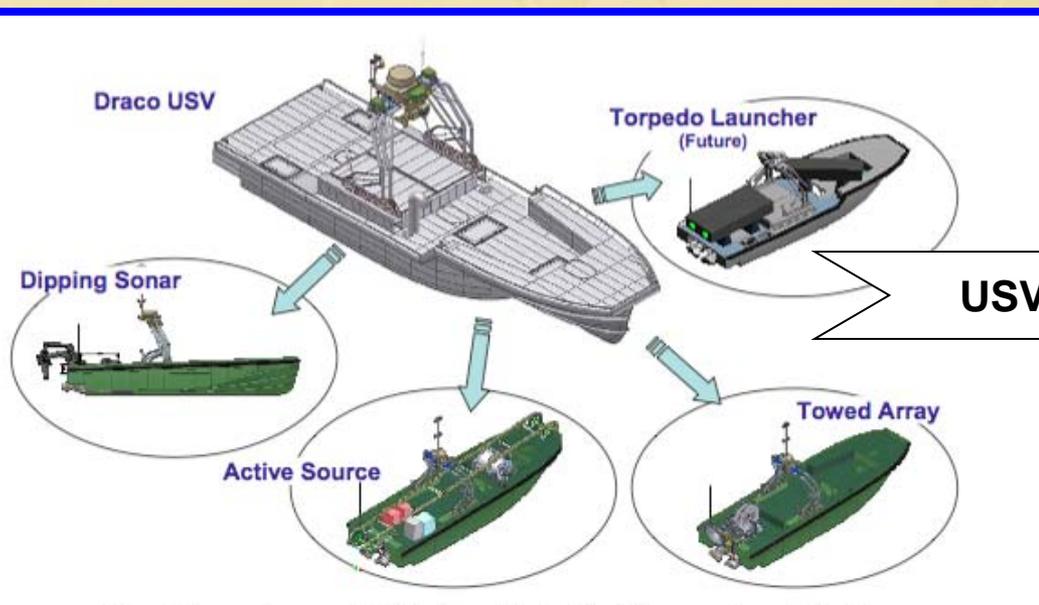
- Tuna –Inspired Vehicle
- Highly Maneuverable !
- Speed goal is 10-20 Knotts

STTR  
Boston Engineering



Dr. Thomas McKenna

## Single Operator: Multiple Unmanned Surface Vehicles



USV Operator Stations

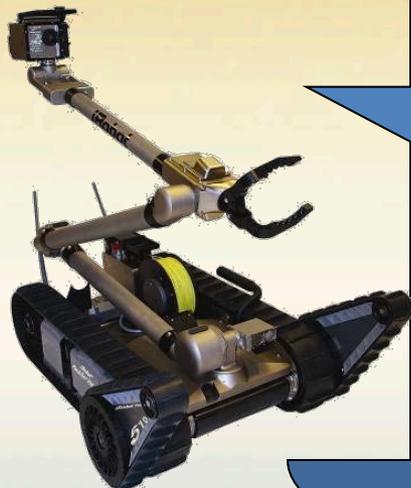


Dr. Ami Bolton

- ✓ Improved operator performance
- ✓ Reduced manning requirement
- ✓ Reduced space / maintenance requirements

# Heads-Up / Hands-Free Robot Coordination / Communication

No controller hardware or displays needed



Dr. Thomas McKenna

## **Near Term: Multi-modal, Natural Human-Robotic Interaction**

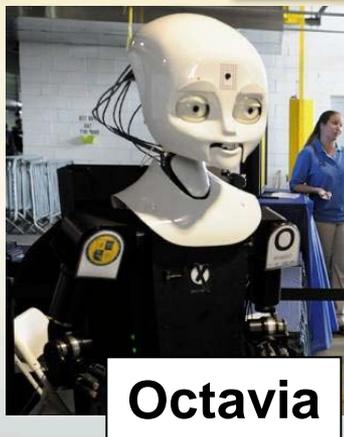
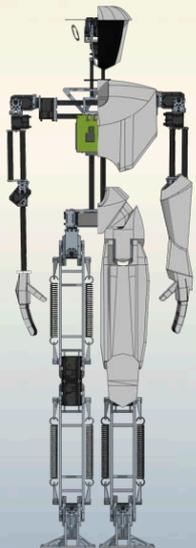
- Automatic detection, tracking, following of human team members
- Speech recognition for voice command and control
- Speech synthesis to communicate to operator
- Gesture recognition for physical command and control

Putting it all together ...

# the HYBRID FORCE

## Humanoid Robots

- Cognitively Compatible HUMAN-ROBOT TEAMS
- Biometric-enabled recognition of Blue / Red forces
- Social Cognition / Human-Robot Communications



**Octavia**

Naval Research Lab

Shipboard Autonomous Firefighting Robot

**Dr. Thomas McKenna**



**Triage in CBRNE Scenario**

Partnership Cost

Unmanned Systems

**Affordable**

Network-Centric

**Efficient**

**Effective**

Irregular Warfare

Manpower, Personnel  
Training and Education



# Naval Warfighter Performance



# ONR34 Program Officers

**ONR34 : WARFIGHTER PERFORMANCE Science & Technology Department**  
**Dr. Terry Allard, Department Head / CAPT David Neri PhD, Deputy**

## 341: HUMAN & BIO-ENGINEERED SYSTEMS

## 342: WARFIGHTER PROTECTION & APPLICATIONS

**Dr. John Tangney, Division Director**

**CAPT David Neri PhD, Division Director**

Name	Program	Name	Program
Dr. Jim Ballas-NRL	C2 Decision Support	Dr. Tim Bentley	Force Health Protection FNC Deputy
Dr. Linda Chrisey	Naval Biosciences	Dr. Ami Bolton	Human Systems Design
CDR Joseph Cohn PhD	Division Deputy	Dr. Mike Given	Casualty Care & Mgmt
Dr. Rebecca Goolsby	Social Networks/ Anthropology	Dr. Laura Kienker	Naval Biosciences
Dr. Harold Hawkins	Training S&T, Modeling & Simulation	Dr. Kip Krebs	Capable Manpower FNC Deputy
Dr. Tom McKenna	Neuroscience/Biorobotics/ Biometrics	CDR Sheri Parker PhD	Division Deputy, Basic Biomedical
Mr. Ranjeev Mittu-NRL	Team Collaboration	LCDR Matt Swiergosz PhD	Undersea Medicine Program
Dr. Ray Perez	Training & Education S&T	Mr. Kurt Yankaskas - NAVSEA	Noise Induced Hearing Loss (NIHL)
Dr. Igor Vodyanoy	Biophysics, Stress, Medical Devices		

## Questions?