

ENVIRONMENTAL, BIOPRODUCTS AND ROBOTICS REFERENCES

Environmental Programs & Projects in the Mid-Atlantic Region

Army Center for Environmental Health Research Ft Detrick

<http://usacehr.detrick.army.mil/>

The mission of the USACEHR is to plan, direct, and conduct research, development, testing and validation for occupational and environmental health surveillance (OEHS) and environmental health technology in support of Force Health Protection.

National Energy Technology Laboratory (Morgantown, WV and Pittsburg, PA)

www.netl.doe.gov

The NETL is the only U.S. national laboratory devoted to fossil energy research and implements a broad spectrum of energy and environmental research and developmental R&D programs. One of DOE's primary strategic goals is "to protect our national and economic security by promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy." NETL contributes to this strategic goal through cutting-edge research and development, focused on the clean production and use of our Nation's domestic fossil energy resources. Advanced technologies provide policy makers with expanded options for meeting vital national energy, environmental, and security needs. Technology advances will equip power generators to use fossil resources with ever-greater efficiency and reliability, in ways that protect our natural environment.

Institute of Water Resources, (Alexandria, Virginia)

<http://www.iwr.usace.army.mil/waterresources>

Coastal Storm Damage Reduction

The Army Corps of Engineer's works to reduce damages to shorefront development caused by shore erosion, hurricanes, and abnormal tidal/lake flooding by undertaking a variety of shore protection projects. Working in cooperation with a number of other federal and state agencies the Corps has helped restore 3,800 miles of riparian forest buffers, preserved over 6 million acres of land and re-opened 1,500 miles of river to migratory fish in the Chesapeake Bay area.

Environment

The U.S. Army Corps of Engineers Civil Works environmental program has three major focus areas: ecosystem restoration, stewardship, and the Formerly Used Sites Remedial Action Program, or FUSRAP. Efforts in both areas are guided by the Corps Environmental Operating Principles, which help us balance economic and environmental concerns through sound management of existing Corps lands and waters and restoration/repair of degraded ecosystems and contaminated sites.

Flood Damage Reduction to Human and Natural Environment By

- Providing flood risk and water management information
- Coordinating with federal and state agency efforts to assist local communities with flood hazmat mitigation measures
- Performing Levee inspections and certification and repairs to damaged structures
- Implementation of structural and nonstructural flood damage reduction projects.

Clean Non-Polluting Hydropower

The U.S. Army Corps of Engineers is the largest operator of hydroelectric power plants in the United States and one of the largest in the world. Corps hydropower plants provide 100 billion kilowatt-hours annually, enough power to serve more than 10 million households.

Environmental Protection Agency, Mid Atlantic Region

www.epa.gov/region03/index.htm

The Mid-Atlantic regional office of the U.S. Environmental Protection Agency is responsible for programs in Delaware, Maryland, Pennsylvania, Virginia, West Virginia and the District of Columbia. Headquartered in Philadelphia, the region has field operations and laboratories in Wheeling, W.VA., Annapolis and Ft. George G. Meade, Md., and Pittsburgh, Pa. Federal environmental programs include air and water pollution control; toxic substances, pesticides and drinking water regulation; wetlands protection; hazardous waste management; hazardous waste site cleanup; and some regulation of radioactive materials. Activities include compliance and enforcement, inspection, engineering reviews, ambient monitoring, analysis of environmental trends, environmental planning, pollution prevention, risk assessment, and education and outreach.

Environmental Science Center,8 Fort Meade (Laurel, MD)

www.epa.gov/region3/esc/index.htm

At the Environmental Science Center, EPA scientists conduct tests on soil, air and water samples to determine the presence of pollutants and other contaminants. EPA microbiologists test drinking water to ensure its safety. Hospital disinfectants are tested to ensure the validity of their claims and chemists develop the analytical methods necessary to monitor pesticide residues in food. Science center staff also inspects and investigate manufacturing facilities, hazardous waste sites, and public and private labs.

National Center for Environmental Assessment

<http://cfpub.epa.gov/ncea/index.cfm>

EPA's National Center for Environmental Assessment, NCEA, provides guidance and risk assessments aimed at protecting human health and the environment. This guidance presents critical analyses and summaries of scientific consensus, vetted through a rigorous peer review process, on the risks of pollutants to human health and the natural environment.

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EPA Office of Science Policy

www.epa.gov/osp

EPA functions as both a scientific and regulatory agency in the United States. Research conducted under ORD provides the basis for the formulation of environmental policies and programs. OSP plays a vital role by providing expert advice and evaluation on the use of scientific knowledge and science policy to support sound science in the Agency.

US Geological Survey, (Reston, VA.)

<http://www.usgs.gov>

The USGS serves the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

NASA GSFC Earth Science Project Division

<http://eos.gsfc.nasa.gov>

NASA Earth System Science Data and Services

<http://nasadaa.eos.nasa.gov>

National Institute Of Standards and Technology (Gaithersburg, MD)

<http://www.nist.gov/>

NIST is committed to protecting human health and our natural resources. Among many environmentally related research projects are ones on measurements standards for sulfur in fossil fuels; safety or toxicity of nanomaterials studies, and methods development for detection and quantification of chemicals with perceived human health issues.

National Oceanic and Atmospheric Administration, (Silver Springs, MD)

<http://www.noaa.gov/about-noaa.html>

NOAA is a federal agency focused on the condition of the oceans and the atmosphere. It is a supplier of environmental information products and environmental stewardship services. It provides scientific information related to ecosystems, climate, weather, water, environmental restoration and more.

Naval Research Laboratory, (DC)

<http://www.nrl.navy.mil/>

Environmental research at NRL includes meteorology, El Nino modeling, polar ozone and aerosol measurements, seafloor mapping and more.

Bureau of Reclamation (DC)

<http://www.usbr.gov/main/about/>

The mission of the Bureau is to assist in meeting the increasing water demands of the West while protecting the environment and the public's investment in these structures. The Bureau places great emphasis on fulfilling water delivery

obligations, water conservation, water recycling and reuse, and developing partnerships with customers, states, and Native American Tribes.

The bureau manages, develops, and protects water and related resources in an environmentally and economically sound manner in the interest of the American public by:

- Honoring State water rights, interstate compacts, contracts with Reclamation users, further the Secretary of the Interior's Indian Trust responsibilities, and comply with all environmental statutes.
- Ensuring the continued delivery of water and power benefits in conformity with contracts, statutes, and agreements.
- Developing strategies to manage and deliver water more efficiently and effectively to our customers in order to help satisfy the many needs of irrigation, municipalities, power and the environment and serving as a technical resource for water users and planners.

National Institute For Occupational Safety and Health (DC & WV)

<http://www.cdc.gov/niosh/about.html>

The National Institute for Occupational Safety and Health (NIOSH) is the federal agency responsible for conducting research and making recommendations for the safe environment as related to the human work place. NIOSH is part of the Centers for Disease Control and Prevention (CDC) in the Department of Health and Human Services.

GLOBAL CLIMATE CHANGE

FirstGov for Science

www.science.gov >

Environment & Environmental Quality > Climate Change

NASA Links to Federal Programs

<http://gcmd.nasa.gov/Resources/pointers/feds.html>

AAAS Global Climate-Change Resources

http://www.aaas.org/news/press_room/climate_change

AAAS seeks at to increase the volume of scientific leadership on the issue of global climate change. Background materials on AAAS efforts related to climate change and links to relevant resources are provided at this site.

Google Climate Change Links

www.google.com > Directory > Science > Environment > Global Change

Global Change Data and Information System (GCDIS)

www.gcrio.org/gcdis.html

Locates multiagency news, data, publications, and research

U.S. Climate Change Science Program

www.climatescience.gov

U.S. Climate Technology Program

www.climateotechnology.gov

U.S. Carbon Cycle Science Program: An Interagency Partnership

<http://www.carboncyclescience.gov/>

Department of Defense

- Air Force Combat Climatology Center (AFCCC) Strategic Climatic Information Service
- Defense Technical Information Center
- U.S. Army Cold Regions Research and Engineering Laboratory (CRREL)
- Master Environmental Library (MEL)
- Fleet Numerical Meteorology and Oceanography Center (FNMOC)
- National Geospatial Intelligence Agency (NGIA)

Department Of Energy (DOE) Home Page

- Energy Efficiency and Renewable Energy Network (EREN)
- Energy Information Administration
- Oak Ridge National Laboratory (ORNL) Home Page
- DOE Office of Environmental Management (EM)
- DOE Environmental Sciences Division
- Atmospheric Radiation Measurement (ARM) Archive

Department of State

- U.S. State Department Bureau of Oceans and International Environmental and Scientific Affairs Policies on Environment and Global Climate Change
- Undersecretary of State for Global Affairs Page

Environmental Protection Agency (EPA) Home Page

- Environmental Protection Agency (EPA) On-line Library
- EPA Envirofacts, A Warehouse of EPA Data
- EPA Global Warming Site
- EPA Environmental Monitoring and Assessment Program (EMAP)

National Aeronautics and Space Administration (NASA) Home Page

NASA Link to Global Change

<http://globalchange.nasa.gov>

- Earth Science Information Partners (ESIP) Federation
- Global Change Data Center (GCDC) at NASA/GSFC
- Earth Observing System (EOS) Home Page
- NASA Science Directorate Destination: Earth

National Institutes of Health

- National Institute of Environmental Health Sciences (NIEHS)

National Oceanic and Atmospheric Administration (NOAA) Home Page

- NOAA Geospatial Data and Climate Services Group
- National Environmental, Satellite, Data and Information Service (NESDIS)

National Science Foundation (NSF) Home Page

- NSF Environmental Research and Education Program
- NSF Office of Polar Programs

U.S. Department of Agriculture (USDA) Home Page

- USDA Natural Resources Conservation Service (formally the Soil Conservation Service)
- USDA Forest Service <http://www.fs.fed.us/research/fsgc/climate-change.shtml>
- AgDB - Agriculture Databases, Datasets, and Information Systems
- Weekly Weather and Crop Bulletin from USDA and NOAA Joint Agricultural Weather Facility

U.S. Department of Interior (DOI) Home Page

- U.S. Geological Survey (USGS) Home Page

- Federal Geographic Data Committee (FGDC) Home Page
- National Biological Information Infrastructure
- National Spatial Data Infrastructure (NSDI)/ National Spatial Data Clearinghouse USGS Node
- USGS Global Change Research Program Home Page

U.S. Global Change Research Program Home Page

- Our Changing Planet: The 2004-2005 U.S. Global Change Research Program Report to Congress
- U.S. Global Change Research Program (USGCRP) Global Change Research Information Office (GCRIO)
- U.S. National Assessment of Climate Change

Other Related Servers

- National Library for the Environment (NLE) - Congressional Research Service Reports on the Environment
- Congressional Research Service Climate Change Briefing Book
- Office of the Federal Coordinator for Meteorological Services (OFCM)

Department of Energy -- Climate Change Research Division

http://www.sc.doe.gov/ober/CCRD_top.html

The Climate Change Research Division includes process research and modeling efforts to (1) improve understanding of factors affecting the Earth's radiant-energy balance; (2) predict accurately any global and regional climate change induced by increasing atmospheric concentrations of aerosols and greenhouse gases; (3) quantify sources and sinks of energy-related greenhouse gases, especially carbon dioxide; and (4) improve the scientific basis for assessing both the potential consequences of climatic changes, including the potential ecological, social, and economic implications of human-induced climatic changes caused by increases in greenhouse gases in the atmosphere and the benefits and costs of alternative response options.

Research is focused on understanding the basic chemical, physical, and biological processes of the Earth's atmosphere, land, and oceans and how these processes may be affected by energy production and use, primarily the emission of carbon dioxide from fossil fuel combustion. A major part of the research is designed to provide the data that will enable an objective assessment of the potential for, and consequences of, global warming. The program is comprehensive with an emphasis on the radiation balance from the surface of the Earth to the top of the atmosphere, including the role of clouds and on improving quantitative models necessary to predict possible climate change at the global and regional levels.

The Best of NASA's Climate Visuals

http://www.nasa.gov/centers/goddard/earthandsun/climate_change.html

From polar ice to phytoplankton, parts of the earth system are constantly changing. At NASA, scientists strive to better understand these changes and how they are interconnected. Using remote-sensing data from satellites, this research diagnoses our planet's current health and will help future generations and explorers understand the earth system as a whole.

This resource collection highlights the best of NASA's climate-related visualizations. Showcasing elements of the entire earth system, this compilation includes years of remarkable satellite data in one, convenient location.

See multi-media presentations on:

- Cryosphere: Earth's Frozen Assets
- 2005 Arctic Sea Ice Decline
- Ice Albedo
- Black and White: Soot on Ice
- Snow Cover and Sea Surface Temperatures
- Larsen B Ice Shelf
- Jakobshavn Glacier Retreat

- Iceland Glacier Recession
- Warmer and Cooler
- Ice: The Planet's Thermostat
- Interview with Claire Parkinson/Senior Scientist NASA GSFC
- Ocean Sciences
- Measuring Sea Level Change
- Sea Surface Temperatures
- Hurricanes and Sea Surface Temperature
- Ocean Circulation Conveyor Belt Helps Balance Climate
- Global Phytoplankton
- Mt. Kilimanjaro's Vanishing Snow Cap
- A Shrinking Lake
- Climate Change Brings Crop Losses
- Landsat 1993 Midwest Floods
- Interview with Dot Zukor/Deputy Director, Earth Sciences NASA Goddard Space Flight Center
- Atmosphere
- Antarctic Ozone Hole in 2005
- Earth's Energy Output
- Greenhouse Gases: Methane
- Cloud Albedo
- Balancing Act
- Water Vapor and Climate Change
- Global Carbon Monoxide
- Interview with James Hansen/Director, NASA Goddard Institute for Space Studies
- Aerosols Absorb, Aerosols Reflect
- Satellites
- ICESat
- NASA's Earth Observing Fleet
- Aquarius Satellite
- Aqua Satellite
- MODIS instrument on the TERRA Satellite
- Earth Views

Biobased Products

Biobased products are "commercial or industrial products (other than food or feed) that are composed in whole or in significant part of biological products or renewable domestic agricultural materials (including plant, animal, and marine materials) or forestry materials."

Points of interest, information and technology sources include:

Office of the Federal Environmental Executive

www.ofee.gov/gp/bioprod.asp

Email: task_force@ofee.gov **Phone:** (202) 343-9125

Promoting sustainable environmental stewardship throughout the Federal government

USDA's Biobased Products and Bioenergy Coordination Council

www.ars.usda.gov/bbcc/

Contact: Ron Buckhalt

The Biobased Products and Bioenergy Coordination Council (BBCC) was established by the Secretary of Agriculture to provide a forum through which USDA agencies will coordinate, facilitate and promote research, development, transfer of technology, commercialization, and marketing of biobased products and Bioenergy using renewable domestic agricultural and forestry materials.

U.S. Environmental Protection Agency, Comprehensive Procurement Guideline Program

www.epa.gov/cpg

The Comprehensive Procurement Guideline (CPG) program is part of EPA's continuing effort to promote the use of materials recovered from solid waste. Buying recycled-content products ensures that the materials collected in recycling programs will be used again in the manufacture of new products.

GSA Advantage Environmental Aisle page

www.gsaadvantage.gov/environmental

GSA Advantage has thousands of products and services available to assist federal agencies meet their environmental purchasing goals. The environmental aisle is designed to allow direct access to the variety of environmental products and services that GSA offers.

ARS Bioproducts Research

http://ars.usda.gov/research/programs/programs.htm?NP_CODE=307

ARS bioenergy research...

- Enables new varieties and hybrids of bioenergy feedstocks with optimal traits.
- Enables new optimal practices and systems that maximize the sustainable yield of high-quality bioenergy feedstocks.
- Enables new, commercially preferred biorefining technologies.

Federal Biobased Products Preferred Procurement Program

www.biopreferred.gov/Default.aspx

BioPreferred is a Federal program that aims to increase the purchase and use of biobased products. Biobased products are made from biological or renewable agricultural materials like plant, animal, marine or forestry ingredients.

Biomass Research and Development Initiative

www.brdisolutions.com/default.aspx

The Biomass Research and Development Initiative (BRDI) is the multi-agency effort to coordinate and accelerate all Federal biobased products and bioenergy research and development.

US Department of Energy Office of Energy Efficiency and Renewable Energy

www.eere.energy.gov

The Office of Energy Efficiency and Renewable Energy (EERE) works to strengthen the United States' energy security, environmental quality, and economic vitality in public-private partnerships.

Bioenergy at DOE

<http://www.energy.gov/energysources/bioenergy.htm>

The Department of Energy's Renewable Energy Biomass Program, run by the Office of Energy Efficiency and Renewable Energy includes major programs for developing and improving technology for biomass power; for making biofuels such as ethanol (from biomass residues as well as grain) and renewable diesel; and for making plastics and chemicals from renewable, biobased materials.

National Renewable Energy Laboratory Biomass Research

www.nrel.gov/biomass/proj_biobased_products.html

This organization conducts analyses of the best potential options for large-scale commodity production of chemical intermediates or building blocks that can be produced from biomass processing platforms.

USDA Economic Research Service

www.ers.usda.gov/features/bioenergy

ERS is approaching bioenergy issues in several ways:

- Monitoring the state of the agricultural system and rural communities;
- Providing market analyses;
- Developing projections of commodity supply, demand, and retail food prices; and
- Conducting in-depth research on policy-relevant topics.

USDA ARS Technology Transfer

www.ars.usda.gov/Business/Business.htm

Richard J. Brenner, Assistant Administrator
Richard.Brenner@ars.usda.gov Phone: (301) 504-6905

ARS continually looks for opportunities to partner with businesses, other federal agencies, state and local governments, and universities. These partnerships are designed to augment research programs, expedite research results to the private sector, exchange information and knowledge, stimulate new business and economic development, enhance U.S. trade, preserve the environment, and improve the quality of life for all Americans.

Sample Projects in Robotics at Selected Federal Laboratories

Defense Advanced Research Projects Agency (Arlington, VA)

<http://www.darpa.mil>

Current Hot Projects

- **Boeing**

1. A160T Hummingbird Unmanned rotorcraft

The Hummingbird features a unique optimum-speed-rotor technology that significantly improves overall performance efficiency by adjusting the rotor's speed at different altitudes, gross weights and cruise speeds. The autonomous unmanned aircraft, measuring 35 feet long with a 36-foot rotor diameter, eventually will fly more than 140 knots with a ceiling of 20,000 to 30,000 feet (high hover capability up to 15,000 feet) for more than 20 hours.

2. Boeing X-45A Unmanned Combat Air Vehicle

The Unmanned Combat Air Vehicle (UCAV) System Demonstration Program is a joint DARPA/Air Force/Boeing effort to demonstrate the technical feasibility for a UCAV system to effectively and affordably prosecute 21st century Suppression of Enemy Air Defenses (SEAD) and strike missions within the emerging global command and control architecture. The Air Force is committed to an aggressive program of exploiting UAV technology for SEAD in the mid-term and moving into a broader range of combat missions depending on technology maturation, affordability, and migration to other forms of warfare. The UCAV System Demonstration Program will provide the information necessary to enable decision-makers to determine whether it is technically and fiscally prudent to continue effects-based development of a UCAV system to perform the SEAD/Strike mission. The knowledge gained from the System Demonstration Program will be a key input to defining the best force mix for the 2010 timeframe.

- **Northrop Grumman**

3. X-47B UCAS

The X-47B will be a transformational, carrier-capable, multi-mission, unmanned combat air vehicle. Strike fighter-sized, it is a survivable, long range, high endurance and persistent platform capable of a variety of missions including Intelligence Surveillance, Reconnaissance, and Time Sensitive Targeting Strike

- **Carnegie Mellon University's National Robotics Engineering Center in Pittsburgh, Penn.**

4. The crusher

The Crusher represents a new class of unmanned ground combat vehicles (UGCV) developed under the DARPA/Army UGCV-Perception for Off-Road Robots Integration (UPI) program. Crusher is a highly mobile vehicle designed from the outset to be unmanned. It is being equipped with state-of-the-art perception capabilities, and will be used to validate the key technologies necessary for an unmanned ground vehicle to perform military missions autonomously. Crusher will be equipped with representative sensing and weapons payloads for planned field experiments.

4. **Non Line of Sight Robotic Vehicle**

http://www.nosc.mil/robot/pubs/IASTED_ADCR.pdf

Tactical mobile robots used in military and law enforcement operations normally require a robust, long range, and non-line-of-sight communications link to the remote control station. High frequency digital communications, which overcome problems encountered by tethered links and analog radios, are subject to line-of-sight (LOS) limitations. This is often impossible to maintain in urban environments. The proposed solution is to develop a system that will allow the mobile robot to carry multiple relay radios that are automatically deployed when and where needed in order to maintain this communications link. This process is completely transparent to the operator and is entirely handled by the ad-hoc network formed by the relay radios. In this paper, we present a radio relay deployment system that is plug-and-playable, and can be attached to many unmanned vehicles requiring long-range and non-LOS operational capability.

Walter Reed Institute of Research (Washington DC)

<http://wrair-www.army.mil>

Automated Casualty Stretcher

- WRAIR is focusing its efforts in combat casualty care on reducing the mortality rate of wounded soldiers, especially within the crucial first hour after injury. WRAIR is helping develop five interrelated computerized devices that will form a system allowing medics to provide quality care to wounded soldiers on the battlefield. When the entire system is fielded, a medic will be able to:
 5. Locate a wounded soldier quickly
 6. Monitor the soldier's vital signs and detailed physiologic information and display them locally or remotely on a computer readout
 7. Get advice from a medical database on the best treatment and step-by-step instructions on unfamiliar procedures
 8. Use computer-regulated intravenous pumps and ventilators to tailor resuscitation to the needs of the casualty
 9. Evacuate the casualty in an enclosed stretcher that provides continuous medical support and monitoring in transit

NSWC Naval Ship Systems Engineering Center – Carderock (Carderock, MD)

www.nswccd.navy.mil

- ***Swarm Tactics***

Low cost, expendable, unmanned air vehicles, operating as a cooperative group, replacing individual losses by re-configuration of the remaining units to complete mission while adhering to basic design philosophy:

10. Design to cost! Max cost of \$2,000!! (Including engine, avionics, and secure communications.)
11. Accept performance imposed by cost
12. All subsystems fully modular (Form, Fit and Function)
13. Provide a seamless upgrade path
14. "Plug - n -Play" payload capability
15. missions
 - Ground surveillance
 - Sea search
 - Battle damage assessment
 - Data link relay
 - Gunfire control spotting
 - CBR aerial sampling
 - Close air support
 - Air defense decoy/ spoofing
 - Clandestine tailing of surface contacts

Naval Research Laboratory (DC)

www.nrl.navy.mil

Unmanned Projects

- Unmanned Aerial Vehicle (UAV) Radar (<http://www.nrl.navy.mil/content.php?P=04REVIEW127>)
 - Goals
 - 16. detect and track moving ground vehicles and small boats to a range of 80 nmi
 - 17. provide a simultaneous SAR ground map,
 - 18. provide targeting quality data for weapons
 - 19. provide for low false track rates
 - 20. use low microwave frequencies for foliage penetration
 - 21. fit in a Navy vertical take-off UAV

- Fuel cell unmanned vehicle (<http://www.nrl.navy.mil/pao/pressRelease.php?Y=2005&R=59-05r>)
 - 22. The Naval Research Laboratory, in collaboration with industrial partners, demonstrated an unmanned aerial system (UAS) flight solely powered by fuel cell technology.

- Unattended Ground Sensor Network (<http://www.nrl.navy.mil/content.php?P=04REVIEW185>)

Scientists are exploring a novel unattended ground sensor network, the Adaptive Reactive Sensor and Effector Network and Insertion Capability (ARSENIC) that would be deployed by unmanned asset to provide precise and covert placement.

- Dynamic Autonomy Interaction (<http://www.nrl.navy.mil/content.php?P=03REVIEW149>)

Natural interactions, such as natural language and gestures, facilitate dynamic autonomy. They affect easy communication, allowing the participants to concentrate on the task and not on the ways to communicate. Awareness of the environment is also important.

- Tactical Micro-satellite (<http://www.nrl.navy.mil/content.php?P=04REVIEW207>)

The DOD's Office of Force Transformation (OFT) and the Naval Research Laboratory are working on the development of and experimentation with a tactical micro-satellite system, with emphasis on producing operationally relevant capabilities. Touchstones of this system include: quick response, Joint Task Force (JTF) organic, selectable payloads, coverage for military conflicts and opportunities at any location on Earth, and an unmanned aerial vehicle (UAV) class of cost. This system ultimately integrates space assets into the forces such that the JTF Commander can call up the assets by deciding the payload capability needed, the area of interest, the area for direct downlink, and the date to call-up the assets. Once deployed, the space assets are directly tasked via the SIPRNET, which is also used to distribute the collected data and products.

- Unmanned Tank Inspection Instrument (<http://www.nrl.navy.mil/content.php?P=02REVIEW110>)

Currently, U.S. Navy maintenance practices for ballast tank spaces include Fleet-wide inspection of the 20,000 tanks. Approximately 4,000 of these occur annually, at a conservative cost of \$24M. Operationally, each tank may see different degrees of service depending on mission requirements, thus creating widely variable maintenance concerns, in addition to those problems routinely anticipated for each tank type. As a result, up to 50% of current tank maintenance is due to hidden damage or unplanned work. Costs for tanks identified for refurbishment soar to \$250M/year for a fraction of the total tanks Fleet-wide. NRL has developed a strategy by which the "state of preservation" can be determined by the implementation of Tank Monitoring Systems (TMS), which is essentially an unmanned tank entry method for inspection and qualification of tank integrity. The TMS systems include (1) an in-situ corrosion sensor which is installed in the tank to monitor coating integrity, the corrosion status, and cathodic protection functionality; (2) optical systems that can be inserted for periodic remote visual and analytical assessment of coatings damage; and (3) software to integrate the results of the corrosion sensor and optical measurements, which allow maintenance needs and dollars to be predicted and assessed on a "condition basis" rather than the traditional "time interval" method.

Office of Naval Research (Arlington, VA)

http://www.onr.navy.mil/sci_tech/32/321/ocean_engineering_marine_systems_applied.asp

Application of Autonomous Platform Systems to Mine Warfare

The Team seeks to identify and develop component technologies and system concepts to enable the application of small mobile robotic platform systems to mine countermeasures missions particularly in the very

shallow water, surf zone and beach zone environments. Current research and development areas include sensors, communications, navigation, and neutralization technologies which can be integrated into unmanned underwater platforms for the purposes of obstacle detection and avoidance, and detection, classification, identification, mapping/reporting and neutralization of moored, bottom and buried mines. In addition, the Program Executive Office for Littoral and Mine Warfare (PEO-LMW) is addressing this area.

Air Force Office of Scientific Research (Arlington, VA)

www.afosr.af.mil

Robotic Mine Clearing Vehicle

MACE (Mine Area Clearance Equipment), a robotic mine clearing system converted from a man-in-the-seat vehicle to a remotely controlled system by engineers, in order to remove military personnel from dangerous mine clearing situations and to improve driving and position accuracy. The system, developed by the Advanced Robotics Team using the Joint Architecture for Unmanned Systems, is operated via radio frequency using a controller, a laptop computer, and an Operator Control Station that houses the Ethernet and power for the system. A high-end differential Global Positioning System was integrated which allows the remote operator to more precisely control the vehicle and provides positioning feedback to ensure more accurate area coverage.

DOE Office of Science and Technology Policy (DC)

www.pi.energy.gov/orgsummaries.html

The Assistant Secretary for Policy and International Affairs (PI) is the primary policy advisor to the Secretary, Deputy Secretary, and Under Secretary on domestic and international policy analysis, development, evaluation, and implementation. PI has primary responsibility for coordinating the efforts of diverse elements in the Department to ensure a unified voice in our policy and international affairs. PI works closely with organizational elements within the Department, other Federal agencies, national and international organizations and institutions and the private sector to coordinate and align national energy policy, and international energy agreements. e

Robotics in Manufacturing Technology Roadmap

http://www1.eere.energy.gov/industry/newsandevents/printable_versions/news_detail.html?news_id=10633

Automation of manufacturing environments with robots has many advantages:

23. Robots can consistently produce more high quality products than humans
24. Never tire
25. Can work nonstop without breaks
26. Do not require benefits
27. Increase productivity
28. Lower manufacturing costs
29. Reduce use of energy and raw materials

Explorer: Untethered Autonomous Live Gas Distribution Main Inspection System

http://www.netl.doe.gov/technologies/oil-gas/publications/td/41155_Final.PDF

30. The Explorer system is intended to be a long-range untethered live in-pipe inspection system for use by the gas utilities in distribution mains ranging in size from 6 to 8 inches ID. The system differs from previously designed , developed and tested systems in that it is far simpler, cheaper to build, deploy and operate, while providing at first live video feedback (e.g. no sampling, no repair, no corrosion sensing, etc.), at complete power-autonomy and at a higher speed, range and duration than is currently possible with tethered systems all this from a single 4 ft. W x 15 ft. L x Pipe-Depth excavation.

ROBOTICS TECHNOLOGY FOR IMPROVING MINING PRODUCTIVITY

<http://www.netl.doe.gov/KeyIssues/mining/robotics2.pdf>

Underground mines are dark, cramped, and often full of airborne dust. They are also very rough and hazardous environments. Under these conditions, operators drive equipment and excavate material often with requirements of high accuracy and precision. It is difficult for operators to see and accurately control mining equipment plus systems. Visual cues are not available to aid the operators. Automation and advanced control systems would increase productivity and decrease the health and safety hazards to mining workers.

Robotic Underground tank cleaner

<http://www.rim.doe.gov/GAAT.pdf>

This automated apparatus was created to clean the sludge out of the 3 underground Gunitite tanks by using a new type of procedure called confined sluicing. A water jet pump removes the sludge and liquids from the tanks. The confined sluicing end effector is moved around inside the tanks by two remotely operated systems. Overview cameras in the tanks and cameras located on the robotic arm and vehicle provide equipment operators a view of the tank interiors and waste removal activities.

Sealing Large Diameter Cast Iron Pipe Joint with robotic insert

<http://www.netl.doe.gov/publications/proceedings/02/naturalgas/4-6.pdf>

There are over 47,000 miles of cast iron gas mains in service. A major problem is that as the jute in bell and spigot joints dries out these unions begin to leak. Conventional repair methods (external methods (external encapsulation or installing repair sleeves) are expensive and disruptive to the service. Repair made by a robot have the following benefits:

31. reduction in excavation requirements
32. no interruption of gas service
33. 25-35-percent cost savings

Robot Task Space Analyzer

http://www.netl.doe.gov/publications/proceedings/97/97em/em_pdf/EMPI-11.PDF

Robot Task Space Analyzer will provide operators of remote work systems the complete set of capabilities needed to create task space models for remote control. It will combine scene data acquisition and processing modules, 2-D and 3-D display modules, and interactive analysis capabilities to help the operator build a task space model that is sufficient and appropriate to automate some or all of the tasks at hand for environmental restoration applications such as decontamination and decommissioning, and tank waste remediation. Operationally, *Robot Task Space Analyzer* will be a collection of software processes running on a computer in the operator's console and linked to physical devices on the remote work system. It will be organized into modules that provide a full spectrum of options to the operator for the timely development of task space models.

Results. The RTSA project has just begun this September. At this point, the initial work on refining functional and performance requirements has been started. By December, the conceptual design of a fully integrated task space scene analysis capability will be complete. In addition, the hardware and software systems used in earlier DOE

Department of Energy's Morgantown Energy Technology Center

RoboCon (<http://www.netl.doe.gov/publications/proceedings/96/96em/Em96/Em-p2-10.pdf>)

A state-of-the-art robot operator control station, dubbed RoboCon, with standardized hardware and software control interfaces to be adaptable to a variety of remote and robotic equipment currently funded by the DOE's Office of Science & Technology Robotics Technology Development Program (RTDP). The purpose of RoboCon is to provide a

state-of-the-art control station for the evaluation and experimental phases of DOE's Robotics Technology Development Program (RTDP)- and Integrated Demonstration (ID)-program for a variety of focus areas, such as Decontamination and Dismantlement (D&D), Tanks and Mixed Waste. The control station provides the latest in display, control and software technologies for the upcoming testing and experimentation phase of the

robotics development program underwritten by the DOE's OST. The console is designed to be flexible in terms of hardware and software configurations, to allow for

34. testing of optimized display and control configurations
35. reconfiguration of the control panels and consoles for varied robot systems
36. tailoring of the control station to suit different operators

Automation Using Robotic Arms For Environmentally Sensitive Work Areas Within The DOE.

<http://www.netl.doe.gov/publications/proceedings/99/99em/grupinski2.pdf>

The Department of Energy faces unique and operational challenges to automate operations in each of its environmental management focus areas. Robotics is being considered to reduce worker exposure to harmful contaminants in the following 4 areas:

37. decontamination and dismantlement
38. mixed waste operations
39. tanks
40. automated plutonium processing

Current initiative have resulted in 2 systems that can operate within two types glove boxes, one at ambient temperatures and the other at cold temperatures. The cold robotic box is designed for bag-in and bag-out procedures

Robotic Monitoring of Contaminated Radiological Areas (DOE Contract)

http://www.osti.gov/bridge/product.biblio.jsp?osti_id=820843

The 224-T Building is a small canyon style facility where plutonium solutions were purified and concentrated from 1945 until the mid-1950s. The last known entry into the process cells occurred in 1986. Limited amounts of information

regarding shutdown and status were available. A robotic crawler was deployed into the process cells at the 224-T Building to perform cell characterization. Due to the unknown fissile inventory in the cells and the potential moderation affects of a person, manned entry was considered too high of a risk, and a robotic crawler was determined to be the best option for the initial characterization. The robotic crawler provided maneuverability, allowing access to areas in the cells where debris was found. It provided visual inspection in areas with little light, using a low lux pan and tilt camera system. Also, it provided fissile inventory measurements using a non-destructive assay (NDA) detector. The NDA detector supplied real time data to maintain criticality control.

NASA

Goddard Space Flight Center (Greenbelt, MD)

The thrust for Goddard's Robotic unit is in technologies that will allow robots to interact more safely with one another and with humans.

Robotics Academy

<http://robotics.gsfc.nasa.gov/>

The NASA Robotics Academy is a 10-week resident summer internship for students specifically interested in robotics. Students who have previously participated in the FIRST Robotics Competition, VEX, Botball, or have taken active interest in robotics in demonstrable ways are given priority. Participants are assigned to a team project sponsored by NASA/GSFC, local industry, or academic institution (4 students per project). In addition to direct guidance from the Principal Investigator (PI) who sponsored the project, an advanced robotic student is assigned as team lead to guide interns and manage the project on a daily basis. The interns and team leads participate in enriching activities such as a group project, lectures, field trips, and meetings with leaders in the field. The University of Maryland, College of Computer, Mathematical and Physical Science is also a GSFC Academy co-sponsor granting 4 credits to participants who successfully complete the Goddard program. Students with disabilities are provided reasonable accommodation services.

Robotic Skin

<http://www.nasa.gov/centers/goddard/news/topstory/2005/vladskin.html>

Laboratories at Goddard are developing a high-tech covering that would enable robots to sense their environment and react to it, much like humans respond when something or someone touches their skin. Such a technology, is referred to as a "High-Tech Skin," is essential for carrying out the Vision for Space Exploration because the Vision depends heavily on humans and robots working together under a variety of working conditions, many of them highly unstructured. The idea is to develop a "sensitive skin" that technicians could use to cover a robot. This skin will include more than 1,000 infrared sensors that would detect an object, and send the information to the robot's "brain." The brain would digest the information, apply reasoning and react within milliseconds by directing the robot to move. Future skin prototypes likely will have a higher density of sensors on the skin, which will provide the robots with even greater dexterity.

TETWalker Robot

<http://ants.gsfc.nasa.gov/documents/ants%20marchdemo%20primidi.pdf>

The robot is called "TETWalker" for tetrahedral walker, because it resembles a tetrahedron (a pyramid with 3 sides and a base). In the prototype, electric motors are located at the corners of the pyramid called nodes. The nodes are connected to struts which form the sides of the pyramid. The struts telescope like the legs of a camera tripod, and the motors expand and retract the struts. This allows the pyramid to move: changing the length of its sides alters the pyramid's center of gravity, causing it to topple over. The nodes also pivot, giving the robot great flexibility. When it's done these nanotech swarms will "alter their shape to flow over rocky terrain or to create useful structures like communications antennae and solar sails." The team anticipates TETwalkers can be made much smaller by replacing their motors with Micro- and Nano-Electro-Mechanical Systems. Replacement of the struts with metal tape or carbon nanotubes will not only reduce the size of the robots, it will also greatly increase the number that can be packed into a rocket because tape and nanotube struts are fully retractable.

Compliant Cable Mechanism

<http://ipp.gsfc.nasa.gov/ft-tech-cable-compliant.html>

Industry and government are finding a wide array of uses for NASA Goddard Space Flight Center's compliant mechanisms. Originally developed for the mechanical isolation of sounding rocket assemblies and further developed during robotic research, these compliant mechanisms provide customized structural response and mitigate shock and vibration damage in applications as diverse as medical devices, industrial and recreation equipment, and ergonomic designs.

Space Rovers/Landers

41. Viking 1 and 2 (1976-1982)
<http://nssdc.gsfc.nasa.gov/planetary/viking.html>

The primary mission objectives were to obtain high resolution images of the Martian surface, characterize the structure and composition of the atmosphere and surface, and search for evidence of life. The results from the Viking experiments give our most complete view of Mars to date. Volcanoes, lava plains, immense canyons, cratered areas, wind-formed features, and evidence of surface water are apparent in the Orbiter images.

42. Mars Pathfinder (1997)
<http://nssdc.gsfc.nasa.gov/planetary/mesur.html>

The Mars Pathfinder (formerly known as the Mars Environmental Survey, or MESUR, Pathfinder) is the second of NASA's low-cost planetary Discovery missions. The mission consists of a stationary lander and a surface rover. The mission has the primary objective of demonstrating the feasibility of low-cost landings on and exploration of the Martian surface. This objective will be met by tests of communications between the rover and lander, and the lander and Earth, and tests of the imaging devices and sensors.

The scientific objectives include atmospheric entry science, long-range and close-up surface imaging, with the general objective being to characterize the Martian environment for further exploration. The spacecraft entered the Martian atmosphere without going into orbit around the planet and landed on Mars with the aid of parachutes, rockets and airbags, taking atmospheric measurements on the way down. Prior to landing, the spacecraft was enclosed by three triangular solar panels (petals), which unfolded onto the ground after touchdown.

43. Mars Global Surveyor (1996-ongoing)
<http://nssdc.gsfc.nasa.gov/planetary/marsurv.html>

The Mars Global Surveyor (MGS) mission is designed as a rapid, low-cost recovery of the Mars Observer mission objectives. The science objectives involve high resolution imaging of the surface, studies of the topography and gravity, the role of water and dust on the surface and in the atmosphere of Mars, the weather and climate of Mars, the composition of the surface and atmosphere, and the existence and evolution of the Martian magnetic field.

44. Mars Climate Orbiter & Mars Polar Lander (1998,1999)
<http://nssdc.gsfc.nasa.gov/nmc/masterCatalog.do?sc=1998-073A>

The Mars Surveyor '98 program is comprised of two spacecraft launched separately, the Mars Climate Orbiter (formerly the Mars Surveyor '98 Orbiter) and the Mars Polar Lander (formerly the Mars Surveyor '98 Lander). The two missions were to study the Martian weather, climate, and water and carbon dioxide budget, in order to understand the reservoirs, behavior, and atmospheric role of volatiles and to search for evidence of long-term and episodic climate changes. The Mars Climate Orbiter was destroyed when a navigation error caused it to miss its target altitude at Mars by 80 to 90 km, instead entering the Martian atmosphere at an altitude of 57 km during the orbit insertion maneuver. The last telemetry from Mars Polar Lander was sent just prior to atmospheric entry on 3 December 1999. No further signals have been received from the lander, the cause of this loss of communication is not known.

45. Deep Space2 (1999)
<http://nssdc.gsfc.nasa.gov/nmc/masterCatalog.do?sc=DEEPSP2>

The Deep Space 2 (DS2) project is a New Millennium mission consisting of two probes which were to penetrate the surface of Mars near the south polar layered terrain and send back data on the sub-surface properties. On 3 December 1999 the probes were nearing Mars on a trajectory to enter the atmosphere and bring them to their intended landing site, but contact was never made with either probe and the mission was presumed lost. Also named the Mars Microprobe Project, the probe mission had as scientific objectives to: 1) test for the presence of water ice below the surface, and if ice exists, attempt to resolve the mineral phases in which the ice is stored; 2) determine the thermal and physical properties and temperature gradient of the subsurface material; 3) measure the atmospheric pressure and temperature. Data was also to be obtained on the atmospheric density profile and near-surface soil stratification using deceleration measurements during atmospheric entry and landing. The mission was also planned to serve as a technology test for many of the components of the probes and a demonstration of passive atmospheric entry and survivable hard impact. The individual probes were named Amundsen and Scott in honor of the famous polar explorers.

U.S. Geological Survey (Reston, VA) <http://www.usgs.gov>

46. **Laboratory Robotics**

Geochemical studies generate large quantities of samples to be analyzed in the laboratory. Although technological advances have produced vast improvements in analytical measurements and data reduction, the manual preparation of samples has remained a time-consuming problem. As a result, one of the most rapidly growing areas in laboratory automation is the use of robotics for sample preparation.

There are several advantages to the use of robotics. Robots have improved productivity by a factor of 2 or 3. Because sample preparation requires the use of hazardous chemicals, the robot minimizes human exposure to these chemicals. By delegating the repetitive applications to the robot, the technician is available to assume greater responsibilities. Finally, robots provide consistency in sample preparation and improve the precision of the data. In USGS laboratories, robotics have been applied to a range of techniques including sample disaggregation, the decomposition of tens of thousands of samples per year for the ICP-AES methods, the weighing of 7,000 charges of flux per year for the XRF major element analyses method, and other similar sample preparation methods. The use of laboratory robotics continues to increase as the benefits from each application are realized.