Human Systems Science & Technology

Dr. Terry Allard ▪ ONR34
Department Head
Warfighter Performance S&T
Office of Naval Research

Terry.Allard@Navy.mil

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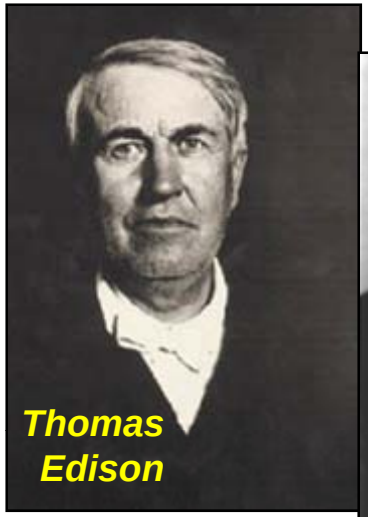
ONR History

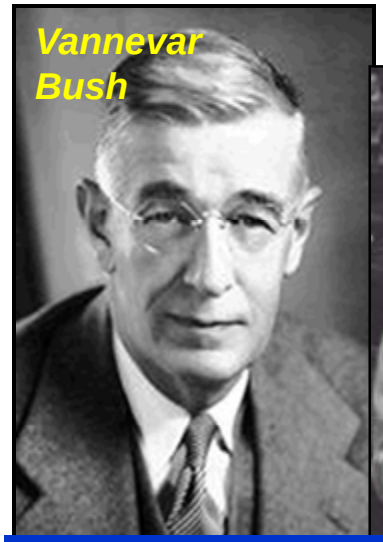
Naval Research Laboratory *(Appropriations Act, 1916)*

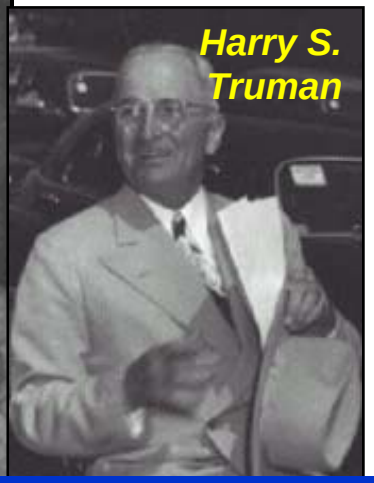
"[Conduct] exploratory and research work…necessary… for the benefit of Government service, including the construction, equipment, and operation of a laboratory…."



Office of Naval Research *(Public Law 588, 1946)*

"… plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the preservation of national security…. "



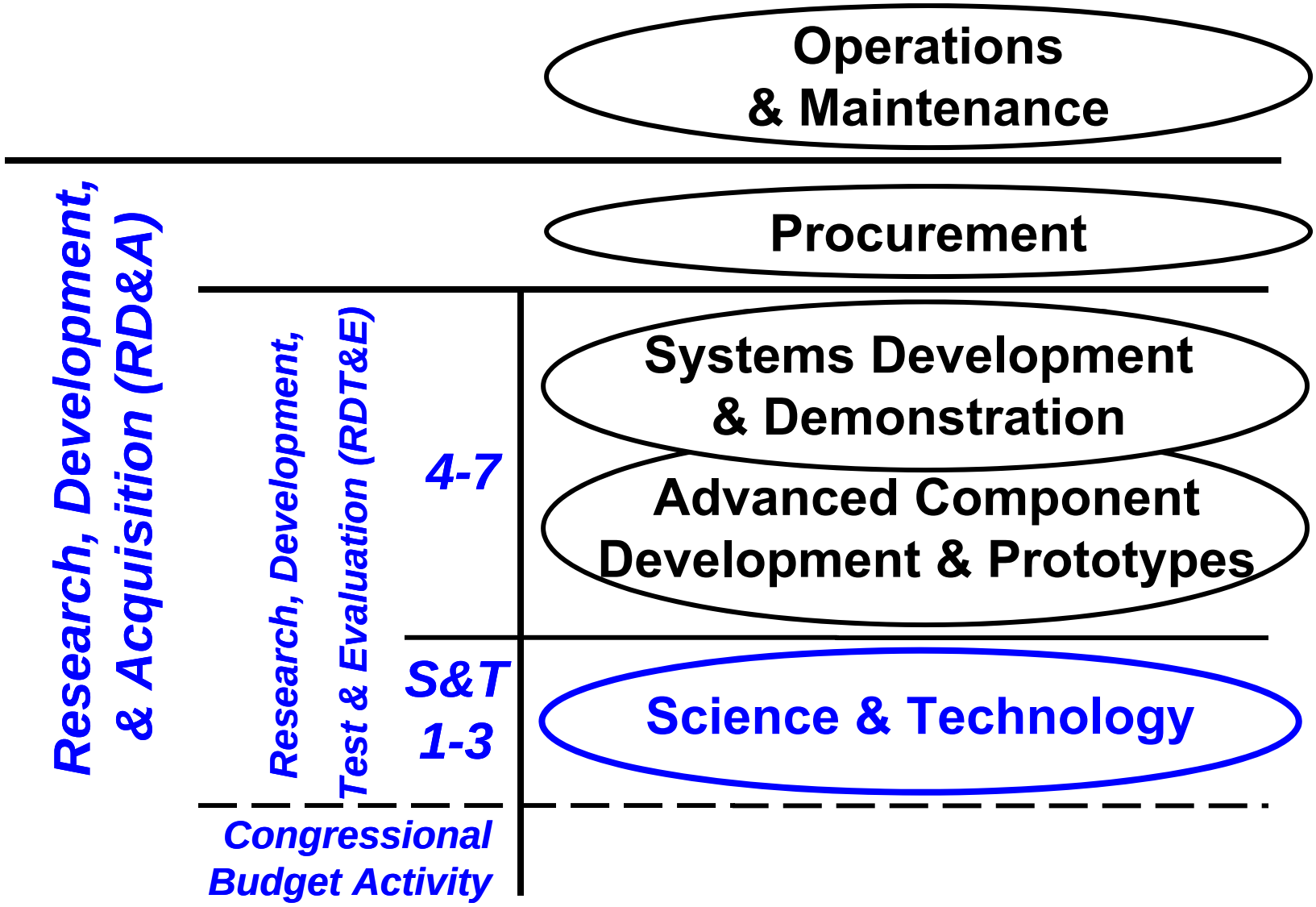


Transitioning S&T *(Defense Authorization Act, 2001)*

"…manage the Navy's basic, applied, and advanced research to foster transition from science and technology to higher levels of research, development, test, and evaluation."

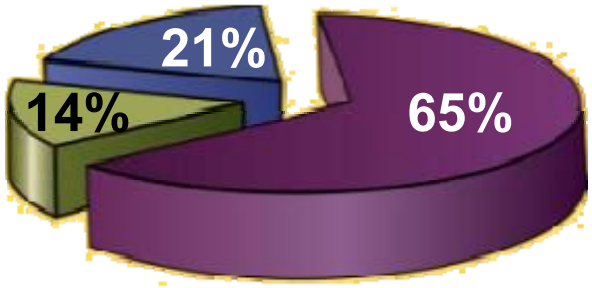
Today: Continued Strong Support for Science & Technology

Research, Development, Acquisitions, Operations

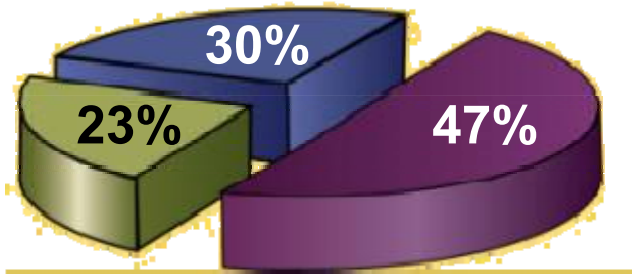


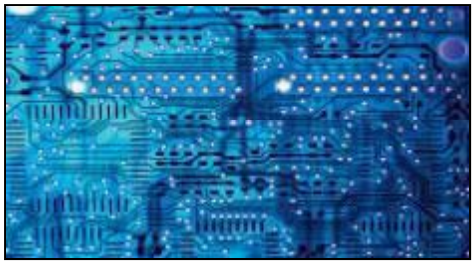
Naval S&T Investment by S&T Community

6.3: Advanced Tech Development

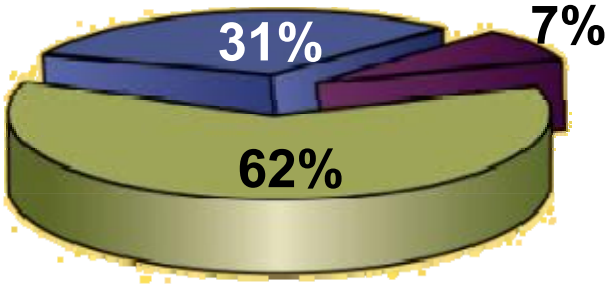


6.2: Applied Research

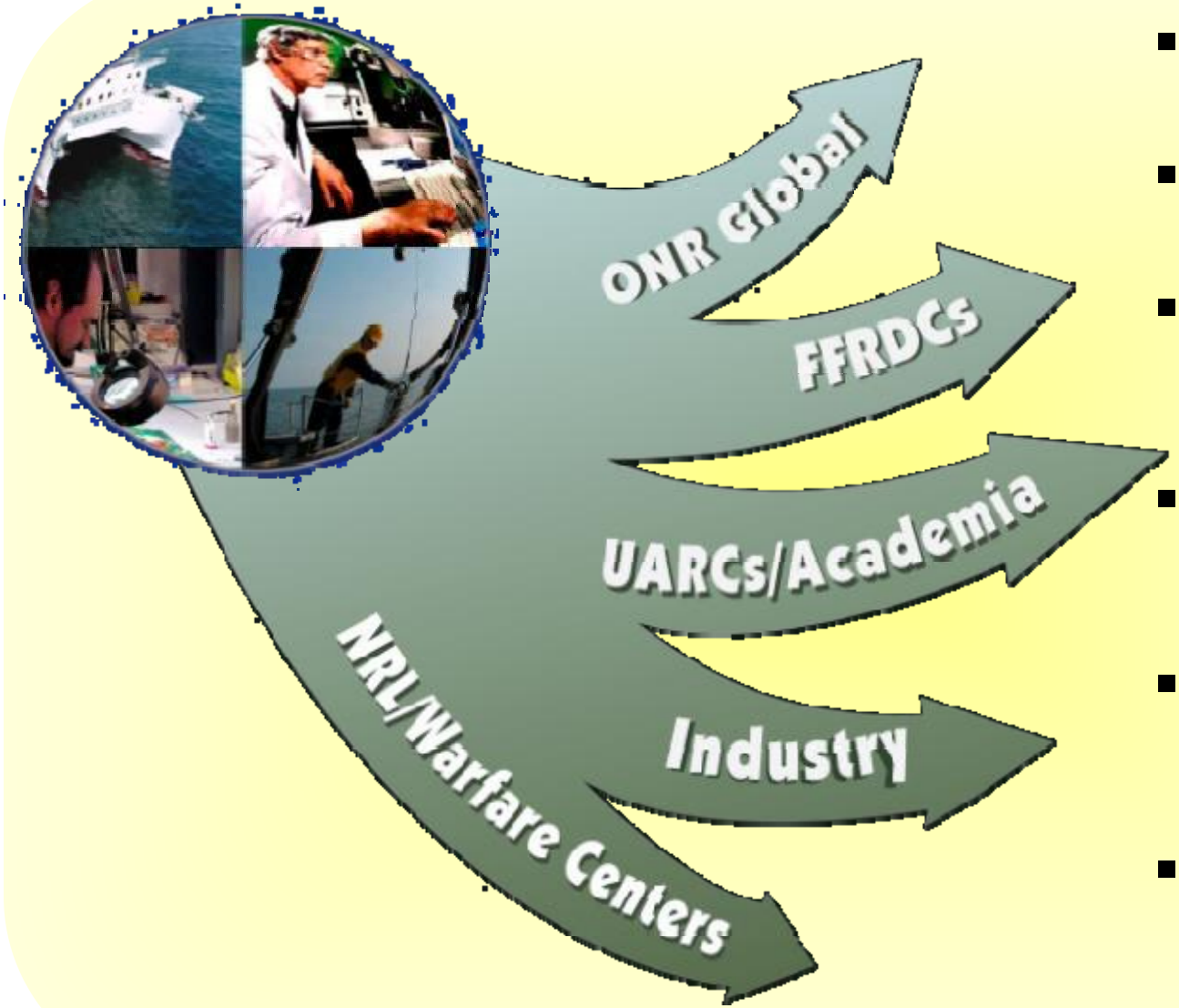




6.1: Basic Research



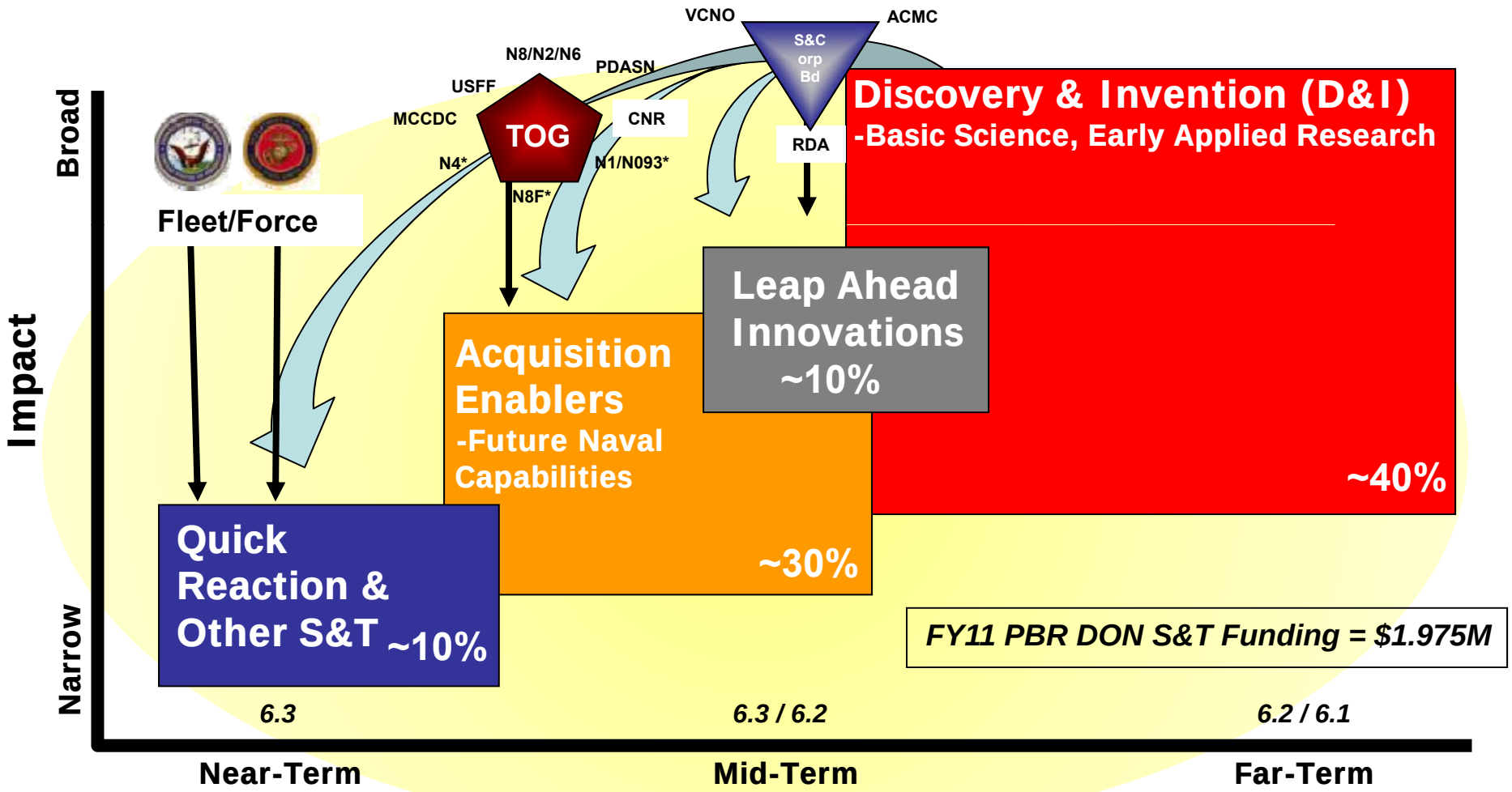
How We Execute



- 70 Countries
- 50 States
- 1,078 Companies
  - 859 small business
- 1,035 Universities & Nonprofits
- 3,340 Principal Investigators
- 3,000 Grad Students

2009 Naval Science & Technology Strategy

Near-term Deliverables and Long-lead Innovation

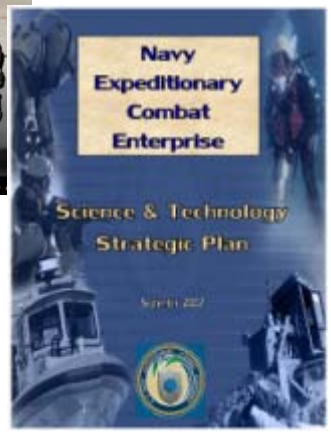


Approved by 4-star Corporate Board (2011 update pending)

Naval S&T Strategic Plan Focus Areas

Approved by S&T Corporate Board

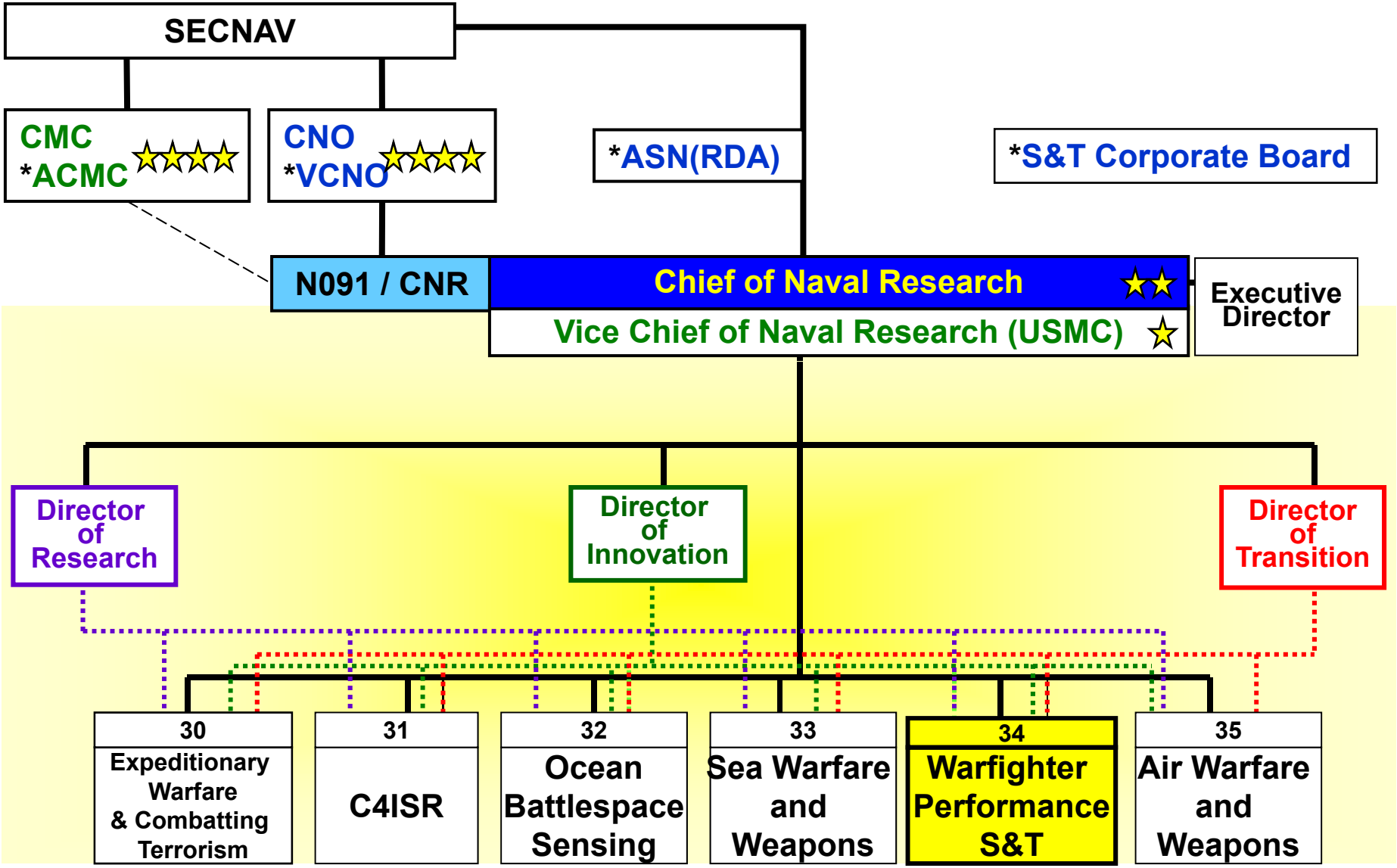
- Naval Warfighter Performance
- Total Ownership Cost
- Information Superiority & Communication
- Distributed Operations
- Asymmetric & Irregular Warfare
- Operational Environments



- Maritime Domain Awareness
- Platform Mobility
- Power and Energy
- Power Projection
- Assure Access & Hold at Risk
- Survivability & Self-Defense
- Fleet/Force Sustainment

Naval S&T Strategic Plan Focus Area

Office of Naval Research



Collaboration crosses all ONR Departments

ONR34 Warfighter Performance S&T Strategy

"Warfighter-System Integration"

- **Solving today's problems while planning for the Navy and Marine Corps after next**
  - Naval Enterprise Science & Technology Objectives (STO's)
  - Understanding current and future issues
  - Avoiding technological surprise
  - Reducing investment risk in new ideas
- **Art of the possible from the state of the art**
  - Building on in-house S&T expertise
  - Drawing on broad stakeholder partnership
  - Visualizing the future
- **S&T Competency and Global awareness:**
  "Consultants of the 1st resort"

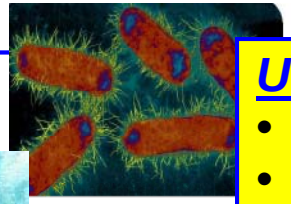
ONR34 Science & Technology Competencies

Human Systems Integration

- Manpower Modeling
- Personnel Selection & Assignment
- Training
- User-Centered Design
- C2 Decision Support
- Safety

Bio-Engineered Systems

- Marine Mammal Health
- Bio-based Sensors
- Microbial Fuel Cells
- Bio Robotics
- Human-Autonomy Systems



Undersea & Expeditionary Medicine

- Undersea Medicine
- Point of Injury Care
  - Hemorrhagic shock
- Automated Medical Care
  - CASEVAC

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Warfighter Performance S&T Department

ONR34 Department Head
Dr. Terry Allard, SES

Deputy
CAPT David Neri, PhD

Staffing	Number of Personnel
Military Active Duty	4
Civilian (ONR)	21
Civilian Vacancies	2
Detailees	3
On-Site Contractors	22
Total	52

Human & Bioengineered Systems
ONR 341 Division
Dr. John Tangney, SES

Warfighter Protection & Applications
ONR 342 Division
CAPT David Neri, PhD

Research Protections
ONR 343 Division
Dr. Tim Singer

Human-Systems Integration D&I

Training

C2 Architecture & Decision Support

Social, Cultural, & Behavioral Sciences

Human-Robotic Interaction

Cognitive & Computational Neuroscience

Bio-inspired Science & Technology

Stress Physiology & Performance

***Future Naval Capabilities*:**

- **CAPABLE MANPOWER**
- **FORCE HEALTH PROTECTION**

Basic Biomedical

Combat Casualty Care

Undersea Medicine

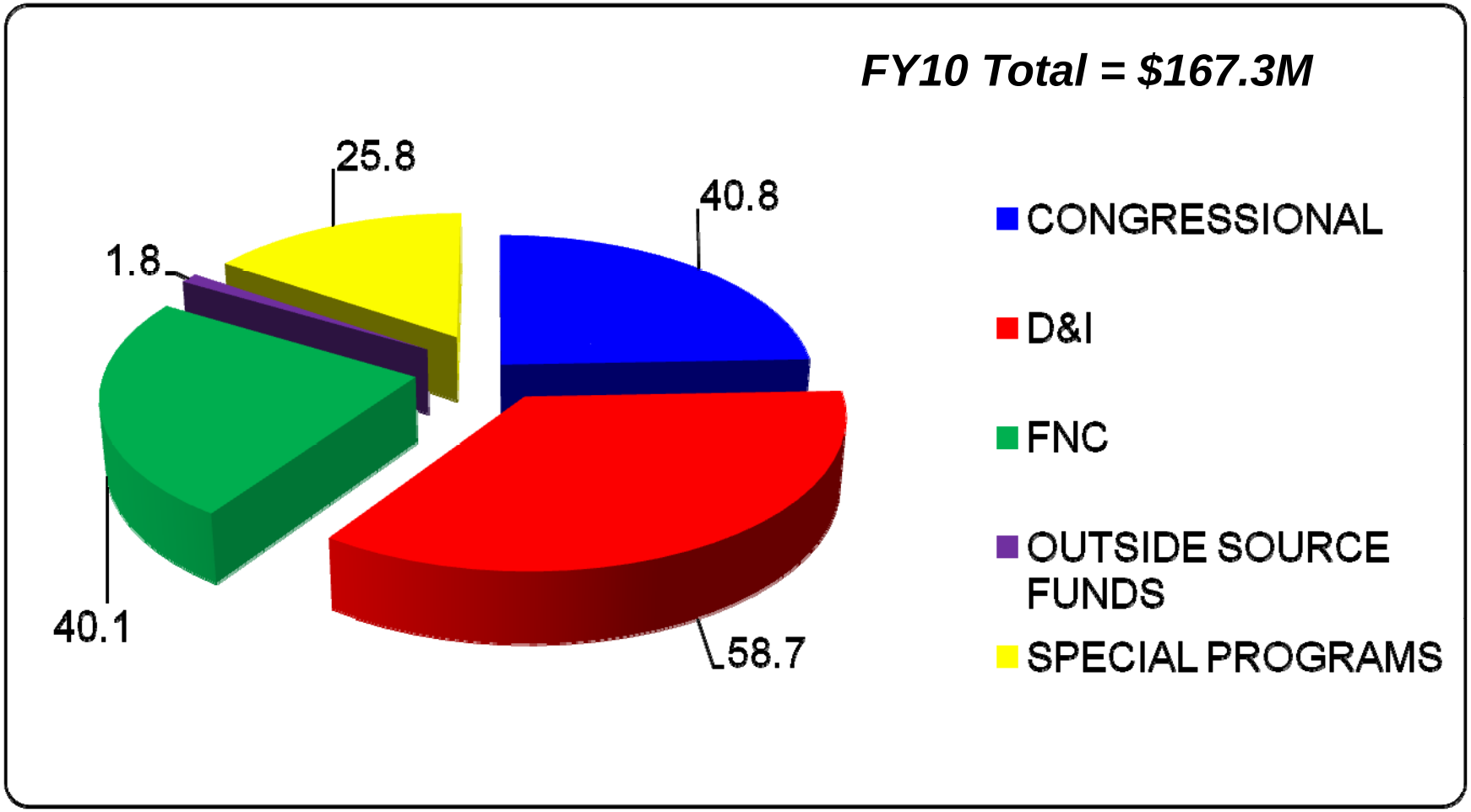
Noise Induced Hearing Loss

Navy Human Research Protections

- ***SYSCOMs***
- ***Training Commands***
- ***Operational Commands***
- ***Extramural Research***

* *except Navy Medical Laboratories*

ONR34 FY10 Funding Distribution

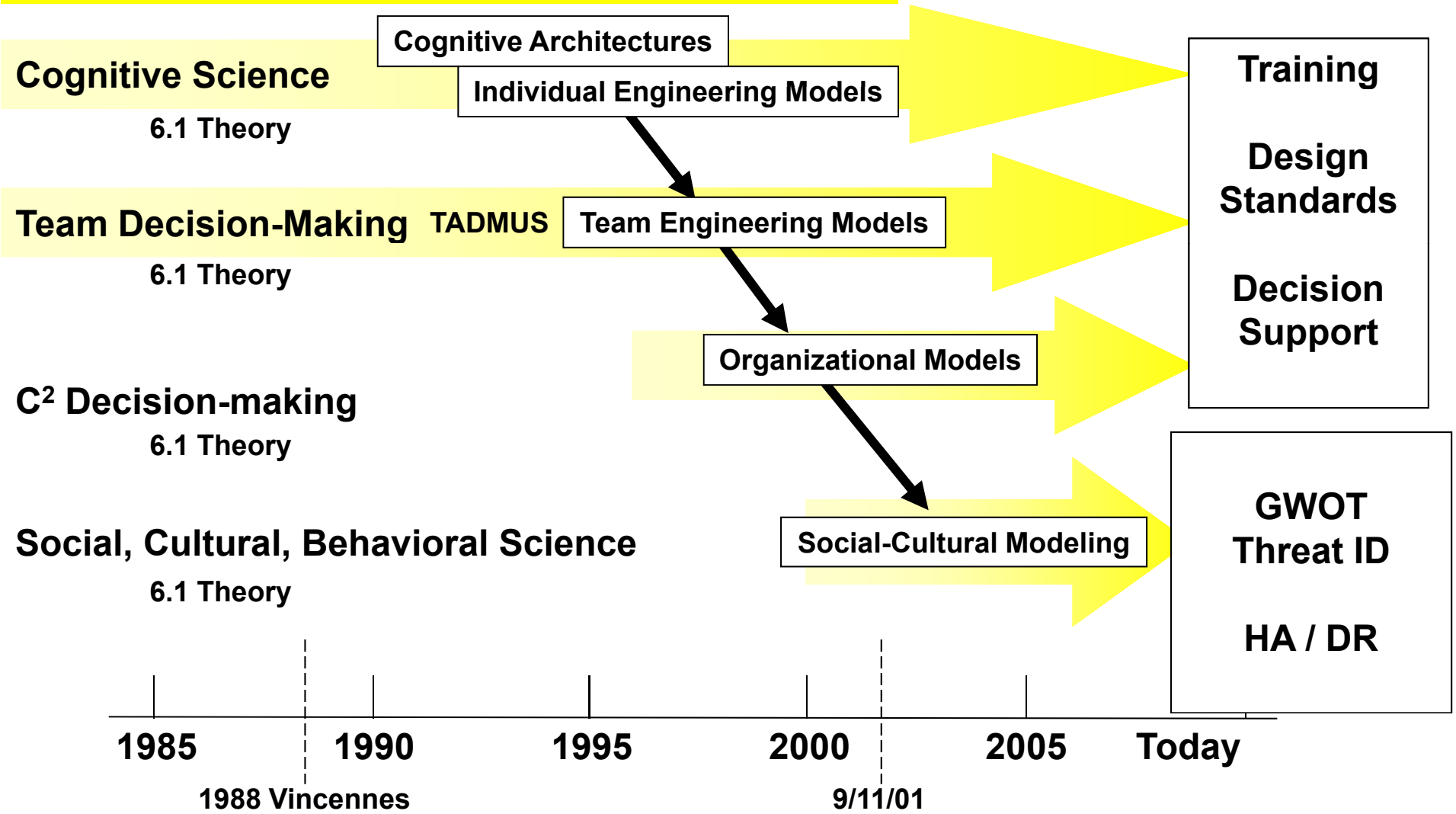


Special Programs: 14 MURI, 14 YIP, 14 SBTT, 13 SBIR, 5 DURIP, 4 PECASE, 4 BRC, 1 RTT

Creating new fields / Anticipating requirements

Computational Modeling of Human-System Performance

1969: First ONR investment in Intelligent Tutoring



Naval STEM Education Forum

June 15-16, 2011

Hilton Alexandria Mark Center, VA

- Content lead: Carolyn Van Damme, DOR 588-2429, carolyn.vandamme.ctr@onr.navy.mil
- Coordination lead: Dave Nystrom, CSC 696-0738, dave.nystrom@navy.mil

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. Tim Bentley	Force Health Protection FNC Deputy
Dr. Paul Bello	Computational Cognition	Dr. Ami Bolton	Human Systems Design
Dr. Linda Chrisey	Naval Biosciences	Dr. Mike Given	Casualty Care & Mgmt
LCDR Joseph Cohn PhD	Division Deputy	Dr. Laura Kienker	Naval Biosciences
Dr. Rebecca Goolsby	Social Networks/ Anthropology	Dr. Kip Krebs	Capable Manpower FNC Deputy
Dr. Harold Hawkins	Training S&T, Modeling & Simulation	CDR Sheri Parker PhD	Division Deputy, Basic Biomedical, Stress Phys
Dr. Tom McKenna	Neuroscience / Biorobotics/ Biomimetics / Biometrics	CDR Matt Swiergosz PhD	Undersea Medicine Program
Dr. Jeff Morrison	Command Decision-Making	Mr. Kurt Yankaskas - NAVSEA Detailee	Noise Induced Hearing Loss (NIHL)
Dr. Ray Perez	Training & Education S&T	Dr. Peter Squire	NSWC-Dahlgren Detailee
		Dr. Melissa Walwanis	NAWC-TSD Detailee

Back-Up

Some Emerging Human-Systems Issues

- **Quantifying Human-System Design trades on Total Ownership Costs and System Performance / Combat Readiness**
  - *Rising personnel costs, declining budgets : "This time it's different."*

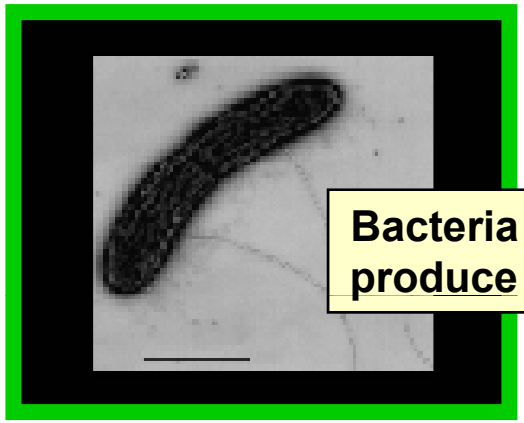
- **Beyond Individual Performance:**
  Extending HSI analysis to Networked Human-Machine teams
  - *Exploiting machine computational speed and power*
  - *Collaborative control over autonomous agents / vehicles*
  - *the Hybrid Force: human – machine collaboration*

- **"Embodied" Intelligence enhances Human-Autonomy Interaction**
  - *Natural Language interaction based on common internal models*

- **Neural and Functional plasticity throughout life**
  - *"Innate" traits like fluid intelligence can be enhanced through training*

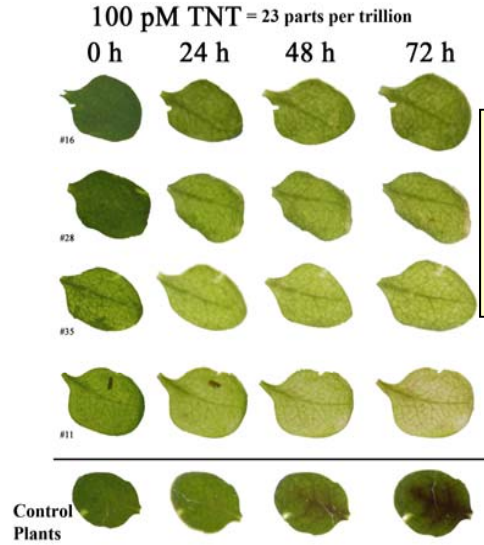
Synthetic Biology

Exploiting Nature's Design Principles



Bacteria in seabed produce electricity

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



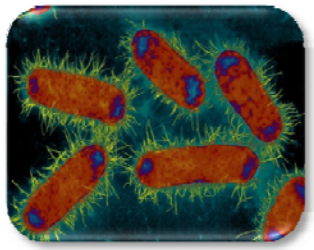
TNT Biosensor
Plant's leaves turn white in presence of TNT

Microbial physiology and electron transfer mechanisms for microbial "batteries"

- Persistent "Green" Power

Dr. Linda Chrisey

Engineered ***Sentinel*** ***Cells*** attack Wound Infection

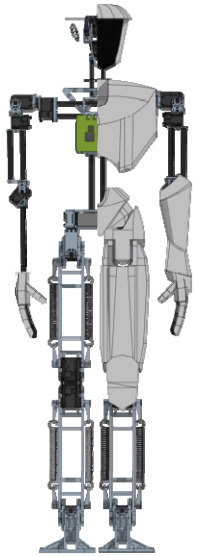


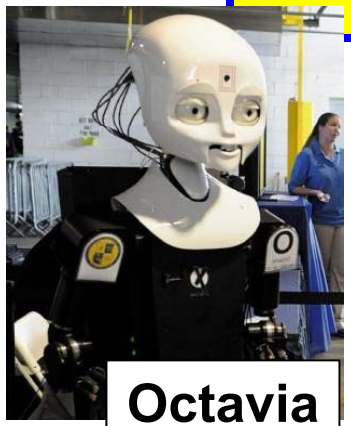
THE HYBRID FORCE

Peer-to-Peer Collaborative control

- Hands-free control of autonomous vehicles / robots
- Cognitively Compatible HUMAN-ROBOT TEAMS
- Biometric-enabled recognition of Blue / Red forces
- Social Cognition / Human-Robot Communications

Humanoid Robots





Octavia

Naval Research Lab
Industry / Academia

Shipboard Autonomous Firefighting Robot

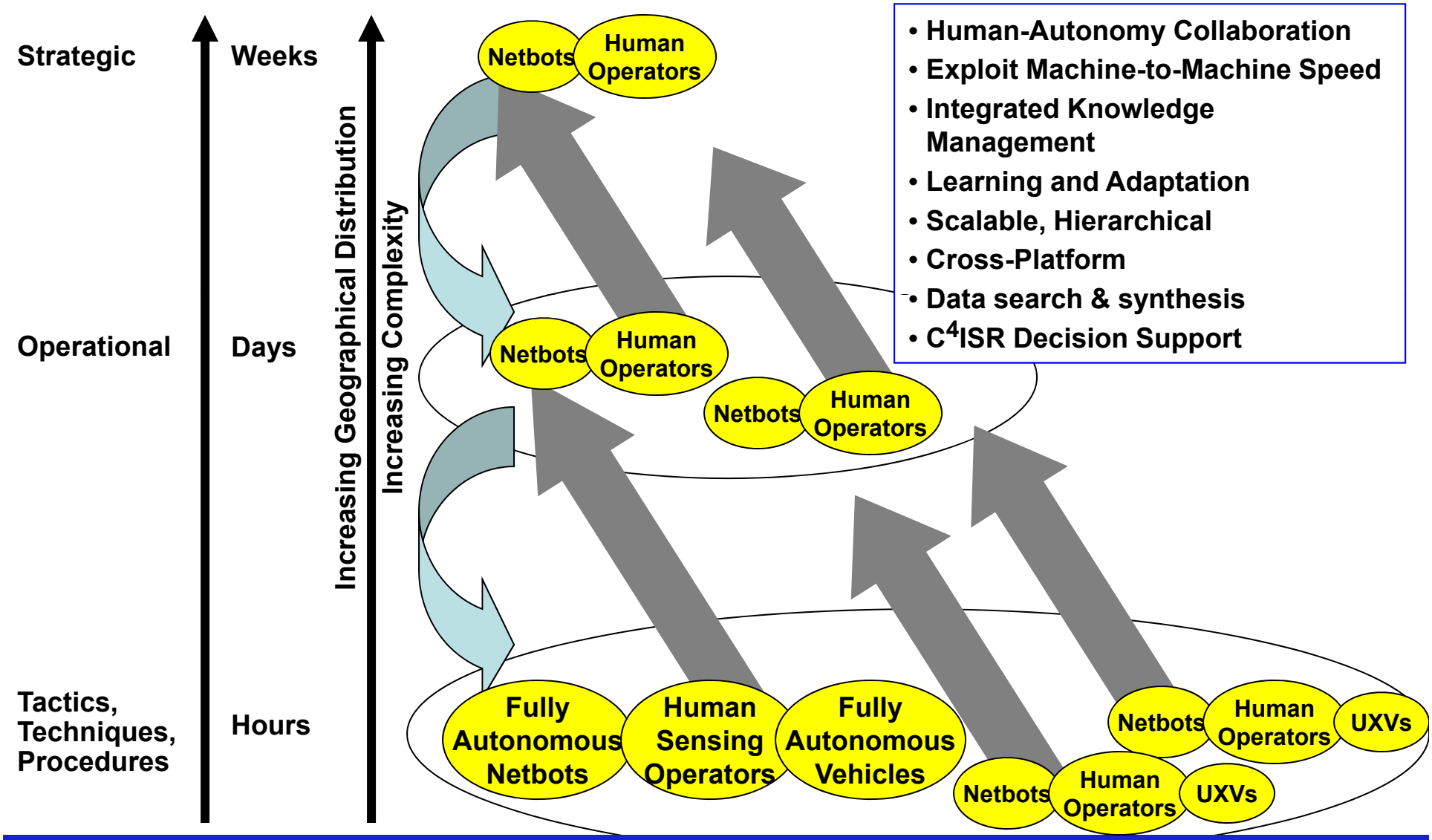
Triage in CBRNE Scenario

Dr. Thomas McKenna

Extending Human-Autonomy Interaction beyond Vehicle Systems to all Mission Focused Autonomy

Future C2: Nested Autonomy & the Hybrid Force

Beyond Autonomous Vehicles

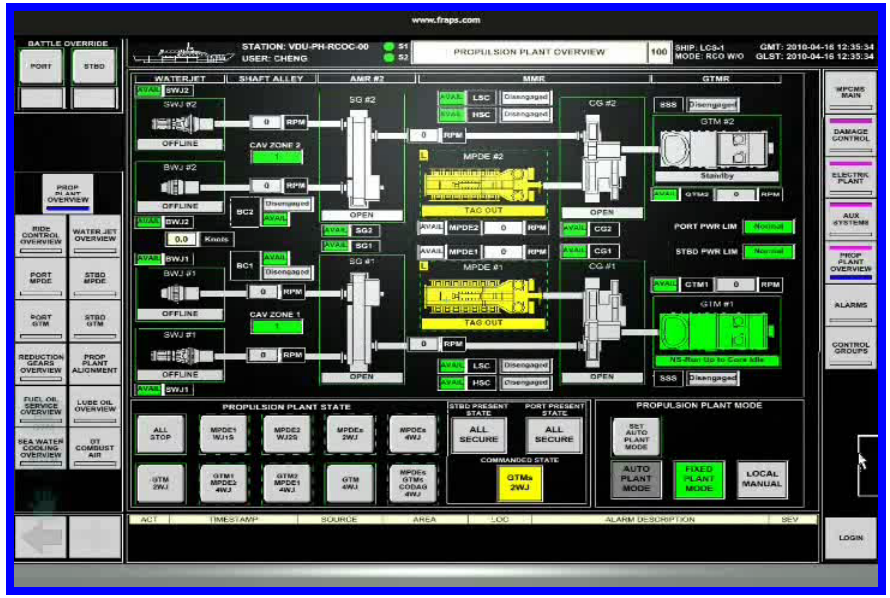


Hybrid Force: People & Machine elements at all system levels

Scenario-Based Training:
Virtual Maintenance Performance Aid

Physics-based simulation for the Littoral Combat Ship

VMPA Instructor



Engineering Plant Technician "Rover"

Dr. Harold Hawkins

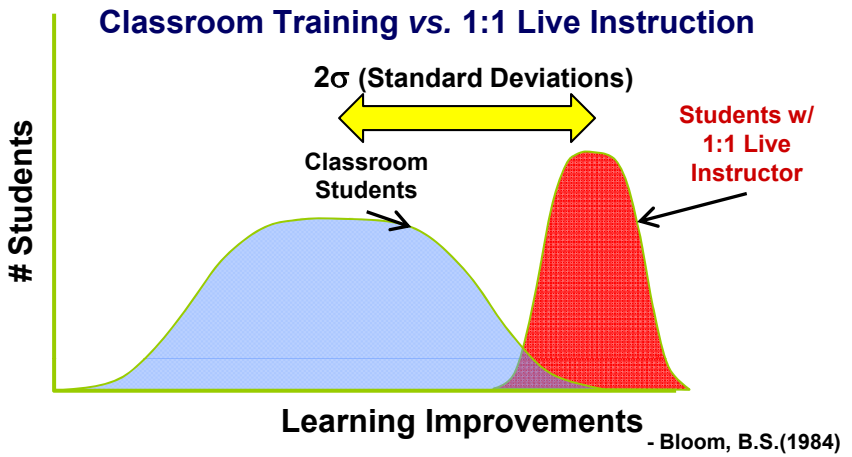
Readiness Control Officer (RCO) training using the Machinery Plant Control & Monitoring System (MPCMS) on the virtual bridge of LCS-1 Freedom

13 student and 2 instructor stations deployed to the Surface Warfare Officers' School (SWOS):
1 student and 1 instructor station deployed to LCS CLASRON and in current use for RCO training

Intelligent Tutoring Systems (ITS)

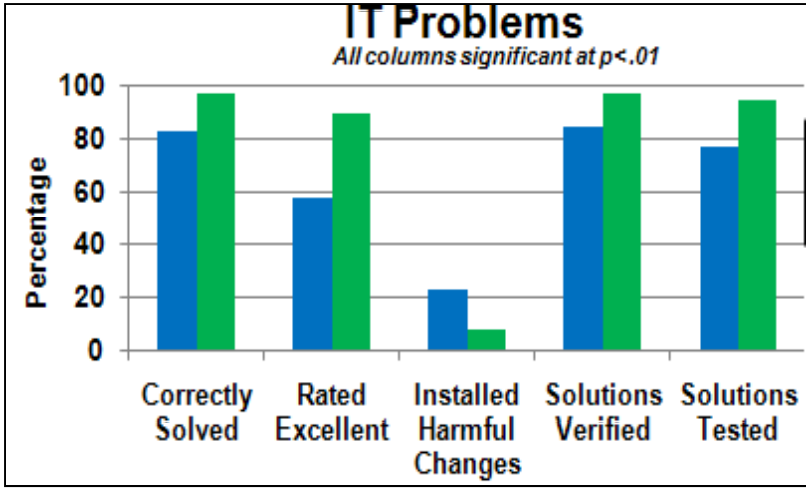
Empirically demonstrated: best results achieved using one-on-one live instruction

- **2 standard deviation improvement in student performance over classroom training for *a limited amount of course material***
- **Live instructors are able to *tailor their teaching methods to each student's unique learning style***
- **One-on-one approach is *economically infeasible***



Today's ITS can improve students' scores by ~1 SD & are economically feasible

- **Build on RTC-Great Lakes remedial reading success**
- **Broaden ITS domains and target populations to high-school, entering or potential recruits**
- **Tailor instruction to individual student styles**
- **Provide instructor support to author STEM content**
- **Disseminate ITS web on web / social media**



Navy recruits (Pre – "A" School) trained on an Information Technology ITS performed *significantly better* (>1 SD) than experienced ITs (7+ years Fleet experience) when solving actual Navy-reported IT problems