Employment and Graduate Opportunities

The Pennsylvania State University
Applied Research Laboratory
Our Mission

Serve as a university center of research excellence and provide advanced capabilities for critical Naval sciences and technology and related DoD applications.

Champion the transition of advanced technology to operational systems in support of Naval and DoD acquisition programs and the defense industry.

Contribute to the education, research, and service mission of The Pennsylvania State University.
Background

1945  Established by the U.S. Navy

1998  Designated a University Affiliated Research Center (UARC)

- Largest research unit within Penn State with more than 1,000 employees.
- ARL faculty and staff provide technical leadership in the Navy for our areas of expertise.
- Educate the next generation of scientists and engineers for the Naval workforce.
Educational Programs Offered

- Exploratory & Foundational Program
- Support Graduate Program in Acoustics
- Fluids & Structural Mechanics Initiative
  - Undergraduate Summer Interns
- Distance learning
  - Master of Engineering in Acoustics
  - Instruction Program for Navigation
- Short courses in underwater acoustics and signal processing
- U.S. Naval Academy Fellowship Program
- Undergraduate Students Honors
- Laser Processing Summer Interns
- Academically-credited short courses in acoustics and signal processing
- Electro-Optics Workforce Development (K-12, JC, DoD, and civilians)
- Diversity Outreach, Open D.O.O.R.: Students and Faculty
- Take our Daughters and Sons to Work Day
Degree Candidates working at ARL
Total Employees: 1,205

Personnel Backgrounds

Research Scientists and Engineers

- Electrical Engineering: 28%
- Mechanical Engineering: 19%
- Acoustics: 11%
- Physics and Math: 8%
- Computer Science and Engineering: 13%
- Aerospace Engineering: 5%
- Other Engineering: 11%
- Other Science: 5%

- BS: 33%
- MS: 42%
- Ph.D.: 25%
Diversity and Outreach at ARL

- Partnerships with Historically Black Colleges and Universities (HBCUs) and other universities
- Multiple Department of Defense monetary awards for the above joint efforts
- ARL hosts visiting professors and students
- ARL presents guest faculty lectures at universities
- ARL sponsors summer interns

For more information: http://www.arl.psu.edu/diversity.html
Summer Internships

“The internship was enjoyable because my adviser was easy to work with and the project was interesting. My adviser was always willing to answer questions and offer insight. At the same time, I had a degree of freedom in deciding how to approach problems and show data. The project was enjoyable because it explored a novel idea and it incorporated my interests in mathematical modeling and fluid mechanics.”

– Sekou Wilson
Summer intern in power systems modeling
Example of Summer Internship Research

Research
• Explore using laser light to recharge Unmanned Undersea Vehicles (UUVs) and compare to current methods

Results
• Laser light requires less work than conventional electric charging and is faster than solar charging
• It is an effective technique for charging UUVs
**Why work at ARL?**

Better pay than typical assistantships.

Research that can turn into a thesis topic.

More interaction with practicing engineers.

Opportunity for summer work at sponsor/customer sites.

Contact for later employment, either at ARL, with sponsors, or with work contacts.
Express interest to:

Alan Payne
tap1@only.arl.psu.edu
(814) 863-4107

Apply to department of interest:

www.engr.psu.edu
www.science.psu.edu
Research areas are not confined to one area. We encourage you to peruse all competencies.

http://www.arl.psu.edu
Acoustics
Recent Research Topics

Acoustic vector sensors

Propagation models

Explanation of signal statistics

Thermoacoustic AC power generator

Wideband, wide area seafloor physical property survey method

http://www.arl.psu.edu/capabilities/rap_acoustics.html
Environmental Acoustics

- Surface, volume, and bottom acoustical characterization and scattering
- Measurements and modeling in the ocean
- Acoustic fluctuations in the ocean and atmosphere
- Effects of irregular terrain on the propagation of sound in the atmosphere
Thermoacoustics

- Study acoustically driven heat transport
- Developed a thermoacoustic refrigerator for Ben & Jerry’s
- Developed a prototype thermoacoustic heat engine
- Products have been flown on the space shuttle and have been used to cool radar electronics onboard a U.S. Navy warship
Test Facilities

- Water Tunnel
- Wind Tunnel
- Anechoic Chamber
- Structural Acoustics Tank
- Reverberant Water Tank
Guidance and Control
Recent Research Topics

Analysis

Simulation

Visualization

Real-time coding

Signal processing

System integration

Embedded algorithms

Autonomous unmanned vehicles

http://www.arl.psu.edu/capabilities/at.html
Signal Processing

- Automation, pattern recognition & data fusion for mid-frequency surface ship sonar
- Bayesian framework for multi-sensor information networks
- Fundamental research in application of group theoretic concepts to time-frequency and wavelet transforms
- High frequency broadband time/frequency spreading

Sample Projects

- Blind source separation
- Multistatic signal processing
- Shallow water acoustics
- Broadband detection and classification
Guidance Systems Technology

• Detection, classification, & localization of targets
  – Increase probabilities of detection, correct classification acquisition, homing, terminal homing

• False targets
  – Reduce probability of false alarms, false targets, false homing

• Waveform specific processing
  – Countermeasure resistance
  – Environmental robustness
  – Low probability of exploitation
Guidance
Systems
Technology

• Torpedo tactics
  – Robustness to threat tactics
  – Environmental adaptation
  – On-the-fly plan generation

• Threat characteristics
  – Target models
  – Evasion tactics
  – Frequency, bandwidth, and aspect dependencies
Guidance Systems Technology

• Sensor specifications
  – Narrowband
  – Broadband
  – Source level
  – Frequency dependencies
  – Beam patterns

• Embedded systems
  – Rapid prototyping for insertion of advanced algorithms
  – Modular, real-time software
  – Processing architectures
  – Data recording and reduction

• Sea tests and demonstrations
  – Launch, recovery (sub & ship)
  – Site analysis (tactical relevance)
  – Environmental compliance
  – Rapid turn-around
  – Fleet interactions
Intelligent Control Systems

• Reusable intelligent control architecture

• Correctly inference/recognize patterns from incomplete/erroneous input

• React to unforeseen situations (no scripted cases)

• Autonomous, on-the-fly planning and re-planning

Perception

Smart Sensor Data and Messages

Data Fusion Algorithms

Physical Properties

Continuous Inference Network (Interpretation)

Inferred Properties

Behavior Interface Property

Representational Class (RC)

Response

Context for Sensor Interpretation

Offboard Communications

Behaviors

Orders

Mission Manager

Plan Execution

Effector Commands

Actions

Messages

Other ICs
Intelligent Control Systems

• Unmanned Aerial Vehicles (UAV)
  – Joint effort with PSU Aerospace

• Unmanned Armed Rotorcraft
  – Simulation experiment
Intelligent Control Systems

Research

- Intelligent control and health monitoring
  — (dynamic mission replanning)
- Health status and prognostics
Systems Analysis and Simulation

- High-fidelity digital modeling and simulation
  - Used to define requirements
  - Develop concepts
  - Develop, and evaluate subsystems
  - Evaluate system-level performance
  - Educate fleet personnel on torpedo capabilities

Transmit Pattern

Receive Pattern
Fluids & Structural Mechanics
Recent Research Topics

Fundamental and exploratory research areas

• Cavitation
• Flow control
• Hydrodynamics
• Boundary layer flows

Experimental fluid dynamics

• Design and analysis of underwater propulsors and turbomachinery

Technology Integration

• Materials science
• Manufacturing science
• Computational mechanics
• Flow and structural acoustics

http://www.arl.psu.edu/capabilities/fsm.html
Fluids & Structural Mechanics

- Fluid Dynamics
- Hydroacoustics
- Computational Mechanics
- Operations Design & Fabrication

Tools
Test Facilities

- **Field Testing**
  - Keyport Naval Facility
  - Dabob Bay
  - Nanoose Bay
  - Bayview ARD
  - Lake Pend Oreille

- **Water Tunnels**
  - 48” Diameter (≤ 35.5 knots)
  - 12” Diameter (≤ 47.5 knots)
  - 6” Diameter (≤ 41.5 knots)
  - 1.5” Diameter (≤ 163 knots)

- **Wind Tunnels**
  - Closed Loop (≤ 89 knots)
  - Open Return (≤ 71 knots)

- **Glycerin Tunnel** (≤ 12 knots)

- **Flow-through Anechoic Chamber**

- **Reverberant Tank**

- **Pump Loop**
Large Unmanned Undersea Vehicle

- Design and develop a multi-use testbed platform
  - UUV mission development
  - Advanced submarine propulsion research

- Conduct concept studies to determine proper scale and cost effective size, range, and payload capacity

- Conduct preliminary design of all subsystems and distributed pump and jet propulsion tail
Drag Reduction (DR) System

• Demo of Cortana Corporation DR System
  – System components each evaluated at ARL/PSU (2001-2004)
  – AT-SEA: July - September 2005
Technology Investigations

Water tunnel tests of variable cavitator

Very low flow noise laminar flow cavitator

Acoustic array development

Field tests at Aberdeen

Water tunnel tests of variable cavitator

Return to Research Areas
Left Ventricular Assist Device

• ARL/Datascope Insertable LVAD
  – Larger flow rate
  – No surgery to implant or remove – 3mm incision in femoral artery
Materials and Manufacturing
Recent Research Topics

- Materials design
- Laser processing
- Component design
- Materials processing
- Manufacturing systems
- Repair and sustainment

http://www.arl.psu.edu/capabilities/mm.html
Product and Process Design

- Cost estimating
- Workcell development
- Multidisciplinary organization
- Advanced design environments
- Discrete event simulation
Environmental Technology

- Air and water treatment
- Coatings application and removal
- Bio-filtration
- Odor control and chemical monitoring
- Modeling and risk assessment
Electro-Optics

- Spectroscopy
- Digital shearography
- Non-contact gaging
Laser Assisted Nanomaterial Synthesis

Silver writing from silver salt solution on Si wafer, electrical resistivity improved by 30%

Silver Nanoparticles

Nanorods of silver alloy

Porous Nickel Nanoparticles

Nano-tube
Laser Welding

Benefits:

• stable weld pool
• less porosity
• doubled weld speed
• thicker welded plated
• (desirable up to 3" thick steel plate)
Ceramic Coatings Applied to Turbine Components

Ceramic Coatings enhances component life two fold for every 25 F decrease in metal temperature

\[ \Delta T = 180 \, ^\circ C \]

Bottom: 200 nm/layer
Top: 10 nm/layer
Cold Spray Process Coatings

A – Titanium encapsulation of ceramic for armor – to absorb artillery impact

B – Direct Cu writing technology

C – Al-SiC wear coating on Expeditionary Fight Vehicle (EFV) road-wheel

D – Corrosion coating (Al-alloy) on Armor
**Composite Material Use**

- Survivability
- Weight reduction
- Increases stealth properties
- Affordability – acquisition and life cycle
Propulsion & Navigation
Recent Research Topics

Gyrocompasses

Vehicle information sensors

Undersea weapon development

Geographic information systems

Global Positioning System (GPS)

Gravity and terrain estimation systems

Relative, passive, inertial, magnetic, and bathymetric navigation systems

http://www.arl.psu.edu/capabilities/cn_ndr.html
Unmanned Underwater Vehicle

“SEAHORSE”

• First vertically launched unmanned underwater vehicle (UUV)

• Collected oceanographic data

• Looked for mines and mine-like objects collected

• Delivered soil samples to confirmed presence of chemical weapons
Torpedo Defense

• Supports the U.S. Navy in defending surface ships and submarines against torpedo attack

• Builds on ARL’s experience in undersea systems, acoustics, signal processing, modeling and simulation, energy and power systems, systems engineering and hydrodynamics
Navigation Research and Development Center

- Inertial sensors and systems:
  - Conventional mechanical
  - Electrically suspended
  - Ring laser
  - Fiber-optic
  - Micro-machined
  - Covert / Passive navigation
  - Bathymetric, gravity, and magnetic
  - Navigation
  - Terrain estimation

- Global Positioning Systems

- Geographic Information Systems

- Navigation test vehicle operations
Communication & Information
Recent Research Topics

Information fusion

Wireless communications
  • Cellular
  • Ultra Wideband
  • Local Area Network
  • Personal Area Network
  • High Frequency Wireless

Software radio architectures

High fidelity modeling and simulation

Signal processing algorithm development
  • Detection, Geolocation, Interference Mitigation

Quick-Reaction software radio prototyping

http://www.arl.psu.edu/capabilities/cn.html
Information Systems

- Integrated data environments
- Distributed computing
- Custom database development
- Collaborative design environment
Synthetic Applications Environment Laboratory (SEALAB)

- Expertise in advanced visualization techniques, immersive environment technologies, and modeling and simulation architectures
- Improves users’ abilities to design, model, analyze, and visualize
Research & Academics
Programs

Acoustics

Information science and technology

Exploratory and foundation programs

http://www.arl.psu.edu/capabilities/rap.html
Acoustics

Resident Expertise & Technologies

• Active vibration and acoustic control
• Computer modeling of machinery vibration and noise
• Nondestructive testing
• Process control and diagnostics
• Advanced sensor design and applications
• Sound propagation and radiation in air and water
• Structural acoustics
• Environmental acoustics
• Physical acoustics
Information Science and Technology

- Multi-disciplinary innovative research

- Used for conceptualizing, designing, analyzing, deploying, and efficiently operating distributed and intelligent dynamic systems

- Contracted by Department of Defense, government, business, and education
Exploratory and Fundamental Programs

• Provide support and research guidance to graduate students whose interests match those of the faculty and staff of ARL

• Student has a primary academic home in one of the Colleges of the University

• Half-time Graduate Assistantships allow the student to participate in the Program during the each semesters

• No obligations placed upon the student upon receiving the degree and none while work is in progress except to make reasonable progress toward their degree objective

• Provides both a stipend and full tuition

• Must be a U.S. citizen
http://www.arl.psu.edu