Homeland Security Expertise at
Pacific Northwest National Laboratory (PNNL)

www.pnl.gov or http://www.pnl.gov/nationalsecurity/

Scientists and engineers at the Pacific Northwest National Laboratory are drawing upon its fundamental science base to develop the next generation of technologies brought to bear on homeland security issues. Achieving greater levels of security needed to safeguard the homeland from terrorism without adverse impacts on the economy or individual rights poses enormous scientific and technical challenges. PNNL is harnessing the Lab's capabilities in advanced chemical, nuclear and biological detection, analysis and visualization of massive data streams, high performance computing and simulation and modeling of complex systems to tackle the most daunting homeland security issues.

PNNL is investing its own funds to advance science for the next generation of information analysis tools for radiation, chemical and biological detection. PNNL's capabilities most relevant to protecting the homeland include atmospheric monitoring; sensors for explosives, chemical biological and nuclear threats; and information analytics.

PNNL is a world leader in atmospheric monitoring of ultra-trace and low-level radionuclides for detecting proliferation of weapons of mass destruction. The Radiological and Chemical Sciences group within the National Security Directorate has had the mission of radiation detection technology development and deployment for more than 50 years. Instruments incorporating PNNL radiation detection technology have been deployed in an array of "field" locations, including: outer space, deep undersea, within the core of both naval and civilian reactors, international border crossings, international test detection network sites, high altitude aircraft, nuclear accident sites such as Three Mile Island and Chernobyl, nuclear complex sites such as PNNL is deploying radiation portal monitors at U.S. ports of entry for the Department of Homeland Security to detect smuggling of WMD onto American soil.

Electronics experts provide scientific and technology development to meet a broad range of sensor, measurement technology, electronic (including controls), and system integration application requirements to detect chemical, nuclear and biological weapons proliferation. PNNL's expertise is tailored to meet client and project needs and includes: scientific investigations and analysis; feasibility studies; measurement and data analysis; method development; validation and application; laboratory testing; prototype equipment development and evaluation; and development and deployment of field hardened equipment and methods.

PNNL mathematicians and computer scientists have been developing the science behind innovative tools that will help analysts look for trends in a vast amount of information. One of these tools is Starlight, an innovative visualization tool that recently won a R&D 100 Award from *R&D Magazine.* Starlight, which was originally developed for defense purposes, enables an analyst to look for trends in various media including structured and unstructured text, maps, digital data, video and even satellite imagery.

PNNL's William R. Wiley Environmental Molecular Sciences Laboratory (EMSL) provides world-class capabilities for enabling fundamental research on physical, chemical, and biological processes, laying a foundation for new solutions to environmental challenges and other critical issues. With instruments ranging from state-of-the-art nuclear magnetic resonance spectrometers, mass spectrometers, and one of the most powerful supercomputers in the world, to suites of surface characterization, complex systems, environmental spectroscopy and trace detection tools, EMSL has the resources needed to address a multitude of research topics.

PNNL's Experience Hosting Undergraduate Students

Pacific Northwest National Laboratory holds to a core belief that our nation's future is inextricably linked to future research developments in science, mathematics and technology. The demands of our changing economy and workplace, the need for an educated people, the impact on our national security, and the intrinsic value of mathematical and scientific knowledge make these areas essential to the education of today's students and tomorrow's citizenry.

The Office of Science and Engineering Education (SEE) at Pacific Northwest National Laboratory (PNNL) is responsible for linking the human, financial and technical resources of the Laboratory with elementary and secondary schools, colleges and universities, and other education/scientific and technological organizations in ways that support the education, diversity, and the research objectives of DOE, PNNL and our partner academic institutions.

From 2003 through the current fiscal year (2007), PNNL has hosted 4,100 interns ranging from pre-college students to post-doctoral appointees. During this time span, 42% were undergraduate students from hundreds of different colleges/universities, both national and foriegn. PNNL averages appointment of 290 undergraduate students to research assignments in science, techology, engineering, and mathematics each summer.

To further investigate the rich variety of internship programs at PNNL that are available to pre-college, undergraduate and graduate students, access the URL address at: http://science-ed.pnl.gov/students.

Internship Benefits

The Office of SEE at PNNL is committed to providing the programs and activities necessary to enhance the Lab's research and development efforts, while providing educational opportunities to students that will ultimately assist in building, enriching and diversifying the nation's technical workforce. Students will have opportunities to network with PNNL staff, attend technical seminars, poster presentations and enrichment activities/events developed by SEE Program Managers. Students will also have the opportunity to attend Battelle Staff Association social events that are offered during the internship period.

PNNL is exceptionally excited about the quality of the DHS students and is willing to provide expense reimbursements of $750 per month to help defray costs the student may incur while in Richland. Other allowable expense reimbursements may be provided based on funding availability.

PNNL is flexible with appointment start/end dates in order to work with the student's academic calendar. All summer appointments at PNNL begin on a Monday and typically end on a Friday.

Onsite Housing and Transportation

PNNL's on-site dormitory, called The Guest House, is extremely well-suited for students and is located within walking distance to most PNNL facilities. The Guest House has a very limited number of rooms available at the student rate during the summer. Students expressing interest may be assigned accordingly based on certain criteria.

Ben-Franklin Transit (http://www.bft.org/) provides a unique, demand response, curb-to-curb service within Ben Franklin Transit's boundary area. This is a scheduled ride to the location you'd like to go which operates Monday through Saturday. Sunday service is also available by scheduling the day before. These services are $1.00 each way.

PNNL Contact Information

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2008 DHS Summer Intern Program
PNNL Project Descriptions

Contact: Rebecca Janosky (509) 375-2302

1. *Field Testing of Explosives Standoff Screening Technologies*

Mentor: Nick Lombardo 509.375.3644 nj.lombardo@pnl.gov
DHS Research Area: Explosives Prevention, Detection, Mitigation and Response

Project Description: The Explosive Division supports this effort through R&D, testing, and evaluation of promising explosives detection, mitigation, and response technologies. A priority for the Explosives Division is the development of standoff explosive detection technologies that could be used to detect and interdict suicide bombers and vehicle-borne improvised explosive devices. The technologies being developed by DHS S&T will be focused on large public events, such as sporting events, national political conventions, holiday celebrations, etc. Promising prototype or commercial-off-the-shelf technologies that meet the mission needs will be tested in realistic operating environments. The activities described below directly support the spiral development of standoff technologies. The DHS intern will support PNNL with the following tasks:

Equipment Qualification for Field Testing. Equipment being considered for field deployment will be tested in a laboratory setting with realistic threats to document the fundamental technical and operational performance of the device. Where necessary, technologies will be taken outside of the laboratory setting—in a representative field environment—to confirm the ability to perform adequately in the field. Collectively, this testing will serve to qualify the equipment for field deployment.

Field Trial Planning and Preparedness. PNNL will provide technical and project leadership for technology field demonstrations that will evaluate promising standoff technologies in representative deployment environments. Activities include developing project schedules, coordination among performers (e.g., national laboratories, commercial industry, etc.), support to customer/end user relationships, test site selection, test plan and concept of operations development, data collection and management approach and architecture, field operations approaches, public relations data analysis and reporting.

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2. *Group Violent Intent - Content Analysis*

Mentor: Paul Whitney 509.375.6737 paul.whitney@pnl.gov
DHS Research Area: Social, Behavioral and Economic Sciences

Project description: A substantial amount of effort has been devoted to the study of violent behavior, its root causes and its precursors, in the literature on terrorism. Several social science theories --- including Social Movement Theory, Social Identity Theory, Collective Action Theory, Attribution Theory, Prospect Theory --- can and have been used to understand the process of radicalization which leads to the emergence of political violence. The goal of this project is to apply insights from such

theories to develop computational models that estimate the likelihood of a group to engage in violent behavior. These models can be used to assist both the prediction of radical behavior and the identification of measures that can be taken to prevent or mitigate such behavior. The social scientists working on this project will help develop and evaluate causal models of radicalization relative to a focus problem which will be selected in consultation with the project manager(s).

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3. *Group Violent Intent - Content Analysis*

Mentor: Antonio Sanfilippo 509.375.2677 antonio.sanfilippo@pnl.gov
DHS Research Area: Social, Behavioral and Economic Sciences

Project description: A substantial amount of effort has been devoted to the study of violent behavior, its root causes and its precursors, in the literature on terrorism. Several social science theories --- including Social Movement Theory, Social Identity Theory, Collective Action Theory, Attribution Theory, Prospect Theory --- can and have been used to understand the process of radicalization which leads to the emergence of political violence. The goal of this project is to apply insights from such theories to develop computational models that estimate the likelihood of a group to engage in violent behavior. These models can be used to assist both the prediction of radical behavior and the identification of measures that can be taken to prevent or mitigate such behavior. The social scientists working on this project will help develop and evaluate causal models of radicalization relative to a focus problem which will be selected in consultation with the project manager(s).

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4. *I4 Initiative Project: Development of Serious Gaming Technology*

Mentor: Louis Martucci 509.375.3799 Lou.martucci@pnl.gov
DHS Research Area: Advanced Data Analysis and Visualization, with strong focus on application of serious gaming technology

Project Description: Dual activity with PNNL's Techno-Socio Predictive Analytics and I4 Initiatives; seeking an excellent student with strong math skills, familiar with math modeling, and a passion for gaming technology

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5. *Identify Friend or Foe Correlation from multiple sensor systems*

Mentor: Dave Millard 509.375.2947 dave.millard@pnl.gov
DHS Research Area: Infrastructure Protection & Geophysical Applications, Border Security, Maritime & Port Security

Project Description: Development of modeling and interoperability tools to accept device detections from multiple sensors (and heterogeneous) sensor systems to generate a single target for display and actions. Direction, Speed, sensor characteristics and semantic information will be used to reduce multiple detections and make a single friend or foe assignment

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6. *Interagency Biological Restoration Demonstration (IBRD)*

Mentor: Ann Lesperance 206.528.3223 ann.lesperance@pnl.gov
DHS Research Area: Social, Behavioral and Economic; Bio Countermeasures, Emergency Response and Recovery

Project Description: The IBRD program, funded jointly by DHS and the Department of Defense, will develop a blueprint for the recovery and restoration of large urban areas and Department of Defense installations in the event of aerosol release of a biological agent. The tasks to be completed include: conduct a front-system study to identify requirements and capabilities for large-scale restoration efforts; examine existing frameworks and develop an integrated Consequence Management Plan; select and develop technology solutions to be applied in recovery and restoration actions; and conduct exercises, demonstrations and workshops to showcase these efforts. This program is conducted in the Seattle Washington urban area and at Fort Lewis Military Base.

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7. *Rail Test Center (RTC) - Port of Tacoma*

Mentor: Barbara Reichmuth 509.375-2128 Barbara.reichmuth@pnl.gov
DHS Research Area: Social, Behavioral and Economic Sciences and Risk & Decision Science

Project Description: PNNL is supporting the Domestic Nuclear Detection Office (DNDO) Assessments Directorate (ASD) in standing up the Rail Test Center (RTC) at the Port of Tacoma. The RTC will provide DNDO a location for testing, and evaluating the capabilities of radiation detection systems in an intermodal rail environment. As the Site Manger, PNNL, on behalf of DNDO, will be responsible for the overarching coordination functions, the establishment of the RTC, the evaluation of test sites, center and site designs, required procurements, and the initial test campaigns to evaluate operational impact and CONOPS for intermodal cargo scanning. The DHS intern would be providing assistance in evaluating the risks and economic impacts associated with different scanning opportunities.

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8. *NVAC Information Synthesis and Fusion*

Mentor: Richard May 509.375.6976 richard.may@pnl.gov
DHS Research Area: Advanced Data Analysis

Project Description: The inability to analyze different types of data—text and graph structures, for example—in a commonly defined space is a critical challenge. Although “information fusion” has been discussed at length for several years, there are still no functional prototypes. Where current analytical tools will allow analysts to view disparate data sets side-by-side, this project is researching how to provide a single interactive visualization that can represent all data types. This fusion of data types cannot be done during the later stages of process—for example, just before information is rendered to the user. Those approaches still require the analyst to

manually fuse the information. Our research is looking into early binding algorithms and approaches. We are interesting in interns with a strong math background that would like to explore mathematical foundations for information representation and processing. Further information is available at: http://nvac.pnl.gov/

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9. *NVAC Rapid User-Guided Analytics*

Mentor: Richard May 509.375.6976 richard.may@pnl.gov
DHS Research Area: Advanced Data Analysis

Project Description: Most analysts, whether federal or regional, spend up to half their time getting to know their data. This has been well recognized by many in the traditional intelligence community, and we are seeing this in the regional centers as well. We are developing information summaries and storyboards based on guided topics, situation descriptions, and analytic goals of the end users. We expect these tools to initially run off line but extend to real time when the technology has matured. Our initial approach is to take advantage of current information summary technologies such as those in statistical graphics and automated summary approaches. Techniques such as fractal dimensional summarization of documents show promise for adapting to more steerable summarization techniques. We are looking for a wide range of possible interns ranging from those interest in conceptual interface design to developing mathematical approaches for information abstraction and summarization. Further information is available at: http://nvac.pnl.gov/

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10. *NVAC Active Reports*

Mentor: Richard May 509.375.6976 richard.may@pnl.gov
DHS Research Area: Advanced Data Analysis

Project Description: Not only do analysts spent a significant amount of time getting to know there data (see Rapid User-Guided Analytics) they also spend a significant (around 40%) amount of time generating reports. These are generally flat reports with limited or no reach back into the analytical process used to generate the report. Neither are the reports easily configurable to adapt to a consumers (readers) knowledge level or environment. Active reports will allow a distinction to be made between knowledge management and simple document management; a document is only one representation for a collection of knowledge resources. A knowledge management system that follows the active reports Further information is available at: http://nvac.pnl.gov/

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11. *NVAC Evaluation and Threat Stream Generation*

Mentor: Richard May 509.375.6976 richard.may@pnl.gov
DHS Research Area: Advanced Data Analysis

Project Description: Analytical tools and techniques must be tested and evaluated to determine usefulness and applicability to specific analytical tasks. However, good

test data is nearly impossible to find. This work is to understand the characteristics of the data that analysts encounter and to create a tool suite that will build synthetic data sets mimicking real data to help analytic tool builders test and evaluate their creations. Evaluation methods and techniques are also being developed to better apply the synthetic data sets and better understand the utility of analytical tools and techniques. We are looking for interns interested in working to develop storyboard approaches for stitching together narratives through and between heterogeneous data types. This work is for both conceptual design and implementation. Those interested in developing new evaluation approaches for validating analytical tools and techniques are strongly desired as well. Further information is available at: http://nvac.pnl.gov/

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12. NVAC Lightweight Visual Analytics

Mentor: Richard May 509.375.6976 richard.may@pnl.gov
DHS Research Area: Advanced Data Analysis

Project Description: Current analytical tools are not keeping up with advances in web-based tools and distributed information retrieval resources being created by researchers and industry. Old-style heavyweight analytical applications require costly and time-consuming software updates on the user machine for each installation. Web-based delivery mechanisms can bypass many of these hassles and still maintain security. New lightweight SOA development paradigms provide unique visualization and interaction opportunities that allow analytical tools to be seamlessly integrated into a common operating environment. These new visual analytic techniques can be adapted to the analyst's environment whether he or she is in the office, using a mobile appliance, or working at a large wall-mounted touch screen. This provides all analysts with the same tools regardless of where they are, while at the same time allowing customization based on user and environment. This project is looking at SOAs to support a wide variety of visual analytical capabilities. Further information is available at: http://nvac.pnl.gov/

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13. NVAC Real-time Graph / Transactions

Mentor: Richard May 509.375.6976 richard.may@pnl.gov
DHS Research Area: Advanced Data Analysis

Project Description: When graph structures get beyond a small number of nodes and links, they can quickly become a "bird's nest" of connections. This problem becomes worse when analysts change, add to, or remove elements from the graph. As the graph grows even larger, rendering of the graph structure slows down, making interactive exploration impossible. The project has developed a wide variety of techniques to interactively explore large graph structures. We are working to expand these graph analysis capabilities and to apply the techniques to several different domains that use graph structures, particularly those dealing with transaction information. We are looking for interns with an understanding in graph

theory and interest in developing new approaches for analyzing cyber, financial, social network, or other transactional domains.

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14. Support to Operational Components – ICE Text Analysis

Mentor: Gus Calapristi 509.375.6853 gus.calapristi@pnl.gov
DHS Research Area: Advanced Data Analysis

Project Description: The goal of this project is to refine our understanding of analysis needs within the ICE Office of Intelligence, map those needs to currently available technologies, integrate and expand those technologies as necessary to meet identified needs, deploy pilot technology prototypes in operational environments, and evaluate said technologies for effectiveness in the operational environment. The student will assist with test data preparation, software application testing and setup, evaluation of usability and effectiveness of visual analysis techniques, and documentation of the workflows for the pilot technologies. The activities outlined above may also be applied to related activities in the area of Advanced Data Analysis and Visualization in support of DHS.

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15. USARS-D Comp Scit T1: Real-time sensor collection, display and analysis standalone system (note: leverages other federal agency funded project within DHS Research Area)

Mentor: Dave Millard 509.375.2947 dave.millard@pnl.gov
DHS Research Area: Emergency Preparedness and Response

Project Description: Standalone system to receive real-time sensor information from guided and autonomous UAV sensors. Store and combine GPS, video, and sensor information to perform simple analysis in the field. This project will emphasize skills in information acquisition, interoperability mechanisms, situational awareness and display, and end-to-end systems engineering and testing.

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16. USCG District 1 Moveable Bridges

Mentor: Dave Millard 509.375.2947 dave.millard@pnl.gov
DHS Research Area: Emergency Preparedness and Response

Project Description: Alignment of spreadsheet-like displays and service-based mapping tools to provide user-centric situational awareness tools. Development of operational status boards (http://webosb.pnl.gov) that convey textual and graphical status of user-defined objects (traffic control points, shelters, moveable bridges) without the use of commercially licensed tools. Would emphasize systems engineering and systems integration skills. Would develop new interaction paradigms for examining spreadsheet / map display information.

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17. Organic Signatures

Mentor: Karen Wahl 509.376.3635 Karen.wahl@pnl.gov
DHS Research Area: Biological Threats and Countermeasures

Project Description: This internship involves bioforensics research to help determine residual process signatures. This is an interndisciplinary area that includes analytical chemistry, microbiology and statistical analysis. Experimental tools can include multidimensional separations and mass spectrometry.

18. West Coast Maritime Preventive Rad/Nuc Detection (PRND) Pilot Project

Mentor: Robert T. Brigantic 509.375.3675 Robert.brigantic@pnl.gov
DHS Research Area: Maritime and Port Security; Transportation Security; and Risk and Decision Science

Project Description: This internship will involve mathematical modeling to solve homeland security problems

19. Enhanced Bioaerosol Detection System

Mentor: Cindy Bruckner-Lea 509.376.9145 cindy.bruckner-lea@pnl.gov
DHS Research Area: Biological Threats and Countermeasures

Project Description: This internship involves the development of biodetection systems for facility protection. This internship can involve experimental work to collect and analyze optical signatures, and the evaluation of rapid biodetection approaches.

20. Development of Automated Fluidic Methods Employing Functionalized Nanoparticles for Enhanced Biological Threat Agent Concentration, Purification, and Detection

Mentor: Richard Ozanich 509.375.4586 richard.ozanich@pnl.gov
DHS Research Area: Biological Threats and Countermeasures

Project Description: This internship involves the development and application of new nanoparticle materials for enhanced biological threat detection. The focus of this internship will be tailored to match the experience and interest of the intern in the areas of nanoparticle synthesis and characterization, biological assay development, surface modification and characterization. The project will involve working with an interdisciplinary team of chemists, engineers and biologists.

21. Development of Real Time PCR Assays

Mentor: Rachel Bartholomew 509.376.8960 Rachel.bartholomew@pnl.gov
DHS Research Area: Biological Threats and Countermeasures

Project Description: This internship involves the development of PCR assays. The intern should have a background and interest in microbiology or molecular biology.

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22. Automated Methods for the Quantification and Infectivity of Human Noroviruses in Water

Mentor: Timothy Straub 509.372.1953 timothy.straub@pnl.gov
DHS Research Area: Biological Threats and Countermeasures

Project Description: This project involves the development of automated methods for virus concentration in water, and the development and optimization of infectivity assays for human noroviruses. This project involves an interdisciplinary team of engineers, chemists and biologists. The internship will focus on the project tasks that best match the skills and interests of the student intern.

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23. Immunoassay Reagent Development

Mentor: Charyl Baird 509.372-6760 cheryl.baird@pnl.gov
DHS Research Area: Biological Threats and Countermeasures

Project Description: This internship is focused on the development of high affinity antibody reagent using techniques such as yeast display in combination with flow cytometry selection. Molecular biology and microbiology skills and interests are required.