National Defense University

Center for Technology and National Security Policy

Unmanned Systems in Overseas Contingency Operations Seminar

Eisenhower Hall, The Baruch Auditorium (Rm. 259)
Fort Lesley J. McNair, Washington, DC
Thursday, May 10, 2012

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A Center for Technology and National Security Policy Event
Eisenhower Hall, Baruch Auditorium, Fort Lesley J. McNair, Washington, DC
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0800-0815 Welcome

- **Dr. James M. Keagle,** Director, Transforming National Security Seminar Series, Center for Technology and National Security Policy, NDU

0815-0915 Panel 1: Current and Emerging Unmanned Technologies: Changing Landscapes of Air, Land, Sea and Space Operations

Theme: Unmanned vehicles have proven their usefulness in providing a modern means of conducting combat and civil operations or tasks. What technologies are on the horizon and what do we currently have entering operation to continue enhancing the strategic goals of the United States National Security and overall long term welfare? Mobility, stealth, survivability, stand-off distance, and surveillance technologies will be discussed, as well as the growing importance of automation and unmanned platforms.

- **Mrs. Ellen Purdy,** Joint Oversight Executive, Joint Capabilities Technology Demonstration Program OUSD(AT&L)DDRE/RFD/CS
- **Mr. Jeff Jaczkowski,** Deputy Program Manager, Robotic Systems Joint Program Office
- **Dr. Paul Muessig,** Chief Technology Officer, Marine Corps Warfighting Laboratory

0915-0930 Break

0930-1030 Keynote Speaker

Theme: Evolving use of unmanned vehicles and how it directly impacts acquisition as well as research and development cycles in federal government circles. How does industry prepare for those demands and how do defense research facilities support the cutting edge of technology to maintain America's scientific lead?

- **The Honorable Jacques S. Gansler, PhD**, Former Under Secretary of Defense for Acquisition, Technology and Logistics; Professor and Roger C. Lipitz Chair, Public Policy and Private Enterprise, University of Maryland

1030-1115 Panel 2: Legal and Ethical Challenges of Unmanned Vehicles and Emerging Autonomous Technologies

Theme: As unmanned vehicle become the "Tip of the Spear" in many operations what dilemmas will be faced by the human operator in regard to ethics, legalities and answering the questions when mishaps occur? Who maintains responsibility if the technology fails?

- **Dr. James M. Keagle,** Director, Transforming National Security Seminar Series, Center for Technology and National Security Policy, NDU
- **Mr. Eric Schmitt,** Washington Correspondent, New York Times , Coauthor of Counterstrike: The Untold Story of America's Secret Campaign Against Al Qaeda
- **Mr. Thom Shanker,** Pentagon Correspondent, New York Times , Coauthor of Counterstrike: The Untold Story of America's Secret Campaign Against Al Qaeda
- **Dr. Peter Mario Asaro,** Assistant Professor, The New School for Public Engagement, School of Media Studies

1115-1200 Keynote Speaker 2

Theme: The current use of unmanned vehicles has become main stream with the most recent conflicts. Although unmanned vehicles have been used in previous wars, what significance will future iterations of unmanned technologies have on the nation and fighting wars in general? Will future polices be required for unmanned vehicles and what will rules of engagement look like to use unmanned systems in contingency operations?

- **General (Retired) Paul Kern, US Army**, Senior Counselor, The Cohen Group

1200-1300 Lunch

1300-1400 Panel 3: Senior Warfighter Panel

Theme: Conducting America's wars and military operations with unmanned vehicles: Do unmanned vehicles support the requirements and are unmanned vehicles safeguarding the warfighter from the most nefarious operations? A panel of shared lessons learned and perspective from the front lines.

- **Colonel Gerald Muhl, USA,** Chief, EOD and Humanitarian Mine Action, Peacekeeping Policy and Operations Directorate, OUSD (Policy SO/LIC)
- **Colonel David Crow, USAF,** Chief, Readiness Division at Air Combat Command
- **Captain Frederick Gaghan, USN,** Acting Deputy Director Rapid Acquisition & Tech and Chief, Technology, Requirements and Integration Division, Joint Improvised Explosive Device Defeat Organization (JIEDDO)
- **LtCol Brad "Myrtle" Beach USMC,** UAS Coordinator, Headquarters Marine Corps Aviation

1400-1500 Panel 4: The Future Environment: Policy, Budget Issues and Constraints

Theme: Political realities, future constraints and balancing requirements will be discussed. Can industry meet requirements and will the overarching policy changes enhance or hinder the future of unmanned technologies? Is the unmanned vehicle an enduring strategy for America's safety?

- **Mr. Dyke Weatherington,** Deputy Director, Unmanned Warfare, OUSD (AT&L) S&TS
- **Mr. Rob Maline,** Director, Joint Ground Robotics Enterprise
- **Mr. Mike Toscano,** President & Chief Executive Officer, Association for Unmanned Vehicle Systems International (AUVSI)

1500-1600 Closing Keynote

Theme: Future use of unmanned robotics and unmanned vehicles for contingency operations and how science will continue to enhance strategic capabilities.

- **Dr. Arun Seraphin,** Associate Director, National Security & International Affairs, Office of Science and Technology Policy, Executive Office of the President

1600-1730 Break Out Session

Theme: Invited members will assist in the formulation of future themes for this venue and provide input into the session review and future articles for the National Defense University in regard to unmanned systems in Contingency Operations.

- **Mr. Thomas Gonzalez, Command Sergeant Major (Retired), US Army,** Vice President, Stratom, Inc.

SPEAKER BIOGRAPHIES

Dr. Peter Asaro

Dr. Peter Asaro is an Assistant Professor in The New School in New York. He is also a founding member and co-director of the International Committee for Robot Arms Control (ICRAC). He received his PhD in Philosophy from the University of Illinois in Urbana-Champaign, where he also did graduate work in computer science. He has worked as an engineer in the areas of robot vision and control, neural networks, artificial intelligence and natural language processing at Iguana Robotics, the National Center for Supercomputing Applications (NCSA), the Beckman Institute for Advanced Science and Technology, and Wolfram Research. A philosopher of science, technology, and media, he has published numerous articles on the social, legal and ethical challenges posed by automated robotics, tele-operated and autonomous systems. This includes articles on military robotics and Just War Theory, and a forthcoming article in the Journal of the International Committee of the Red Cross on the international legal frameworks surrounding autonomous lethal systems.

LtCol George Beach

George B. Beach graduated from the University of Arizona with a Bachelor of Arts degree in Political Science. In December 1992, he was commissioned as a Second Lieutenant and ordered to The Basic School. Upon completion of The Basic School, Second Lieutenant Beach entered flight school and received his "Wings of Gold" January 5th, 1996 in Kingsville, Texas. First Lieutenant Beach was transferred to Cherry Point, NC and began Fleet Replacement Training in the AV-8B Harrier. In September 1997, Captain Beach was assigned to the VMA-311 Tomcats in Yuma, Arizona. During this time, Captain Beach held positions as the Administrative and Intelligence Officer. In January 1999, Captain Beach transferred to VMA-211 where he deployed in October 1999 to Okinawa, Japan. While assigned to the Wake Island Avengers, Captain Beach was designated a Day/Night Field/Ship Landing Signal Officer, Section Lead and Aviation Safety Officer. He served as flight scheduler, Aviation Safety Officer, and the Director of Standardization and Safety. In October 2000, Captain Beach transferred to Marine Wing Support Squadron 371 where he served as Airfield Operations Company Commander responsible for Fuels, Weather, Expeditionary Airfield Operations, and Crash Fire Rescue. During his tour, MWSS-371 Airfield Operations supported MCAS Yuma, Auxiliary Airfield II and numerous Weapons and Tactics Instructor Courses. Upon completion of his tour with MWSS-371 in Nov 2001, Captain Beach was assigned to Training Squadron Seven, Meridian, Mississippi as an advanced jet pipeline flight instructor in the T-45C Goshawk. While assigned to the squadron, he held the Aviation Safety Officer, Naval Aviation Production Program, and Standardization Department Head positions. In May 2004, Major Beach was assigned to the III Marine Expeditionary Force, Okinawa, Japan where he served as the G-3 Force Fires Targeting Information Officer. During his time with III MEF, he deployed as the Combined Support Group-Thailand Air Officer for Operation UNIFIED ASSISTANCE coordinating

tsunami disaster relief operations to Thailand. In September 2006, Major Beach was reassigned as the Aide-de-Camp to the Commanding General, III MEF where he served until June 2007. Major Beach joined Marine Unmanned Aerial Vehicle Squadron 2 as the Remain Behind Element Officer in Charge in July 2007. In November 2007, he was assigned as the Executive Officer. In April 2008, Maj Beach deployed to Iraq in support of Operation IRAQI FREEDOM 08-01. On June 1, 2008, he was promoted to his present rank. In January 2009 he reported to Headquarters Marine Corps as the APX-50 UAS Coordinator, Headquarters Marine Corps Aviation, Expeditionary Enablers Branch. Lieutenant Colonel Beach's personal decorations include the Meritorious Service Medal with one gold star, the Navy and Marine Corps Commendation Medal, the Joint Service Achievement Medal, and the Navy and Marine Corps Achievement Medal with two gold stars.

COL David Crow, USAF

Colonel David Crow is Chief, Readiness Division, Directorate Installations and Mission Support (A7), Headquarters Air Combat Command, Langley Air Force Base, Virginia. He is responsible for the Prime BEEF, RED HORSE, Fire Protection, Explosive Ordnance Disposal, Emergency Management and Individual Mobilization Augmentee programs. He provides oversight for AF input to joint Chemical, Biological, Radiological, Nuclear defense modernization programs and AF Civil Engineering's Research, Development, and Acquisition programs for Combat Air Forces. Colonel Crow is a native of Rapid City, South Dakota. He earned a Bachelor of Science degree in Civil Engineering from Stanford University and was a Distinguished Graduate of the Air Force ROTC program. He has held a wide range of positions including design engineer, Chief of Resources and Requirements, Chief, Construction Management, Chief, Environmental Compliance, Air Force Academy instructor, Engineering Flight Commander, Operations Flight Commander, head of Air Combat Command's housing construction program and manager of the Air Force's Real Property Maintenance Activity and Base Operating Support programs. He commanded the 341st Civil Engineer Squadron, Malmstrom AFB, MT. During his command, the squadron was selected as the Best Small CE Unit in the Air Force. From June to September 2004, Colonel Crow commanded the 386th Expeditionary Civil Engineer Squadron, Ali Al Salam, Air Base, Kuwait in support of OPERATION IRAQI FREEDOM. Prior to his current assignment, he was Chief of the Engineer Division, CJ1/4/8, Headquarters Multi-National Forces Iraq at Camp Victory, Iraq.

Captain Frederick Gaghan, USN

Captain Gaghan was commissioned in the United States Navy upon graduation from Officer Candidate School, Newport, R.I. in June 1988. As supply officer and operations officer, Captain. Gaghan served onboard USS Opportune (ARS 41) from November 1989 to June

1992. Following his first sea assignment, he attended Explosive Ordnance Disposal (EOD) training. From September 1993 to November 1995, Captain Gaghan was assigned to EOD Mobile Unit Nine as a detachment EOD Officer-in-Charge. His detachment embarked on USS Abraham Lincoln (CVN 72) where he served as the battle group EOD officer. Following the decommissioning of EOD Mobile Unit Nine in 1995, he attended the Naval Postgraduate School as a student in the undersea warfare curriculum. In April 1998, he graduated with masters of science degrees in physics and engineering acoustics. Upon graduation, he assumed duty as the assistant officer-in-charge, Naval School EOD Detachment, Eglin Air Force Base, Florida. In April 1999, he became the first Director of Training for the newly consolidated EOD schoolhouses at Eglin. In July 2001, he reported to EOD Mobile Unit Eleven where he served as executive officer until March 2003. Following this tour, he reported to Commander, Third Fleet in May 2003 as the staff liaison for EOD, Naval Coastal Warfare, Diving and Salvage, and Mine Warfare. During this tour he deployed to Iraq as the Commander, Combined Explosives Exploitation Cell. Upon his return he transferred to Naval Special Clearance Team One where he served as executive officer until August 2006, when he was assigned as commanding officer, EOD Mobile Unit Four and Commander, Task Group 56.1 forwarded deployed to Bahrain until February 2008. Following his command tour, Captain Gaghan was assigned to the joint CREW Program Office (PMS-408) from April 2008 to May 2010 as the director, Test and Evaluation and principle assistant program manager where he earned his level II program management certification. He is now serving in the Capabilities Acquisition Center of the Joint Improvised Explosive Device Defeat Organization as the division chief for the Technology and Requirements Integration Division.

Captain Gaghan's awards include the Bronze Star, Defense Meritorious Service Medal, Meritorious Service Medal (three awards), Navy Commendation Medal (two awards), Navy Achievement Medal (two awards), and various campaign and service medals.

The Honorable Jacques Gansler

The Honorable Jacques S. Gansler is a Professor and holds the Roger C. Lipitz Chair in Public Policy and Private Enterprise in the School of Public Policy, and is the Director of both the Center for Public Policy and Private Enterprise and the Sloan Biotechnology Industry Center. Additionally, he is the Glenn L. Martin Institute Fellow of Engineering at the A. James Clarke School of Engineering, an Affiliate Faculty member at the Robert H. Smith School of Business and a Senior Fellow at the James MacGregor Burns Academy of Leadership (all at the University of Maryland). He also served as Interim Dean of the School of Public Policy from 2003 to 2004, and as the Vice President for Research for the University of Maryland from 2004-2006. He is a Member of the National Academy of Engineering and a Fellow of the National Academy of Public Administration. He currently is chairing three National Academy Committees (one on the "Small Business Innovation

Research Program"; one on "Science and Security"; and one on "Special Forces"). Gansler recently served as the Chair of the Secretary of the Army's "Commission on Contracting and Program Management for Army Expeditionary Forces." He is also the National Academy of Engineering's representative on the Academies' Standing Committee on Science, Engineering and Public Policy; and he currently Chairs a Defense Science Board Task Force on the 21st Century Defense Industry. Previously, Dr. Gansler served as the Under Secretary of Defense for Acquisition, Technology and Logistics from November 1997 until January 2001. In this position, he was responsible for all matters relating to Department of Defense acquisition, research and development, logistics, acquisition reform, advanced technology, international programs, environmental security, nuclear, chemical, and biological programs, and the defense technology and industrial base. (He had an annual budget of over $180 Billion, and a workforce of over 300,000.) Prior to this appointment, Dr. Gansler was Executive Vice President and Corporate Director for TASC, Incorporated, an applied information technology company, in Arlington, Virginia (from 1977 to 1997) during which time he played a major role in building the company from a small operation into a large, widely-recognized and greatly-respected corporation, serving both the government and the private sector. From 1972 to 1977, he served in the government as Deputy Assistant Secretary of Defense (Materiel Acquisition), responsible for all defense procurements and the defense industry; and as Assistant Director of Defense Research and Engineering (Electronics) responsible for all defense electronics Research and Development. His prior industrial experience included: Vice President (Business Development), I.T.T. (1970-1972); Program Management, Director of Advanced Programs, and Director of International Marketing, Singer Corporation (1962-1970); and Engineering Management, Raytheon Corporation (1956-1962). Dr. Gansler serves (and has served) on numerous Corporation Boards of Directors, and governmental special committees and advisory boards. He has been Vice Chairman, Defense Science Board and member for 10 years; Chairman, Board of Visitors, Defense Acquisition University; Director, Procurement Round Table; Chairman, Industry Advisory Board, University of Virginia, School of Engineering; Chairman, Board of Visitors, University of Maryland, School of Public Policy; member of the FAA Blue Ribbon Panel on Acquisition Reform; member of the Federal Emergency Management Agency (FEMA) Advisory Board (10 years); and senior consultant to the "Packard Commission" on Defense Acquisition Reform. Additionally, from 1984 to 1997, Dr. Gansler was a Visiting Scholar at the Kennedy School of Government, Harvard University where he was a frequent guest lecturer in Executive Management courses. He is the author of 3 books, a contributing author of 25 other books, author of over 100 papers, and a frequent speaker and Congressional witness. Dr. Gansler holds a BE in Electrical Engineering from Yale University, a MS in Electrical Engineering from Northeastern University, a MA in Political Economy from the New School for Social Research, and a Ph.D. in Economics from American University.

Mr. Thomas Gonzalez

Tom Gonzalez retired from the United States Army on 1 October 2010. He now serves as the Vice President of Stratom, Inc., in Boulder, Colorado focused on developing corporate strategy and providing leadership in developing business with the government. Tom also serves on the robotics Technology Consortium as an advisor on user requirements and tactics. Currently Tom also assists the National Defense University in determining the way forward for a policy of Robotics in Contingency Operations. Command Sergeant Major Thomas Gonzalez began his military career in 1985 at Fort Bliss, TX. Before assignment as the 71st OD GP (EOD) CSM, he was the Command Sergeant Major, 84th OD BN (EOD), Fort Riley, Kansas.He holds a Bachelors of Science in Management from Regis University of Denver Colorado, a Master's in Business Administration (Honors) (MBA) concentrating in finance and strategic management from the University of Wisconsin, and a Master of Arts in Diplomacy (Honors) from Norwich University, Vermont. CSM Gonzalez is completing his dissertation for his PhD in international Development from the University of Southern Mississippi. His military education includes: U. S. Army Airborne School; Air Assault School; Combat Divers Qualification Course; Northern Warfare, Summer and Winter Course; US Army Sniper Course, Advanced Access and Disablement Course; Primary, Basic and Advanced Noncommissioned Officer Courses; Battle Staff NCO Course; and the First Sergeant Course. He is a graduate of the U.S. Army Sergeants Major Academy, Class 56 and completed the Command Sergeants Major Course. He has held a number of assignments ranging from Team Leader through First Sergeant. In addition, he served as Battalion Command Sergeant Major and Senior Enlisted Advisor to several General Officers. His EOD assignments include the 49th Ordnance Detachment (EOD), Team Leader; 74th Ordnance Detachment (EOD), Team Leader; Defense Threat Reduction Agency, Lead Instructor; 725th Ordnance Company (EOD), First Sergeant; 63d Ordnance Battalion (EOD), Senior Operations Sergeant; 787th Ordnance Company (EOD), First Sergeant; 3d Ordnance Battalion (EOD), Command Sergeant Major; Office of the Program Manager-Saudi Arabian National Guard, Senior Enlisted Advisor; Joint IED Defeat Organization Joint Center of Excellence, Senior Enlisted Advisor; 84th OD BN (EOD),Command Sergeant Major with combat tours in Operation Iraqi Freedom as the TF Troy CSM and Operation Just Cause. CSM Gonzalez has also served overseas in the Balkans, Haiti, Germany, and the Middle East. His awards include the Bronze Star for Valor with Oak leaf cluster; Purple Heart; Defense Meritorious Service Medal with 2 Oak Leaf Clusters; Meritorious Service Medal with 4 Oak Leaf Clusters; Joint Service Commendation Medal with 2 Oak leaf Clusters; Army Commendation Medal with 1 Silver Leaf Cluster; Army Achievement Medal with 1 Silver and 2 Oak Leaf Clusters; Good Conduct Medal; Southwest Asia Service Medal; Armed Forces Expeditionary Medal; Iraqi Campaign Medal (2d Awd); Global War on Terrorism Service and Expeditionary Medals; Joint Meritorious Unit Award (2); Army Superior Unit Award; Humanitarian Service Medal; Armed Forces

Service Medal; National Defense Service Medal with two Oak Leaf Clusters; Noncommissioned Officer Professional Development Ribbon with numeral 4; Military Outstanding Volunteer Service Medal; Army Service Ribbon; Overseas Service Ribbon (4); NATO Medal; Combat Action Badge; Master Explosive Ordnance Disposal Badge; Parachutist Badge; Air Assault Badge; Combat Diver Badge; and the Ordnance Order of Samuel Sharpe Medallion. Command Sergeant Major Gonzalez is married to the former Eva Morales of Anthony, New Mexico. Mrs. Gonzalez and their son Tommy reside in the Colorado Springs, Colorado area.

Mr. Jeff Jaczkowski

Jeffrey Jaczkowski was born in Detroit, MI on 15 November 1970 and resides in the Metro Detroit area with his wife Renee and two daughters, Jillian and Abigail. Currently, he serves as the Deputy Project Manager for the Robotic Systems Joint Project Office (RS JPO) under the Program Executive Office for Ground Combat Systems (PEO GCS). He is responsible for developing, acquiring, fielding and sustaining ground robotics for the Army and USMC. He began his Government service as a co-op student in 1988 at the U. S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) at the Detroit Arsenal in Warren, Michigan. While co-op'ing, he earned his Bachelor of Science degree in electrical engineering from GMI Engineering and Management Institute, Flint, MI (1993). Upon graduation in June 1993, he became an intern rotating through various TARDEC Business Groups gaining experience in systems engineering, technology integration and defense acquisition. In 1995, Mr. Jaczkowski completed his internship and worked as an electrical engineer in the Vetronics Technology Area for the Driver's Automation & Robotics Team where he led and performed field integration of Intelligent Transportation Systems (ITS) consisting of Collision Warning Systems (CWS) and Intelligent Cruise Control. This resulted in the fielding of a collision warning capability as a safety system for Army tactical wheeled vehicles. Mr. Jaczkowski earned his Master of Science degree in engineering management from Oakland University, Rochester, MI (1997). From 1998-2003, as Team Leader for Robotics, Mr. Jaczkowski was responsible for project development, planning and management, customer interface, budget monitoring and execution. He served as IPT chairman for Future Combat Systems (FCS) Unmanned Systems Working Group, comprised of multiple Government agencies, responsible for coordinating a concept development effort with system level programs, defining robotic system metrics, conducting technology trade studies and evaluating technical concepts. In 2003, Mr. Jaczkowski was appointed a member of the Army Acquisition Corps. From April 2003 to May 2007, Mr. Jaczkowski was Team Leader for RDEDOM –TARDEC's Autonomous Navigation Team where he managed the Robotic Follower Advanced Technology Demonstrator (ATD) and Science and Technology Objective (STO) program and led a team of robotics subject matter experts analyzing a variety of functional and cross

discipline areas for the advancement of unmanned ground vehicle performance and operation. In March 2006 (through April 2008), MG Roger Nadeau appointed Mr. Jaczkowski as Co-chair of the RDECOM Robotics IPT responsible for aligning Army Science and Technology development efforts with customer requirements, facilitating multi-organization cooperation, guiding S&T development from concept to experimentation, and defining the path forward for transition to PEO/PM programs of record, including the Robotic Systems Joint Program Office. From May 2007 to May of 2008, Mr. Jaczkowski served as Supervisor Deputy Associate Director (Engineering) of the Intelligent Ground Systems Technology Area responsible for organizational leadership, personnel supervision and career mentoring, program formulation, prioritization of projects and milestones, resource and financial management and technical execution of autonomous systems efforts. He completed the Advanced Acquisition Program at the Naval Postgraduate School in September 2007 and is Level III qualified for Program Management. He also serves as President of the Great Lakes Chapter of the Association for Unmanned Vehicle Systems International (AUVSI) (2004-present).

Dr. James Keagle

Dr. James M. Keagle is the Director of the Transforming National Security seminar series at the Center for Technology and National Security Policy at the National Defense University. Prior to this position, Dr. Keagle served for nine years as the National Defense University's Provost (effective 2004) and Vice President for Academic Affairs (effective 1999). Prior to these positions, he served as a professor of National Security Strategy at NDU. In that role Dr. Keagle worked as a research faculty member assisting with NDU's modeling and simulation and work with interagency education and training. Accepting an appointment to the U.S. Air Force Academy, he graduated 2nd academically in his class in June 1974. Following graduation, he went to the University of Pittsburgh to complete his Master's of Arts degree in political science and earned a graduate certificate in Latin American studies (1975). After a tour as a munitions maintenance officer, Dr. Keagle went on to become an assistant professor of political science at the U.S. Air Force Academy. In 1980, he went on to Princeton University where he completed both a Master's of Arts degree (1981) and Ph.D. (1982) in politics. He proudly notes his honorary Ph.D from the Military Technical Academy of Romania--the only United States citizen so honored. Following his extensive education, Dr. Keagle's next six tours were political-military assignment that included direct access and interaction with Cabinet-level government officials on national security related matters. These assignments included work for two Combatant Commanders as a senior strategist; for the Office of Secretary of Defense pertaining to Cuba; Deputy Director, Office of the Secretary of Defense Bosnian Task Force; and for the Deputy Under Secretary of the Air Force in International Affairs as Senior Strategist. Military. For the last two years he has led multiple NATO and Defense Education Enhancement Teams to Georgia, Azerbaijan,

and Montenegro. Since leaving military service, Dr. Keagle has held the position of adjunct professor at a number of institutions to include: Syracuse University, American University, Central Michigan University, Catholic University, University of Colorado, and Lake Superior State College. He also holds an honorary professorships with Transilvania University in Brasov, Romania, as well as the Mongolian Defense University--again, the only American so honored. Dr. Keagle and wife Kay are the proud parents of three adult children.

General (Ret) Paul Kern

General Paul Kern joined The Cohen Group as a Senior Counselor in January, 2005. In addition, he holds the Class of 1950 Chair for Advanced Technologies at West Point, is an Advisor to Battelle Memorial Institute and serves on the Board of Directors of iRobot Corporation, CoVant Technologies LLC and Agent Science Technologies, Inc. In November 2004, General Paul Kern concluded his more than 40-year career in the United States Army when he retired as Commanding General, Army Materiel Command (AMC). In that capacity, and earlier as Commander of the 4th Infantry Division (Mechanized), General Kern left his impact on the Army's future as he led a drive to digitize and transform its warfighting capabilities. With a staff of over 50,000 civilians and active military members, he won wide respect for his efforts to direct supply chain improvements, maintain field readiness, and modernize weapons systems throughout the Army while still controlling costs. Some of his efforts included consolidating major munitions production operations, employing radio frequency identification, and managing the supply of rebuilt equipment for the front lines, a shift critical to our ongoing operations in Iraq. In June 2004, General Kern undertook a vastly different responsibility when Secretary Rumsfeld tapped him to lead the military's internal investigation into the abuses at the Abu Ghraib prison in Iraq, a tough assignment that he handled with skill. Prior to his command at AMC, he served as the military deputy to the Assistant Secretary of the Army for Acquisition, Logistics and Technology and was the senior military advisor to the Army Acquisition Executive and the Army Chief of Staff on all research, development, and acquisition programs and related issues. He supervised the Program Executive Officer system, and served as the director of the Army Acquisition Corps. General Kern's career has also had stops in the Secretary of Defense office in Washington and several field units. As the Senior Military Assistant to Secretary of Defense William Perry, General Kern was instrumental in ensuring that the Secretary's guidance was implemented throughout the Department and in handling the most sensitive decisions for the Secretary. During that tenure he traveled with Secretary Perry to more than 70 countries, meeting numerous heads of state, foreign ministers and international defense leaders. He participated in U.S. operations in Haiti, Rwanda, Zaire and the Balkans, and helped to promote military relations in Central and Eastern Europe, South America, China, and the Middle East. General Kern had three combat tours during his illustrious

career with two tours in Vietnam as a platoon leader and troop commander, and he commanded the Second Brigade of the 24th Infantry in Desert Shield/Desert Storm. The Second Brigade played a pivotal role in the historic attack on the Jalibah Airfield, which allowed the Twenty-Fourth Infantry Division to secure key objectives deep inside of Iraq. He also served as the Assistant Division Commander of the division after its redeployment to Fort Stewart. A native of West Orange, New Jersey, General Kern was commissioned as an Armor lieutenant following graduation from the U.S. Military Academy at West Point in 1967. He holds Masters Degrees in both Civil and Mechanical Engineering from the University of Michigan, and he was a Senior Security Fellow at the John F. Kennedy School at Harvard University. During his career, General Kern received the Defense and Army Distinguished Service Medals, Silver Star, Defense Superior Service Medal, Legion of Merit, two Bronze Star Medals for valor, three Bronze Star Medals for service in combat, and three Purple Hearts. He has been awarded the Society of Automotive Engineers Teeter Award, the Alumni Society Medal from the University of Michigan, and the German Cross of Honor of the Federal Armed Forces (Gold). In February, 2007, General Kern was elected to the National Academy of Engineering. General Kern has lectured in England as the Kermit Roosevelt Lecturer, and at Harvard, MIT, Stanford, and the United States Military Academy, as well as in numerous public forums on technical and military matters. General Kern has recently served on the Defense Acquisition Performance Assessment Board and the Military Advisory Board on Climate Change. He is a member of the Board of Visitors at the U.S. Army War College, the Mechanical Engineering Advisory Board at the University of Michigan and an Adjunct Professor at the University of Southern California.

Mr. Robert Maline

Mr. Maline spent the first 20 years of his career as a rocket scientist for the Navy, working in a variety of ordnance related fields such as: rocket propulsion, underwater weapons, mine countermeasures and Insensitive Munitions. In 2003, Mr. Maline began serving as staff assistant to the Office of the Undersecretary of Defense for Acquisition, Technology & Logistics (OUSD(AT&L), Land Warfare & Munitions. Among his efforts were coordination of an investment strategy for the Insensitive Munitions S&T roadmap, representing the U.S. in the development of NATO STANAGs on Insensitive Munitions, and harmonizing Insensitive Munitions and Hazard Classification Testing. In 2005 Mr. Maline became the primary action officer for Tactical Wheeled Vehicle issues for the OUSD(AT&L). He was responsible for oversight activities for Stryker, Bradley, Abrams, Joint Light Tactical Vehicle, and the Mine Resistant Ambush Protected Family of Vehicles. One of his major accomplishments in this role was a successful Milestone decision for the Joint Light Tactical Vehicle program, the first major defense acquisition that included competitive prototyping during the Technology Development phase. In May of 2010, Mr. Maline took the lead as head of the Joint Ground Robotics Enterprise within OUSD(AT&L). In this position he is

responsible for the budgeting, planning and execution of department wide R&D robotics funding; harmonizing robotics efforts among the services, and expediting the transition of unmanned systems technologies from research and development into the hands of our warfighters.

Dr. Paul Muessig

Dr. Muessig is a federal government scientist with over 25 years of experience work-ing on advanced technology aircraft and weapon system programs for the Navy and the Marine Corps. His assignments have included modeling, simulation, and analysis in support of weapon system design and development, finding technologies to defeat roadside bombs, and integrating advanced technologies into Marine Corps communica-tions, intelligence and networking systems. He is currently the Chief Technology Officer at the Marine Corps Warfighting Laboratory, and is responsible for technology scouting, evaluation, and forecasting in support of concept-based experimentation. He is also working to develop and integrate commercial technology forecasting into the USMC combat development process. Dr. Muessig holds a B.S. in Chemistry from St. Joseph's University in Philadelphia; a doctorate in Physical Chemistry from Brown University in Providence, Rhode Island; and a Masters Degree in National Security and Strategic Studies from the Naval War College in Newport, Rhode Island. He has authored numerous publications in technical and professional journals, as well as some free-lance writing for the New Oxford Review.

Colonel Gerald Muhl

COL Gerald "Gerry" Muhl Jr, a native of Houston, Texas, enlisted in the US Army in 1984. He received a US Army Green to Gold scholarship in 1985 and was commissioned upon graduation from Sam Houston State University, Huntsville, Texas in 1988. He assumed the duties as Chief, Explosive Ordnance Disposal (EOD) and Humanitarian Mine Action (HMA) in July 2011 and is the principal advisor to the Assistant Secretary of Defense for Special Operations/Low-Intensity Conflict for Explosive Ordnance Disposal (EOD) and Humanitarian Mine Action (HMA) and directly oversees the execution of the $15M Humanitarian Demining Research & Development Program; the $3M Humanitarian Demining Training Program; and the $7M Explosive Ordnance Disposal and Low-Intensity Conflict Research and Development Program. Muhl's experience is operational and tactical. He commanded two EOD companies, CONUS and OCONUS, one EOD Control Team OCONUS, activated the 84th EOD battalion at Ft. Riley, Kansas and selected to command at the COL level. Gerry has executive and operations officer experience at battalion and group level. He deployed to the Balkans, Afghanistan and Iraq where he served as the chief of staff for the counter improvised explosive ordnance disposal (C-IED) coalition joint task force. Gerry is a member of the Logistics Corps and an Ordnance Officer by trade. He attended Naval School Explosive Ordnance Disposal as a second lieutenant and served his

first tour in EOD at the US Army's Technical Escort Unit, Aberdeen Proving Ground, Maryland. COL Muhl also holds a Master of Business Administration in Aviation from Embry Riddle Aeronautical University and a Masters in Strategic Studies from the Army War College. Gerry is married to the former Colleen Strzemp and has four children and three grandchildren. He enjoys shooting, woodworking and brewing beer when the time presents itself.

Mrs. Ellen Purdy

Mrs. Ellen M. Purdy is currently serving as Assistant Deputy, Rapid Fielding under the Deputy Assistant Secretary of Defense, Rapid Fielding. The Rapid Fielding portfolio within the Office of Secretary of Defense includes rapid technology incubation, development, and assessment programs that range from anticipatory technology development, to assessing non-US sources of technology, to rapidly responding to emerging needs of Combatant Commands. Mrs. Purdy focuses efforts on countering insurgency, transnational terrorism, and illicit trafficking; cyber resiliency; and rapid adaptations in an environment of hybrid conflicts that require increased partnering between the DOD and civil authorities. Previously, Mrs. Purdy served as Deputy Director & Force Protection Oversight Executive for Joint Capability Technology Demonstrations (JCTD) within the Rapid Fielding Office. Her responsibilities included initiation and financial/technical oversight of Joint Capability Technology Demonstration projects that rapidly mature emerging operational concepts and technologies to satisfy joint needs and field capabilities to the Combatant Commands. Before joining the JCTD program, she served as the Enterprise Director, Joint Ground Robotics where she had oversight of the unmanned ground systems portfolio, strategic planning for ground robotics and the annual RDT&E funding for ground robotic technology development. Prior to this assignment, Mrs. Purdy served in the Program Management Office, Future Combat Systems Brigade Combat Team (PMO FCS (BCT)) in a variety of positions including Manager, Test, Analysis, Modeling and Simulation; Deputy Director, Combined Test Organization; Director, Combined Test Organization; and Integrated Product Team Lead for Integrated Simulation and Test. Mrs. Purdy has a BS degree in Chemical Engineering, and a MS degree in Engineering Management. She is Level III certified in Program Management and Systems Planning, Research, Development and Engineering, and Level II certified in Test and Evaluation. Her awards include two Superior Civilian Service Award medals, two Commander's Award for Civilian Service medals, and the Achievement Medal for Civilian Service. Mrs. Purdy has published over twenty technical reports and journal articles during her career.

Mr. Eric Schmitt

Mr. Schmitt, 52, is a senior writer for The New York Times who covers domestic and international terrorism issues. He is co-author of "Counterstrike: the Untold Story of

America's Secret Campaign Against Al Qaeda" (Times Books/Henry Holt). For two decades, he has covered military and national security affairs for the newspaper. Since the Sept. 11 attacks, he has made ten reporting trips to Iraq and five trips to Afghanistan to cover American military operations there. In the past year, he has also reported on counter-terrorism operations in Mali, Pakistan and Southeast Asia. Previously, Mr. Schmitt reported on demographic and national immigration issues for The Times and covered Congress for five years. During that time, he one of newspaper's main reporters assigned to the 2000 congressional elections as well as the House and Senate impeachment proceedings against President Bill Clinton in 1999. Mr. Schmitt joined the Washington bureau of The Times in May 1990 as one of the paper's two Pentagon correspondents. He covered the military landing with the Marines in Cap Haitien, Haiti, in September 1994; spent three weeks reporting on the military operation in Somalia in December 1992; and lived for three months in Saudi Arabia and Kuwait covering the Persian Gulf war in 1991. Mr. Schmitt has been a reporter with The Times since 1983, with assignments including financial and business news, commercial aviation and the travel industry, and Long Island regional correspondent. Mr. Schmitt was the assistant to New York Times senior columnist James Reston in 1983-84. Before joining The Times, Mr. Schmitt covered education issues for The Tri-City Herald in Kennewick, Wash. He earned a bachelor's degree in International Relations at Williams College, and during that time studied at El Instituto Internacional in Madrid for a year. He attended Harvard University's Executive Program on National and International Security in 1991 and earned a Knight Journalism Fellowship at Stanford University for the 2006-07 academic year. Mr. Schmitt has shared two Pulitzer Prizes. In 1999, he was part of a team of New York Times reporters awarded the Pulitzer for coverage of the transfer of sensitive military technology to China. In 2009, he was a part of a team of New York Times reporters awarded the Pulitzer for coverage of Afghanistan and Pakistan. He is a member of the Council on Foreign Relations. Reared in the San Francisco Bay area, Mr. Schmitt and his wife, Felice Berkowitz, live with their two daughters in Fairfax, Va.

Dr. Arun Seraphin

Dr. Arun A. Seraphin is a Professional Staff Member on the majority staff of the United States Senate Committee on Armed Services (SASC), where he has worked since July 2001. His areas of responsibility include the Department of Defense's science and technology programs, information technology systems, technology transition, laboratories, and test and evaluation programs. As such he assists Senators in their oversight of DOD technology programs, including in the authorization of budgets, civilian nominations, policy, and hearings. Prior to his work on the SASC, he worked on the United States House of Representatives Committee on Science's Subcommittee on Research as a professional staff member and in the Office of Senator Joseph Lieberman as the 1999-2000 Materials Research Society – Optical Society of America Congressional Science and Engineering

Fellow. In these positions, he covered both civilian and defense research and development programs. Between 1996 and 2000, Dr. Seraphin worked in the Science and Technology Division of the Institute for Defense Analyses, where his research included work on defense technology transition, microelectromechanical systems (MEMS), export controls, technology forecasting, and international research cooperation. In 1996, Dr. Seraphin earned a Ph.D. in Electronic Materials from the Massachusetts Institute of Technology, where he performed research on silicon nanotechnology. His research focused on the development of novel silicon nanostructures and tailoring their optical properties. He also holds bachelor's degrees in Political Science with a concentration in American Government and Engineering Science with a concentration in Materials Science from the State University of New York at Stony Brook.

Mr. Thom Shanker

Thom Shanker is a correspondent covering the Pentagon, the military and national security for The New York Times. He joined The Times in 1997, and was named Pentagon correspondent in May of 2001. Prior to that, he was assistant Washington editor, responsible for managing The Times' coverage of foreign policy, national security and economics from the Washington bureau. He is co-author, with Eric Schmitt, of "Counterstrike: The Untold Story of America's Secret Campaign Against Al Qaeda," published in August of 2011 by Times Books and Henry Holt and Co., and was a New York Times Bestseller. For the war in Afghanistan, Mr. Shanker embedded with Army Special Forces at Kandahar. He has conducted numerous reporting trips to Afghanistan and Iraq, and has embedded in the field with units from the squad and company level through battalion, brigade, division and corps. Prior to joining The Times, he was foreign editor of The Chicago Tribune. Mr. Shanker was The Tribune's senior European correspondent, based in Berlin, from 1992-1995. Most of that time was spent covering the wars in former Yugoslavia, where Mr. Shanker was the first reporter to uncover the Serb campaign of systematic mass rape of Muslim women. After first serving as The Tribune's Chicago City Hall bureau chief, he was named Moscow bureau chief from 1985-1988, covering the first years of the Gorbachev era as well as issues of superpower arms control and human rights abuses under the Soviet regime. From 1988-1990, he was The Tribune's Pentagon correspondent. Mr. Shanker returned to Moscow from 1990-1992 to cover the death of the USSR and the collapse of the communist empire in Eastern Europe. He also spent one year as the foreign and military affairs writer on The Tribune editorial board. His first professional experience in journalism was three years as a general assignment, night police and county courts reporter for The Daily Oklahoman. Mr. Shanker spent two years in the master's degree program at The Fletcher School of Law and Diplomacy, specializing in strategic nuclear policy and international law, passing his master's orals with Highest Honors. He graduated Cum Laude with a bachelor's degree in political science from Colorado College, and was awarded an Honorary Doctor of Laws by

the college in 2004. He is a frequent guest professor on college campuses, and has lectured at Stanford, Harvard and the University of Virginia, among others. He also has been part of the distinguished guest lecturer series at the Special Operations Command and the National Counterterrorism Center. He has been published in The New York Times Sunday Magazine, The New York Review of Books, The New Republic, The American Journalism Review and Military Review. He is a contributor to "Crimes of War: What the Public Should Know," an anthology published by Norton. He also is a member of the Council on Foreign Relations.

Mr. Michael Toscano

Mr. Michael Toscano is the President and CEO of the Association for Unmanned Vehicle Systems International (AUVSI). AUVSI is the world's largest non-profit organization devoted exclusively to advancing the unmanned systems community. AUVSI is committed to fostering, developing, and promoting unmanned systems and related technologies. AUVSI's 7,000 plus members worldwide come from government organizations, industry and academia. Prior to joining AUVSI, Mr. Michael Toscano was the Program Manager for Research and Development for Nuclear Security in the Office of the Deputy Assistant to the Secretary of Defense for Nuclear Matters. He was responsible for leading a physical security equipment RDT&E program that supports the protection of tactical, fixed and nuclear weapons systems, DOD personnel and DOD facilities. He was also the Chairman of the Physical Security Equipment Action Group (PSEAG). Within this capacity, he provides oversight to the administrative execution of the joint Department of Defense (DoD) Physical Security Equipment Research, Development, Test and Evaluation (PSE RDT&E) program. Oversight responsibilities includes programmatic and technical reviews of selected conventional and nuclear DoD developmental and procurement programs in the areas of physical security (PS), antiterrorism (AT), and force protection (FP). He was the DoD centralized coordinator of research, development, and test and evaluation of the PSE program. Previously, Mr. Toscano was a staff specialist in the System Engineering Directorate within the Under Secretary of Defense (Acquisition, Technology and Logistics (AT&L)). In this capacity, he served as a systems engineer in the Assessment & Support office, which supported the Director, Defense Systems. Mr. Toscano was a team leader for systems engineering reviews of major weapon systems in support of the Overarching Integrated Product Team. Prior to that, Mr. Toscano coordinated three Department of Defense (DoD) Joint programs as a member of the Under Secretary of Defense (AT& L) staff. He served as the Coordinator, Joint Robotics Program (JRP) from 1990 to 2003. He served as the Chairman of the PSEAG from 1991 to 2003 and provided DoD oversight responsibility for the Joint Unexploded Ordnance Coordination Office from 2001 to 2003. He has served as the Executive Secretariat to the 2002 Defense Science Board on Combating Terrorism, Advisory Member to the 2003 Army Science Broad on Force

Protection and Manpower Reduction, and Advisory Member to the 2002 Naval Research Advisory Committee study on the Roles of Unmanned Vehicles. In his earlier duties, Mr. Toscano was responsible for the day-to-day oversight of RDT&E budgets that exceed $90 million annually. He prepared and coordinated program master plans, worked closely with the Services, other DoD components, academia, national laboratories and private industry in the development of unmanned and Force Protection equipment and systems for the DoD. Mr. Toscano began his career in 1976 as a junior engineer supporting the David Taylor Research and Development Center, Annapolis, MD. In 1979, he joined the Naval Sea Systems Command (NAVSEA) where he held several key position culminating in selection to Test and Evaluation (T&E) engineer for Anti-Submarine Warfare (ASW) RDT&E programs. In this position, Mr. Toscano was responsible for overseeing the test and evaluation efforts of 30 NAVSEA ASW programs. Mr. Toscano holds Bachelor of Science degrees in both Civil and Environmental Engineering from the University of Rhode Island.

Mr. Dyke Weatherington

Mr. Dyke Weatherington assumed the role of Director, Unmanned Warfare, Strategic and Tactical Systems in the Office of the Under Secretary of Defense (OUSD) for Acquisition, Technology and Logistics (AT&L) and the Office of the Assistant Secretary of Defense for Acquisition. He is responsible for acquisition oversight for Department of Defense Unmanned Aircraft Systems (UAS) and associated subsystems including sensors and communications-links within the OUSD/AT&L. He is responsible for numerous UAS programs including the Navy Unmanned Combat Air System, Global Hawk, Broad Area Maritime Surveillance, Predator, Gray Eagle, Reaper, Shadow, Fire Scout, and many small UAS programs. Mr Weatherington is also the functional lead for the Deputy Secretary of Defense directed UAS Task Force. Prior to coming to the Office of the Secretary of Defense, then Lt. Colonel (USAF Retired) Weatherington was the Program Element Monitor for U-2 and Global Hawk sensors, data-links, and imagery standards within the USAF Air Staff (SAF/AQI), serving in this position from 1997 to 2001. During this assignment, he also served as the U.S. Head of Delegation to NATO Air Group IV in the Intelligence, Surveillance and Reconnaissance mission area. Previous experience included positions as the Chief of the Precision Targeting Branch at the Reconnaissance System Program Office at Wright-Patterson AFB (WPAFB). Earlier Air Force management and engineering positions included activities at Ballistic Missile Office (BMO) at Norton AFB and intelligence analysis efforts at Foreign Technology Division (now National Air Intelligence Center; NAIC) also at WPAFB.

Mr. Weatherington was born and raised on his family farm near Burnside Illinois. He holds a Bachelor of Science Degree in Engineering Mechanics from the United States Air Force Academy (1981) and a Master of Arts in National Securities Studies from California State University (1993). He is also a graduate of the Air Force Air Command and Staff College

and the Defenses Systems Management College. He has been awarded numerous Air Force Decorations including the Airmen's Medal.

Headquarters U.S. Air Force

Integrity - Service - Excellence

Senior Warfighter Perspective

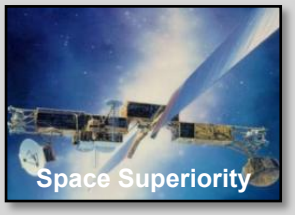
Col Dave Crow
Air Combat Command
Chief, Readiness Division
Langley AFB, VA

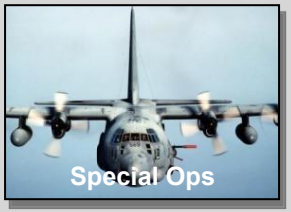
U.S. AIR FORCE

U.S. AIR FORCE

Air Force Core Functions

What We Bring to the Fight



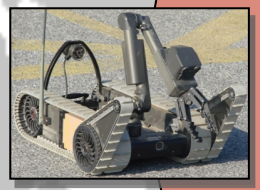


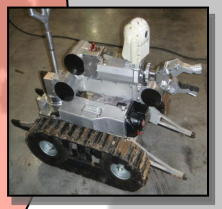
Integrity - Service - Excellence

Air Superiority Environment

1991 2012

C-IED





WMD/CBRN

Force Protection

Warfighter Gaps

- Adaptive/Evil Enemy
- IED Recognition

Other Uses

- Unsafe Structures
- Range Clearance
- Construction
- BRAAT/ADR
- Logistics/Transport
- Medical Support

Anti-Access/Area Denial Environment

2012 → Future

BRAAT/ADR

C-IED

Force Protection

WMD/CBRN

Warfighter Gaps

- Multiple UXO Assessment and Neutralization
- Damage Assessment
- CBRN Assessment

Other Uses

- Unsafe Structures
- Range Clearance
- Construction
- Logistics/Transport
- Medical Support

U.S. AIR FORCE

The Environment

- Declining Defense Appropriations (Budgets and Supplementals)
  - Costs are rising (equip., services, labor, health, energy, etc.)
  - Declining force structures (after Iraq & Afghanistan); but equipment worn out
  - Trends in U.S. demographics and debt payments are adverse
- Broad Spectrum of Security Concerns; and Much Uncertainty
  - Pirates; terrorists; cyber attacks; bio./chem./nuclear; IEDs; widespread proliferation; regional instabilities (that draw us in); nuclear Armageddon; etc.
  - "war among the people" different from tank-on-tank
- Rapid Changes (in technology, geopolitics, economics, globalization security)

"Affordability"; "Uncertainty"; "Flexibility" are Critical Drivers for Coming Era

To Successfully Respond to This 21st Century Environment

- 20th Century policies, assumptions, laws, structures, acquisition practices, must change!
- Requires a focus on:
  - Affordability (in "requirements;" equipment selection; design; force structure, etc.)
  - Changes to Resource Allocations (dollars; people; organizations; education and training; etc.)
  - Flexibility and Responsiveness (from government and industry)
  - Staying Ahead

Expect Significant Resistance to Change

- From Congress
- From Military
- From Incumbent Businesses
- From Unions
- Etc.

This resistance must be overcome!

For "culture change," need:

•Widespread Recognition of the need for change

•Proactive Leadership (with a vision, a strategy, and a set of actions)

In This Era of Rapid Change

- Robots (ground, air, underwater) must be a significant part of the change
- Robots are far more affordable and save lives
- But, robots are counter-cultural (require a "paradigm shift" and will be strongly resisted (e.g. Global Hawk example)

Robots are not a replacement for manpower; they are effective and affordable complements – "partners"; for a wide variety of needs (from RSI, to war fighting assistance, to logistics).

“Robots”*

*** From Cover of “Democracy’s Arsenal: Creating a Twenty-First Century Defense Industry”, Jacques Gansler, MIT Press, June 2011**

Some Applications for Robots

- IEDs
- Air, Land, Sea ISR
- Mines (detection, neutralization, and breaching)
- Logistics
- Operation in Hazardous Environment
- Evacuation of Injured
- Air, Land, Sea "Swarming"

All With Man/Robot Partnership, and Continuous Information Exchange -- for all Increased Mission Effectiveness

"The Coming Partnership of Man and Robot Will Characterize the American Military"*

Driven by:

- Need for a lower cost, yet highly effective military
- Public refused to support prolonged battle causalities
- Demand for fewer forces overseas - - especially if highly valuable

* "Let the Robots Do the Dying", Simon Ramo, Figueroa Press, 2011

Actions, to Implement the "Unmanned/Manned Operations Vision," are Critical

- Budgets
- Tactics and doctrine
- Organization
- Education
- Training
- Exercises
- R & D (e.g. with "intelligence"; controlled autonomy; etc.)
- Industry Responses
- Changes in Policy (e.g. re. export controls)

The Benefits Will be in Cost Reductions, Lives Saved, and Increased Force Effectiveness.

The Vision Can be Achieved!

- There is widespread understanding of the need for change (driven by the declining budgets; the demonstrated technologies; and the significantly-enhanced mission effectiveness)
- There is growing recognition of the life-saving and cost reduction benefits offered by robots
- The challenge is proactive leadership (in overcoming the institutional resistance)

It's Up To You!

UNMANNED GROUND SYSTEMS CURRENT AND FUTURE

Jeff Jaczkowski, Deputy Project Manager

10 May 2012

Distribution Statement A: Approved for public release; distribution is unlimited.

UGV Systems and OEF

"Current Ops"

Evolution of Ground Robotics in Combat

- Sustainment, Modernization, Interoperability and Modularity

2004
162 systems
- No single vendor could produce 162
- 5 vendors, multiple configurations
- Joint effort, EOD focused

2005
1800 systems
- Robot's proven ability to save lives
- Expansion beyond EOD mission (Countermine, Security)
- Agreements w/ AMC and REF

2006
4000 systems
- Engineers and Infantry
- Route clearance, Explosive detection & Weaponization development

2007
5000 systems
- Special Forces robot applications assessed
- Route clearance, Explosive detection & Weaponization on battlefield

2008-2009
6000 systems
- Maneuver elements
- Range extension
- CBRNE detection
- Persistent surveillance
- RC HMMWV
- More capable payloads

2010-2011
7000 systems
- Military Police
- Smaller platforms
- Enhanced battery life
- Commonality
- Remote deploy
- More capable payloads

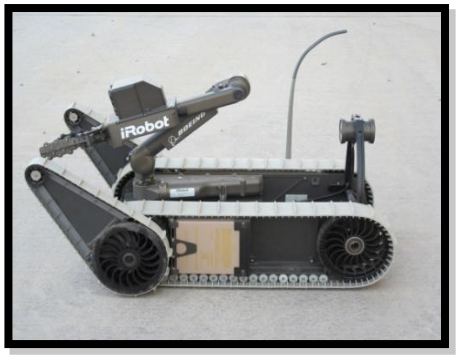
2012-Future
- Interoperability
- 'Plug & play' capabilities
- Limited autonomy
- Weaponization
- Increased agility and dexterity

One third of robots issued between 2009-2011 went to units other than EOD and Combat Engineers

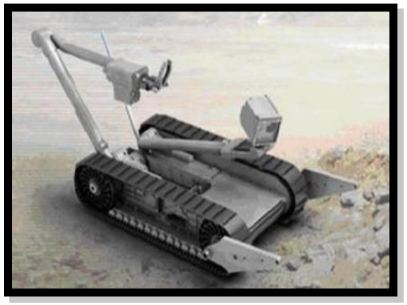
RS JPO Robots Currently in Combat

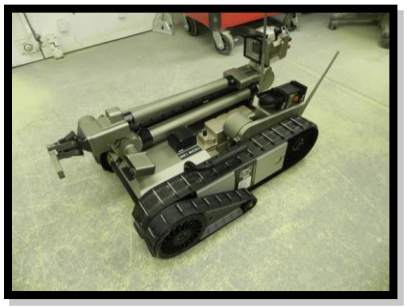
ROBOTIC SYSTEMS JPO

Mini-EOD (SUGV-310)



PackBot Family





Recon Scout XT

MARCBot

XM1216 SUGV Family

TALON Family

M160

ROBOTIC SYSTEMS JPO

RS JPO's Joint Robotics Repair Detachment (JRRD) in Afghanistan

Distribute

Repair

Train

Current Operations Feedback

- Robotic systems have proven their value during OIF/OEF
  - RS JPO has fielded over 7000 since 2004

- What the Soldier wants:
  - Extended range/robust communications
  - Smaller (form and mass) devices
  - Common controller
  - Longer battery life
  - Increased endurance, dexterity & agility
  - More capable payloads
    - » Better cameras, comms, IED detection, etc.
  - MORE systems

Size, Weight, and Power (SWaP) are key focus areas

LOOKING FORWARD

"FUTURE OPS"

Future UGV Capabilities

Modularity, Commonality and Interoperability

ROBOTIC SYSTEMS JPO

1 Soldier to 1 UGV Teleoperation Control Some Limited Autonomy

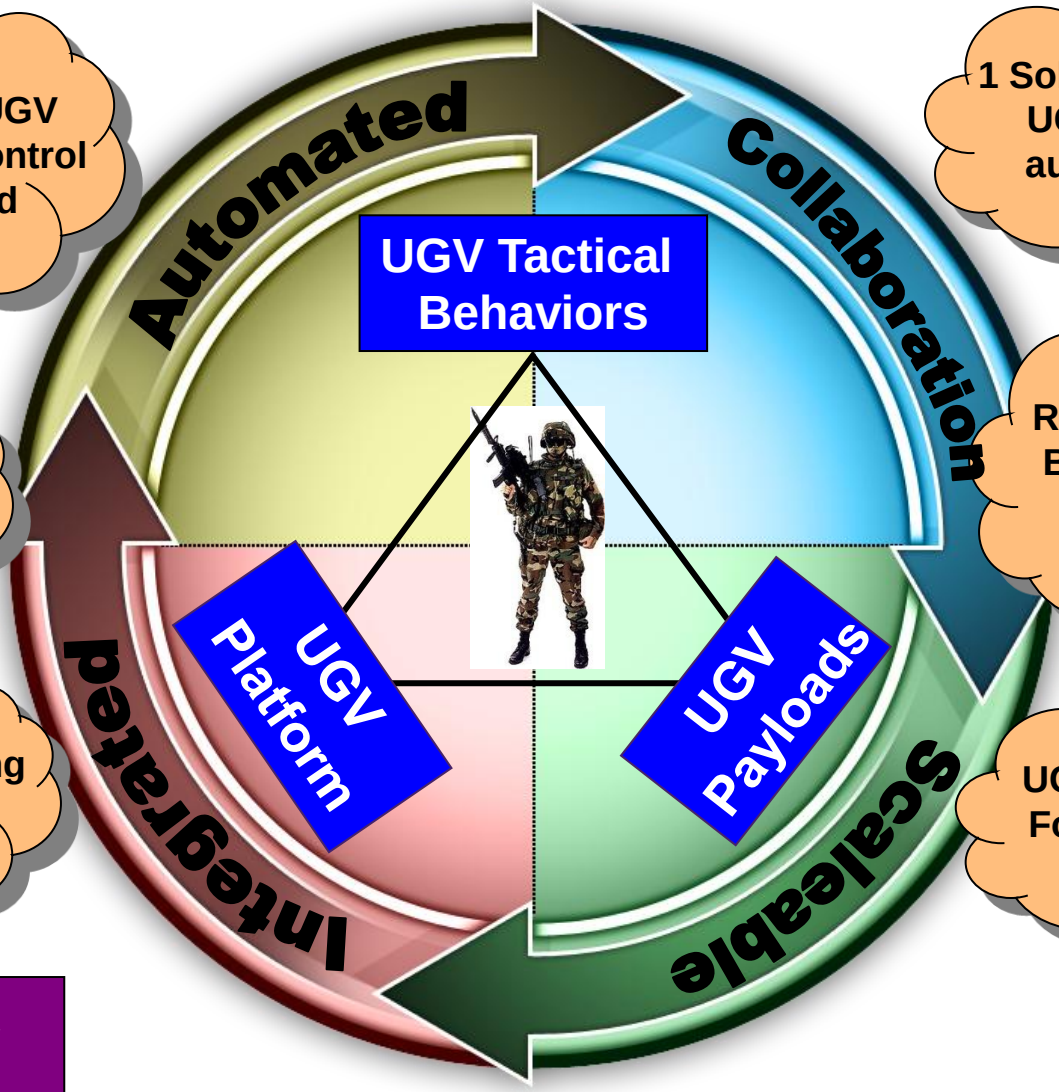
1 Soldier to Many UGVs nearly autonomous

Robots doing dull, dirty, dangerous jobs

Robots doing tasks, Better, faster, safer, &more efficient

UGVs providing Standoff protection

UGV-UAS Teaming For Full Spectrum Operations



Today

Future

Leadership • Service • Innovation

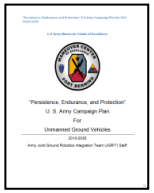
ROBOTIC SYSTEMS JPO

Unmanned Systems Initial Capabilities Document (ICD)*

(Photos are Notional Representations Only)

Joint Roadmap 2011-2036

Army UxS ICD

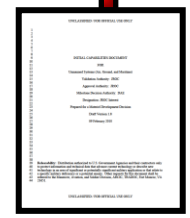


Army UGV Campaign Plan Jun 2012

Army UAS Roadmap Apr 2010

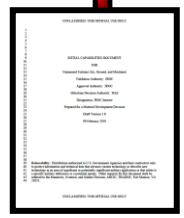
RPUAS CPD

SUGV Inc 2 CPD



MTRS Inc 2 CPD

AMAS CDD



SMET CDD

Micro UGV CPD

TRC CDD

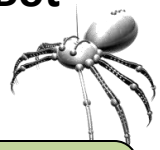
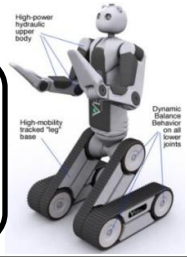
Joint approval of the Unmanned Systems (Air, Ground, Maritime) Initial Capabilities Document will create an overarching relationship for emerging Programs of Record and link various Unmanned System Roadmaps

*Slide courtesy of TRADOC Army Capabilities Integration Center

Army Ground Robotics Capability Sets*

Class of Vehicles / UGV Platforms

(Photos are Notional Representations Only)

Soldier Transportable	Vehicle Transportable	Self Transportable	Appliqué
Crew Served Bot	**Mounted or Towed** Man Transportable Robot System (MTRS) POR	**Soldier Follower** Squad Mission Equipment Transport (SMET) CDD	**Remote Operation** Husky Mounted Detection System (HMDS) POR
Small Bot Small Unmanned Ground Vehicle (SUGV) POR	M160 Light Flail POR	**Recon/Security** Mobile Detection Assessment and Response System (MDARS) POR	**Supervised Autonomy** Autonomous Mobility Appliqué System (AMAS) CDD
Micro Bot Micro Unmanned Ground Vehicle (MUGV) CPD	**Armed**	**Robotic Wingman**	**Full Autonomy**
Nano Bot 	**Humanoid**  Battlefield Extraction Assist Robot (BEAR) Initiative	**Squad Member** Legged Squad Support System (LS3)	**Exoskeleton** Exoskeleton (XOS) CDD

Program of Record

Draft JCIDS Requirement

Technology Initiative

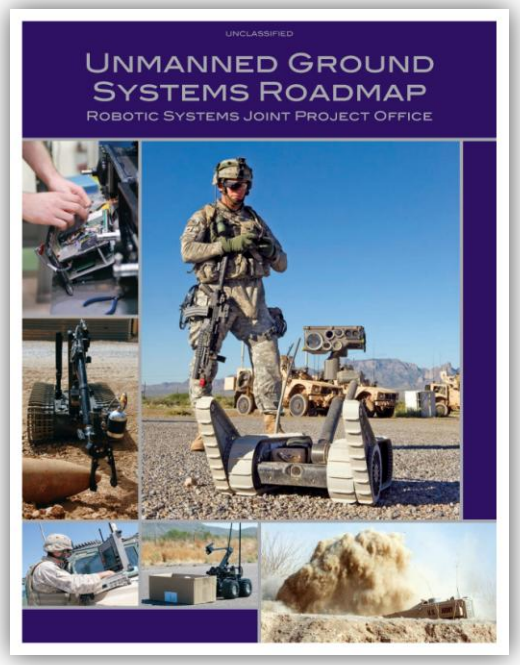
Tactical Robot Controller (TRC) CDD

*Slide courtesy of TRADOC Army Capabilities Integration Center

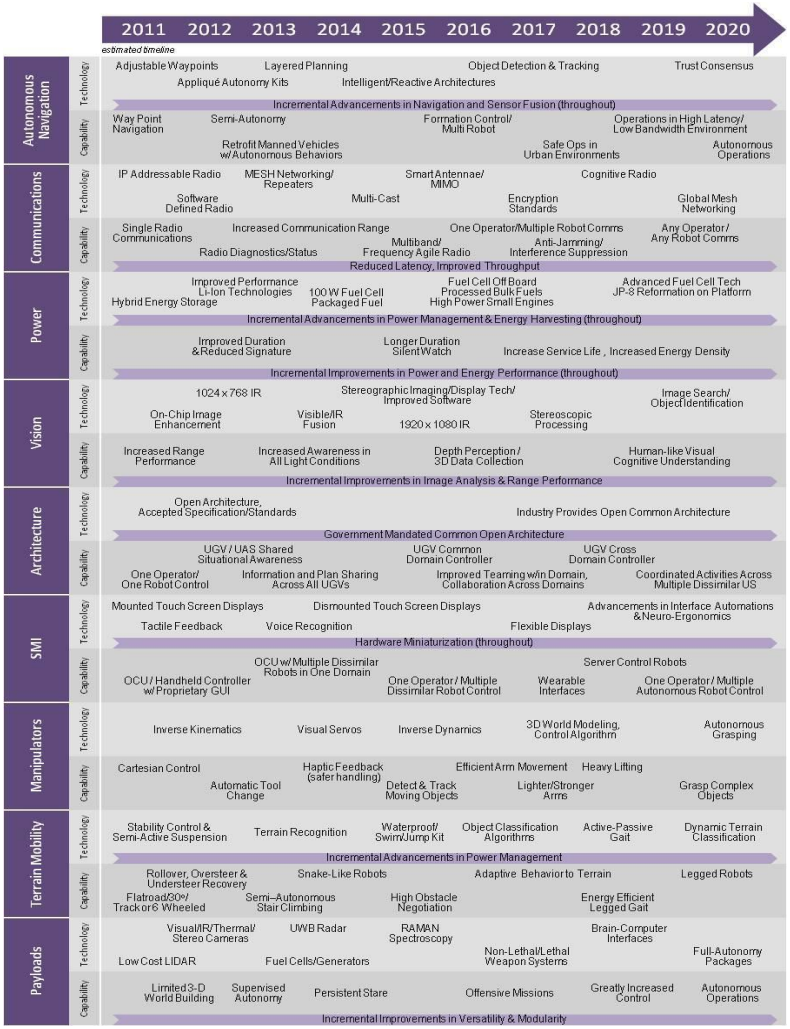
ROBOTIC SYSTEMS JPO

Unmanned Ground Systems Roadmap

- Maps Enablers to Technology/Needs
- Modernization Strategy
- Systems/Programs Portfolio



www.rsjpo.army.mil



RS JPO Roadmap was developed to help define the desired direction and investments in UGSs based on the current and projected states of technology

What is Next?

- UGVs save lives! Over 750 robotic 'casualties' since Oct 2005
- Robotics Systems remain relevant and critical to the success of the Army to execute, as part of the Joint Force, the recently announced Defense Strategy
- We will continue to shape the future towards the Army of 2020 and beyond through affordable modernization - we must “do more without more” given current fiscal realities
- The current state of UGVs is healthy, but…
  - Expanding user-base and missions - ubiquitous robotic domain
  - Institutionalizing robotics
    - Cultural acceptance
    - Standards and policy
    - Infrastructure and manpower
  - Need to move beyond tele-operation
  - The future is manned/unmanned teaming
  - Interoperability/modularity is key
  - UGVs need advocacy

ROBOTIC SYSTEMS JPO

Questions?

Army UGV Campaign Plan*

Capability Timeline

(Photos are Notional Representations Only)

	Near Term 2010 – 2015 Current Solutions/PIPs	Mid-Term 2016 – 2025 Echeloned Family of Systems	Far-Term 2026 – 2035 Integrated System of Systems
Man Transportable	XM1216E1 Small Unmanned Ground Vehicle (SUGV) Micro Unmanned Ground Vehicle (MUGV) Tactical Robot Controller		Nano-Bot
Vehicle Transportable	Man Transportable Robot System (MTRS) Increment 2 M160 Light Flail	HUMANOID	Squad Member
Self Transportable	S-MET MDARS		Robotic Wingman
Robotic Appliqué Kit	Autonomous Mobility Appliqué System (AMAS) HMDS, ADEP, RCIS ABV and Medium Flail		Exoskeleton

REMOTELY OPERATED — SUPERVISED AUTONOMY — FULL AUTONOMY

*Slide courtesy of TRADOC Army Capabilities Integration Center

USMC UGS Strategy Timeline*

(Photos are Notional Representations Only)

	Near Term 2010 – 2015 Current Solutions/PIPs	Mid-Term 2016 – 2025 Echeloned Family of Systems	Far-Term 2026 – 2035 Integrated System of Systems
Man Transportable	Small-UGV – (Engineer Squad Robot) Micro- Bot		Nano-Bot
Vehicle Transportable	Medium UGV (R2C; Packbot; TALON) Combat Robotic System Tactical Robotic Controller	Humanoid	
Self Transportable	GUSS	Medium UGV (LS3)	
Robotic Appliqué Kit		Cargo UGV Autonomous Mobility Appliqué System	Exoskeleton

REMOTELY OPERATED → SUPERVISED AUTONOMY → FULL AUTONOMY

*Slide courtesy of Marine Corps Combat Development Command

Ground and Sea Robotics

Paul Kern
Senior Counselor

THE
COHEN
GROUP

Ground Robotics

THE COHEN GROUP

- DARPA projects of the 90's provided prototypes for early Afghan operations
- Rapid equipping force provided funding and support for early deployment

Lessons Learned

- Too heavy to be man portable
- Standard batteries needed
- Communications in caves a problem
- Soldiers like it – wanted more

Evolution

- Recon to EOD
- Larger to smaller
- SUGV – only survivor of FCS
- False assumption that technology is mature

What We Need

Need Standards

- Common family of controllers
- Operating system
- Navigation
- Communication links

Need Improvement

- Power sources
- Manipulation
- Low cost sensors
- Autonomous/semi-autonomous operations
- One operator – many robots
- Reduction of total manpower

Experimentation

- NOW! Don't wait until we are in harms way again
- Multiple missions
  - Mature EOD
  - Recon
  - Logistics
    - Mule
    - Convoy
    - Warehouse
    - Cook
  - Sentry
  - Medical evacuation
  - Lethal/ROE
  - Interrogation

New Environment – South East Asia

- Water obstacles
- Triple canopy jungle
- Wooded mountains
- Dense urban cities
- Animal obstacles

Marine Applications

Surface: closer to aerial vehicles

Subsurface: similar to ground, but difficult communications with acoustic modems vs. RF missions

- Persistent reconnaissance
- Countermine
- Lethal – Iranian mine analogy
- Communications
- Logistics

Conclusion

- Beginning of a new era for unmanned systems
- Needs strong proponents
- Don’t let adversaries get ahead of US
- Experiment now! Not after we need

Ground Robotics

Rob Maline

Joint Ground Robotics Enterprise

Attack the Network – Defeat the Device – Train the Force

JIEDDO's Robotics Programs

CAPT Fred Gaghan

Acting Deputy Director – Rapid Acquisition & Technology

Joint IED Defeat Organization

National Defense University

10 May 2012

This briefing is classified UNCLASSIFIED

Discussion Points

- Robotics in the C-IED context
- Mounted Troop Support
- Dismounted Troop Support
- Recon Robots
- Future Considerations

Robotics in the C-IED context

- One of the prevalent IED threats in theater for both mounted and dismounted troops is the Victim-Operated IED (VOIED)
- Very simple, but non-discriminatory
- You can do one of two things to it:
  - You can detect it (go around or neutralize it), or
  - If you can't detect it, you can mitigate damages

    (think rollers, pre-det, etc…)
- In most cases, current approaches require exposing soldiers to risk

Robotics in the C-IED context (cont'd)

- Current detection technologies require relatively close proximity & a slow rate of advance
  - GPR, Metal detectors, Cameras, etc.
- C-IED rollers require actual contact with the trigger
- How can robotics be used to address these shortcomings?
  - E.G. Put these capabilities on a UGV, ahead of the convoy, outside of the hazard zone

Mounted Troop Support

- JIEDDO has opted for a 2 phase approach:

1. Prove the UGV concept by adding a simple effector (i.e. rollers, rakes. etc.)

2. Add sensors

   (more than just a sacrificial vehicle)

Ghost Ship

- Simple, bare-bones appliqué solution
- HMMVW-based
- Tele-operation only
- Pulls a modified roller

Pros:

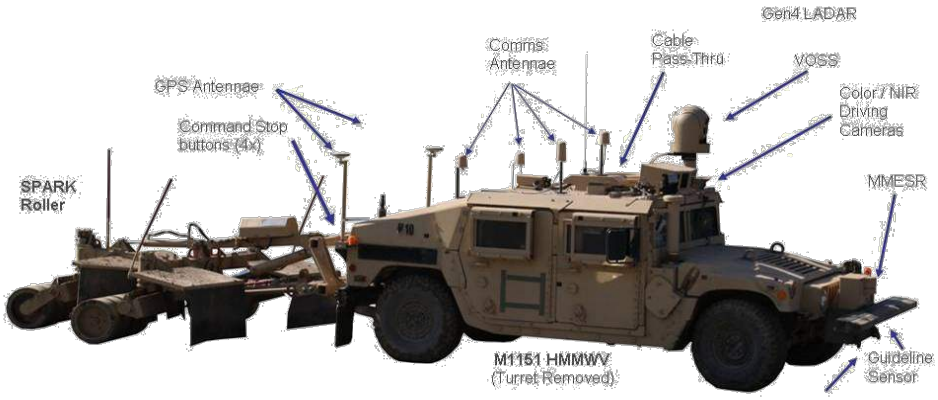
- Simple
- Inexpensive
- Lots of HMMVWs around
- Quick install

Cons:

- High operator workload
  (100% driving, simulator sickness, etc.)
- No real sensors
- Recovery post-blast?

Supervised Autonomy for Defeat of IEDs (SANDI)

- Medium capability appliqué solution
- HMMVW-based
- Semi-autonomy or Tele-operation
- Pulls a modified roller
- SANDI 2 incorporates
  - High Def stabilized camera
  - Better HMMVW (M1151)



Pros:

- Semi-autonomous
  - Waypoint following
  - Obstacle Stop
  - Lower operator workload
- Lots of HMMVWs around
- Has been OCONUS tested

Cons:

- No real C-IED sensors (yet!)
- Recovery post-blast?

SANDI leading a RCP in OEF

Sentinel Scout

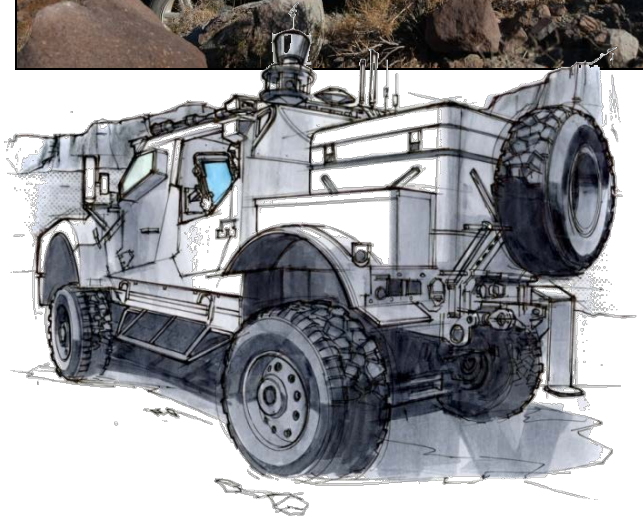
- High performance appliqué solution
- Commercial vehicle (could be integrated to MRAP)
- Full autonomy or Tele-operation

Pros:

- Full autonomy
  - Waypoint following
  - Road detection
  - Obstacle avoidance
  - Low operator workload

Cons:

- Expensive
- Not on an MRAP yet
- Recovery post-blast?



Redshirt

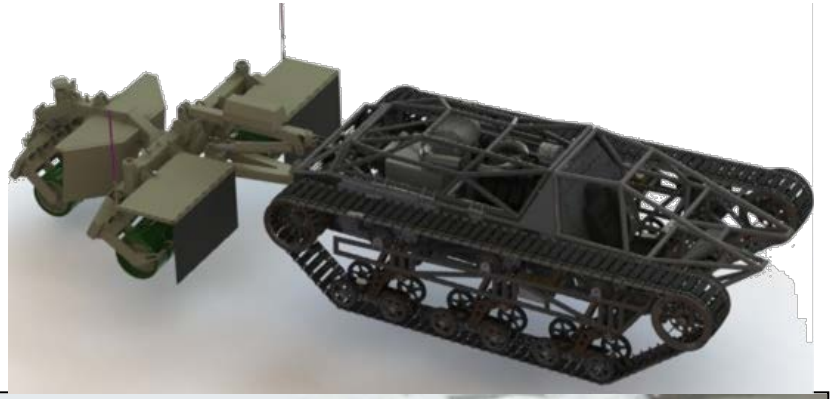
- Custom-built UGV (Howe & Howe MS4 aka RipSaw)
- Teleoperation only
- Pulls or pushes a modified roller

Pros:

- Extremely good mobility
- Has the power to pull or push
- Low vehicle ground pressure

Cons:

- Expensive, unique platform
- High operator workload (100% driving)
- No real sensors (yet!)
- Recovery post-blast?



Dismounted Troop Support

Attack the Network – Defeat the Device – Train the Force

- Robotic Pointman
- Tele-operation only

- Rollers (or Flail)
- 3 Prime Movers / 3 Payloads / 2 Controllers
- OCONUS testing ~SEP 12

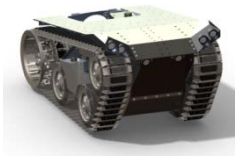
Pros:

- Small form factor
- Good for paths

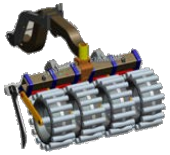
Cons:

- Still heavy (450 lbs+)
- Walls, Qalats, Streams, etc.

H&H
Disrupter-1



Panama City
Mini-Roller



TARDEC Mini-Roller

HDT Prime Mover with
HDT Mini Flail

Panama City
Mini-Roller

Segway RPM400

Dismounted Troop Support

- US Army Rapid Equipping Force
- Tele-operation only
- Rollers
- Modified COTS with Tele-operation appliqué
- OCONUS testing on-going for Minotaur

Pros:

- COTS – easy to maintain
- Can also carry loads

Cons:

- Has to be trailered to area
- Walls, Qalats, Streams, etc.

Minotaur

Armadillo

Dismounted Troop Support

- UGV Mules
  - Carriage – Offload weight from soldier
  - Recon using camera
  - Ride-along or Follow-the-leader
- US Army – Squad Mission Support System
- USMC – Ground Unmanned Support Surrogate

Pros:

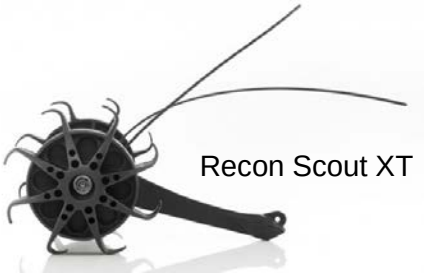
- Offloads weight from soldier
- Can carry sensors

Cons:

- Limited off-road mobility
- Walls, Qalats, Streams, etc.

Ultralight Recon Robot

- Small, throwable robot for dismounted recon
- ~< 10 lbs, including controller


Recon Scout XT

- Following a test of 12+ candidates, 3 finalists chosen to provide 100 ea. to OEF for field testing (APR-JUL 12)
- Results will form the basis of a requirement to provide a final capability
- Extra Recon Scout XTs procured to increase interim capacity using already-fielded item

iRobot FirstLook

MacroUSA Armadillo

Qinetiq Dragon Runner

Future Considerations

- Sacrificial Vehicle vs. Tactical Platform (cost vs. utility)
- Sensor Package and/or Neutralization Capability
- Employment (transportation to area of operation)
- Recovery
- Mission Support (rate of advance, duration, mobility, etc)
- Combat Power (reduction) & Operator Workload
- Change to Threat (RCIED/CWIED, Offset, PSI)
- OPSEC (conspicuous)

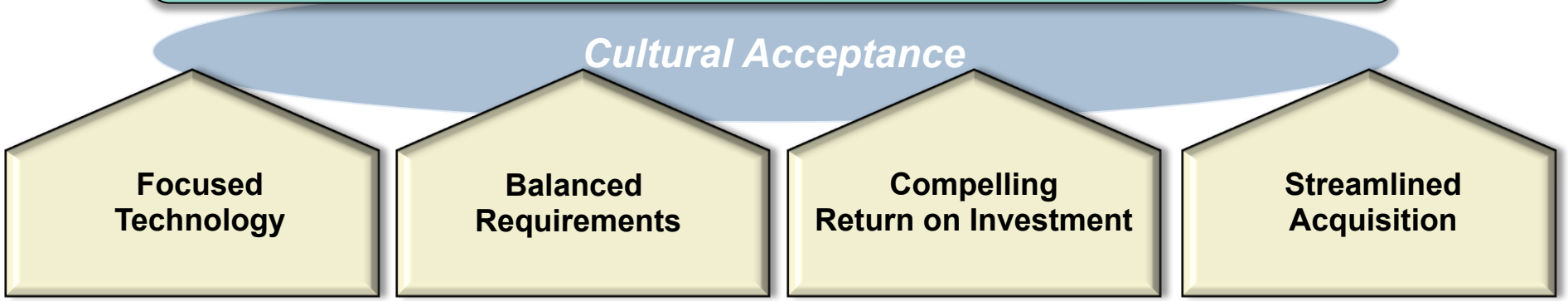
Where we are today

Robots destroyed by IED in Iraq…no one was hurt or killed.

We've proven that robots can perform combat missions and saves lives…why haven't we leapt ahead?

DoD Ground Robotics Vision

An integrated manned/unmanned force that strengthens the United States as the world's preeminent landpower



- Provide affordable robotic solutions that enable natural modes of interaction between man and machine
- Reconcile fieldable technology with prioritized and articulated requirements
- Build the business cases necessary to justify the required investment
- Match the acquisition strategy to the accelerated pace of robotics technology development and transition, reducing the total cost of ownership

Technical Challenges

Robots have limited ability to:

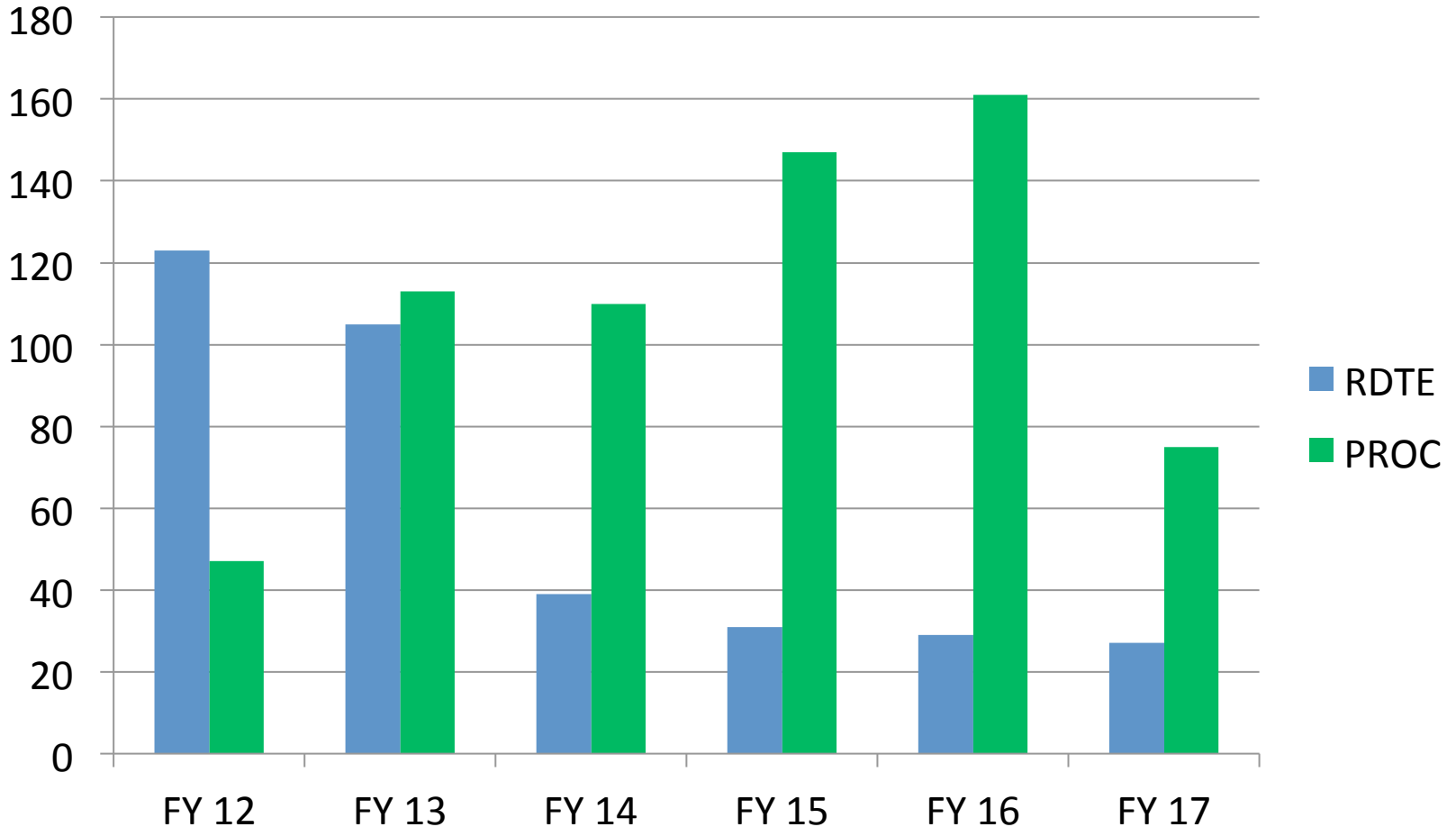
- Perceive and understand situations under all conditions
- Predict behavior of teammates or aggressors
- Collaborate with humans and other robots
- Learn tasks and adapt to new situations
- Move at near human speeds over any terrain
- Communicate effectively with other team members
- Lift, maneuver and interact with physical objects

Ground robots must become more capable and less brittle

Unmanned Ground Systems Evolving Requirements

Mission/Capability Area	2013	2038+
PROTECTION — EOD	Man Transportable Robotic System (MTRS)	
	Advanced EOD Robotic System (AEODRS)	
	AF Medium Size Robot (AFMSR)	
	SUGV	Small Unmanned Ground Vehicle (SUGV) Inc 2
PROTECTION — CBRN		
PROTECTION — Protection	Mobile Detection Assessment & Response System (MDARS)	MDARS Generation 2
	Combat Robotic System	
PROTECTION — Engineer	Autonomous Mine Detection System (AMDS)	
	Light-Flail (M-160)	Area Detection/Clearance Family of Systems
	Husky Mounted Detection System (HMDS) Applique'	
	Route Clearance and Interrogation System (RCIS)	
	Route Reconnaissance & Clearance (R2C)	
	Engineer Squad Robot (ESR)	
	Man Transportable Robotic System (MTRS) / Inc II	
SUSTAINMENT — Transport	All Purpose Remote Transport System (ARTS)	
	AMAS Phase 1 (HMMWV/ JLTV/FMTV)	AMAS Phase 2 (HEMTT/ MRAP/MTVR)
		Autonomous Mobility Applique' System (AMAS)
SUSTAINMENT — Logistics	Legged Squad Support System (LS3)	
	Autonomous Internally Transportable Vehicle (AITV)	Squad Mission Equipment Transport (SMET)
SOLDIER — ISR	Ultra-Light Recon Robot (ULRR)	Nano/Micro UGV
		Small Unmanned Ground Vehicle (SUGV) Inc 2
SOLDIER — Command & Control	Tactical Robot Controller (TRC)	

Funding Outlook



*Based on PB 13 Budget data

The fiscal environment

(-) The austere fiscal environment is going to reduce the amount of RDT&E funding available for ground robotics.

(+) Potential reductions in force structure may bring about an increased demand for robots to augment remaining personnel, impel increased efficiencies, or replace humans entirely.

Recent Push

Due to the fiscally constrained environment, focus has shifted from dedicated vehicles for specific missions to inexpensive, modular, and flexible systems that utilize legacy vehicles when possible

Inexpensive

↓

Ultra-Light Recon Robot

↓

Numerous small, cheap systems are being bought, assessed and fielded to meet urgent requirements

Modular/Interoperable

↓

- AEODRS (Navy)
- TRC (USMC, Army)

↓

Modular systems are easier to upgrade and improve. Interoperability ensures that systems can operate and communicate together

Flexible

↓

Autonomous Mobility Applique' System (AMAS)

↓

Making legacy vehicles "optionally manned" means that you only buy the applique', not a new platform for each mission

What the future holds

- For the immediate future, we expect unmanned ground vehicle technology development will continue to focus on in-theater Warfighter needs. {2:1}

- By FY14, move towards fielding ground robotic systems that allow the soldier to focus on the mission rather than operating/commanding the platform (i.e. work the mission, not the system). Investments in technologies to reduce the brittle nature of robots, when paired with achievable requirements and the proper acquisition model- will allow us to field more capable robots. {1:1}

- By FY16, advance autonomy in unmanned ground systems to increase operational capabilities, increase manpower efficiencies, and provide true economic benefit. Our ultimate goal is to provide Warfighters with overmatch in every situation by creating a manned/unmanned team. {1:many}

A final thought…

- First order impacts of robotic integration are well understood and widely accepted
  - Greater accuracy and persistence
  - Fewer casualties
  - More flexibility for forces
- Second order impacts harder to predict and articulate
  - Changes to Force Structure
  - Life cycle costs
  - Changes to TTPs/ Personnel mix

MARINE CORPS WARFIGHTING LABORATORY

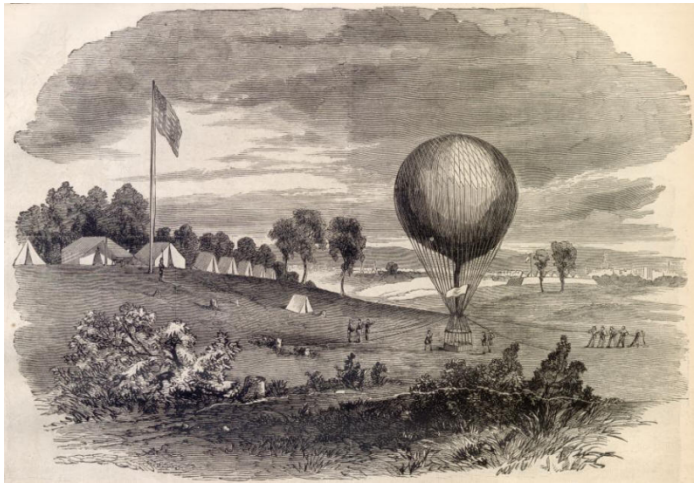
Robotics and Autonomous Systems in Experimentation and Operations

Dr. Paul Muessig

Chief Technology Officer

MCWL = Marine Corps "Forward Reconnaissance"

- **Mission**
  - Define and articulate what the "Marine Corps of the Future" should look like in combat development (DOTMLPF) terms.
- **Approach**
  - Develop and evaluate new operational concepts and their associated tactics, techniques, procedures (TTPs) and technologies.
- **Methods**
  - Live Force Experimentation
  - Technology Forecasting and Assessment
  - Wargaming
  - Modeling and Simulation (M&S)
  - Continuous Analysis of Threats and Opportunities

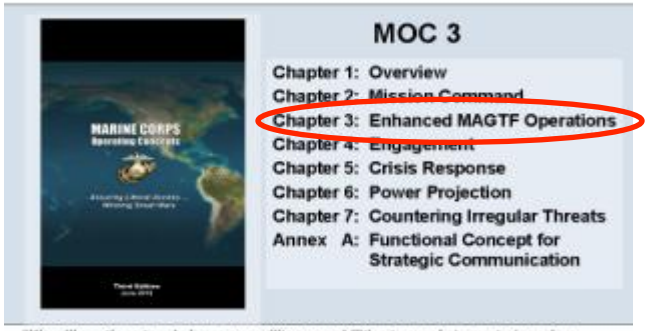


- **Products**
  - Variety of reports, analyses, and DOTMLPF-type recommendations that influence current operations and future combat development

MCWL MAINSTAY: CONCEPT-BASED EXPERIMENTATION

"We will rebalance our Corps, posture it for the future and aggressively experiment with and implement new capabilities and organizations."

- CMC



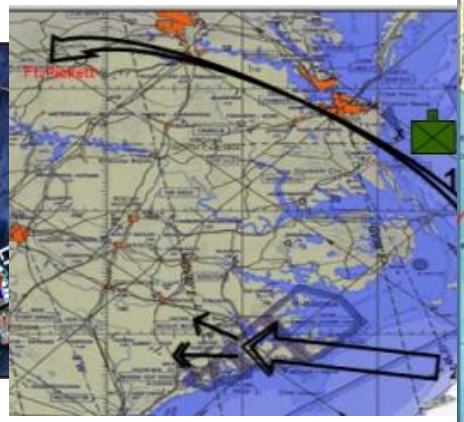
"EMO … advances the ability to operate in a distributed environment… perform multiple, simultaneous tasks… conduct operations at sea, from the sea, and ashore… overcome challenges to access…."

- DC, CD&I

"MAGTFs … must be capable of deploying immediately, maneuvering by multiple means, operating with minimal sustainment, thriving in uncertainty, and adapting…."

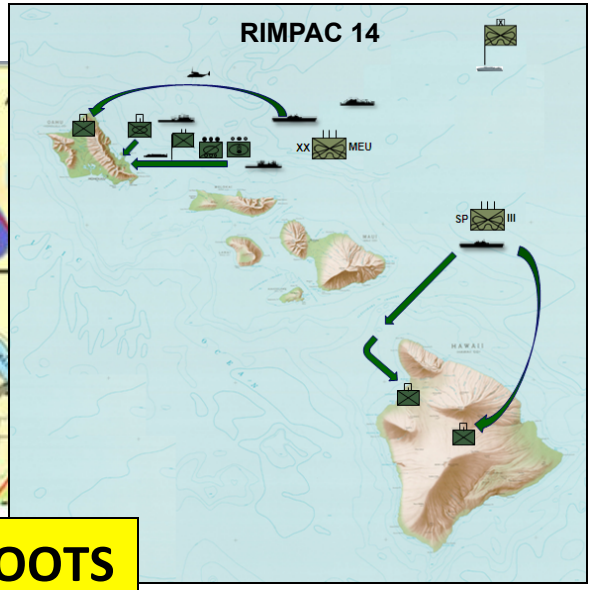
RIMPAC 10

BOLD ALLIGATOR 12



DAWN BLITZ 13

RIMPAC 14



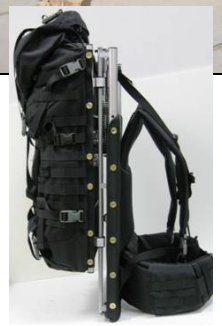
RETURN TO USMC EXPEDITIONARY ROOTS

TECHNOLOGY FOCUS AREAS

Current Imperatives:

- **"Lightening the Load"**
- **Reducing risk to IEDs**
- **Greater use of unmanned vehicles**
  - Logistics delivery, CIED applications
- **Improving tactical energy efficiency**

• Logistics Demand
(Power & Energy, Water, etc.)



• Autonomous Systems

• Cargo UAS

Marine Corps $5M FY10-14

LOGISTICS

2010

LM K-MAX
Boeing A-160

2012

ONR Gyrocopter (MMIST)

TATRC “Black Knight”
(Advanced Tactics, Inc.)

DARPA LS3

Autonomous ITV

Autonomous MTVRs
Robotic Convoys

Autonomous “Mule”

“Lighten the Load”

COUNTER-IED

Explosive Hazard ID and Disposal

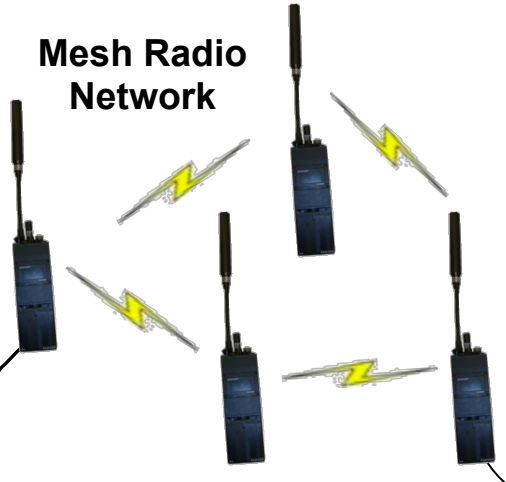
Terrain Clearance

ISR

INTEGRATED UNMANNED SYSTEMS CONTROL

Tactical Robotic Controller

Mesh Radio Network



Ground Sensors

Motion

Acoustic

Mil Battery

Magnetic

Visual (x4) (EO/IR)

Seismic

Air Vehicles

Shrike

Switchblade

WASP III

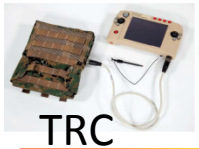
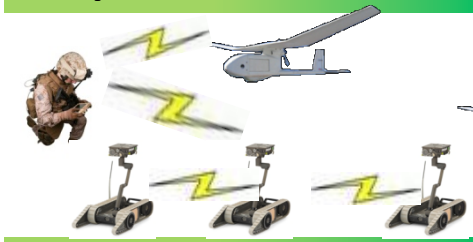
Raven-B

Ground Vehicles

MAARS / Talon

GUSS

UxS VISION

	2011 2012	2013 2014 2015	2037
Commands	**Physical Human Robot Interface**	**Scripted Voice Comnd Hand Signals / Haptic**	**Natural Language Understanding**
	 TRC		Human – Robot
Collaboration	**Individual Platform**	**Teaming w/in Domain X Domain Collaboration**	**Teamed Collaboration**
	FERRET Perception / Semi- Autonomy		
Controller	**1 Operator/Platform**	**1 Operator / Team**	**Advanced Mission Team Planing**
			
Operator Workload	**Operator workload high – heads down**	**Intuitive Human-Robot Control – limited ->No handheld controller**	**Autonomous Adaptive Tactical Behaviors**

USMC UGS Strategy Capability Timeline

AMCB UGV, 2011

	Near Term 2010 – 2015 Current Solutions/PIPs	Mid-Term 2016 – 2025 Echeloned Family of Systems	Far-Term 2026 – 2035 Integrated System of Systems
Man Transportable	Small-UGV – (Engineer Squad Robot)		
	Micro Bot		
			Nano-Bot
Vehicle Transportable	Medium UGV (R2C; Packbot; TALON)		
	Combat Robotic System		
		Humanoid	
	Tactical Robotic Controller		
Self Transportable		Medium UGV (LS3)	
	GUSS		
Robotic Appliqué Kit		Cargo UGV	
		Autonomous Mobility Appliqué System	
		Exoskeleton	
	REMOTELY OPERATED	SUPERVISED AUTONOMY	FULL AUTONOMY

Unmanned Systems in Overseas Contingency Operations Seminar

THE DEPARTMENT OF DEFENSE

EOD and Humanitarian Mine Action

Colonel Gerald “Gerry” Muhl

Chief, Explosive Ordnance Disposal & Humanitarian Mine Action

OASD Partnership Strategy & Stability Operations

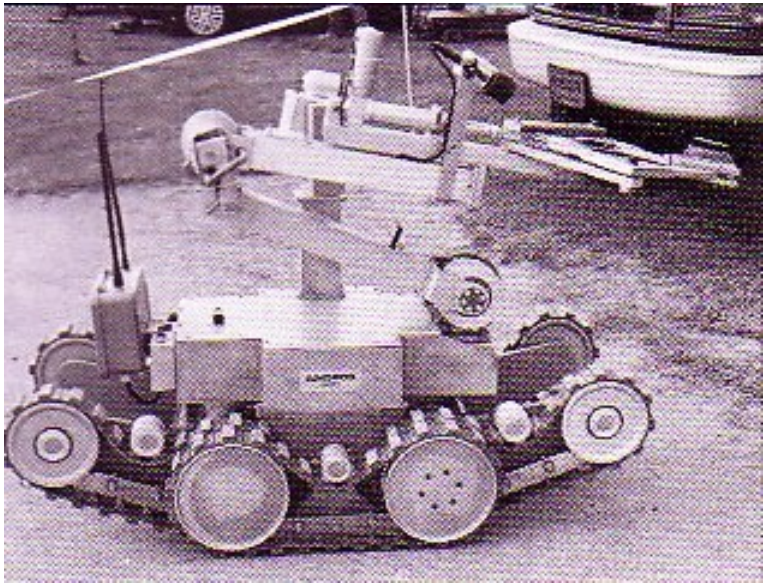
Agenda

- Purpose
- Current Operations
- Future Operations
- Way Ahead
- Summary

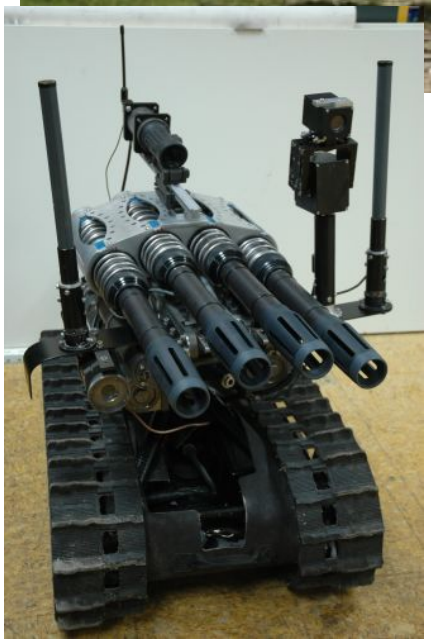
Purpose

To provide a brief overview of the DOD Explosive Ordnance Disposal use of unmanned vehicles in the past ten years of contingency operations

Current Ops (Where we are)



Future Ops (Where we are going)



Way Ahead (How we get there)

Summary

Questions?

COL Gerald "Gerry" Muhl
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703-614-5824

Lets keep them off the wall !!!

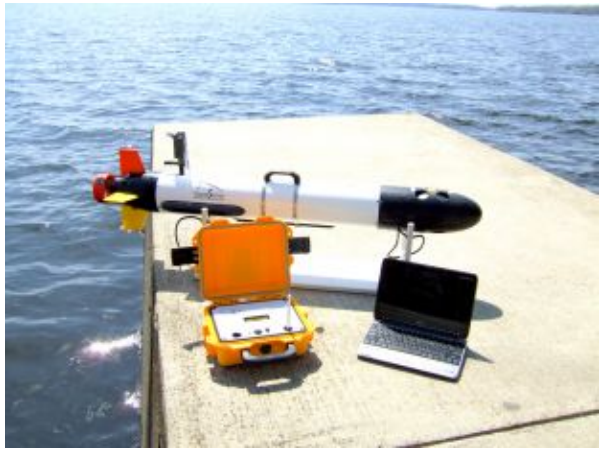
Unmanned Systems in Overseas Contingency Operations Seminar National Defense University

May 10, 2012

Mrs. Ellen M. Purdy
Assistant Deputy, Rapid Fielding
Office of the
Deputy Assistant Secretary of Defense, Rapid Fielding
ellen.purdy@osd.mil

Where We Are…

Autonomous Mobility Appliqué System (AMAS)

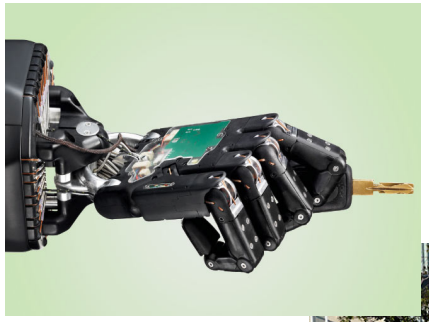


IVER-2 in Frontier Sentinel Exercise

Autonomous Technologies for Unmanned Air Systems (ATUAS)

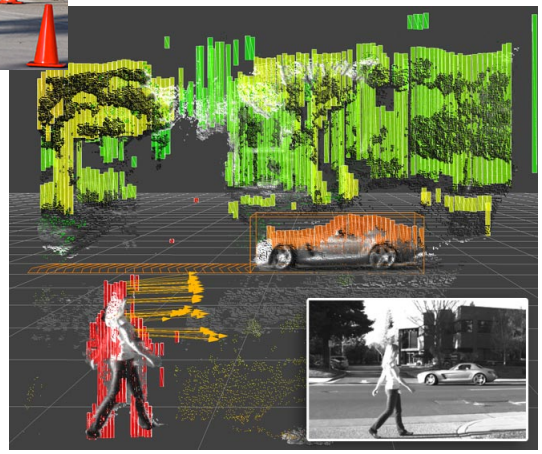
- **Optionally Manned**
- **Remote Control**
- **Limited Autonomous Behaviors**

Where We are Going…



It's not just a DOD effort anymore!

Google Driverless Car

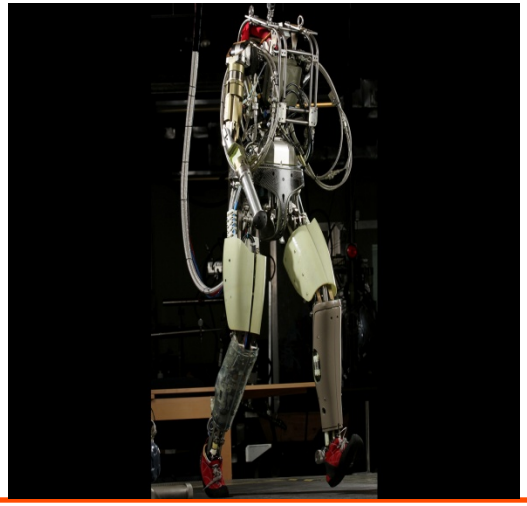


Mercedes 3D imaging for pedestrian & obstacle avoidance

Ground…

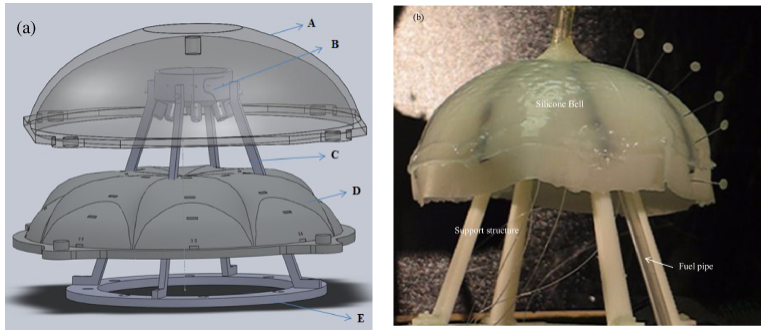
DARPA Robotics Challenge: Disaster Relief Robots

"Soft Robots", George M. Whitesides, Harvard University

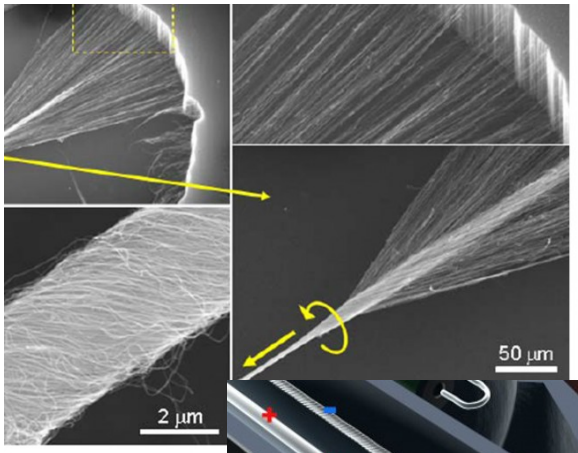


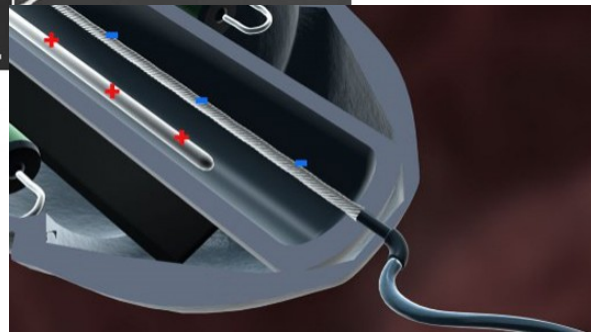
Protection Ensemble Test Mannequin (PET-Man), for the U.S. Army

Marine/Riverine…

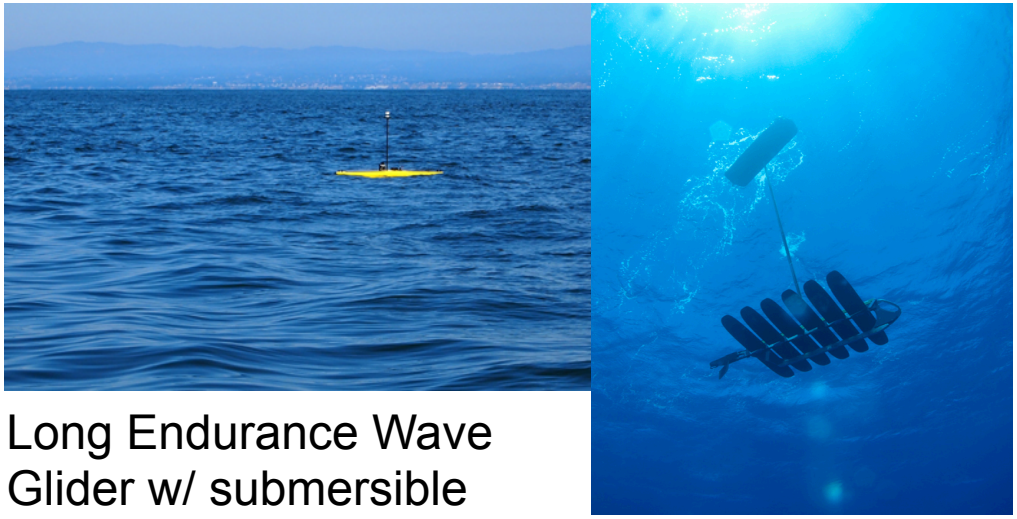


Jellyfish Robots



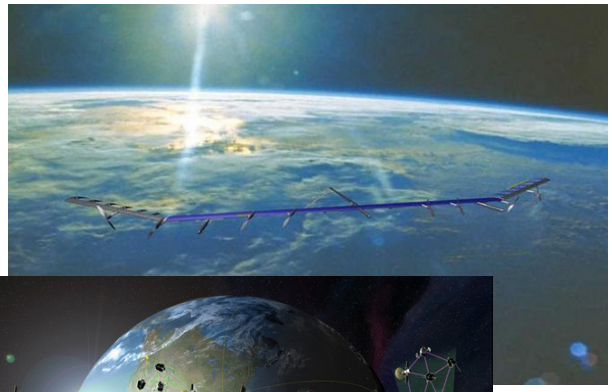


Nano-scale artificial muscle to propel "nanobots"

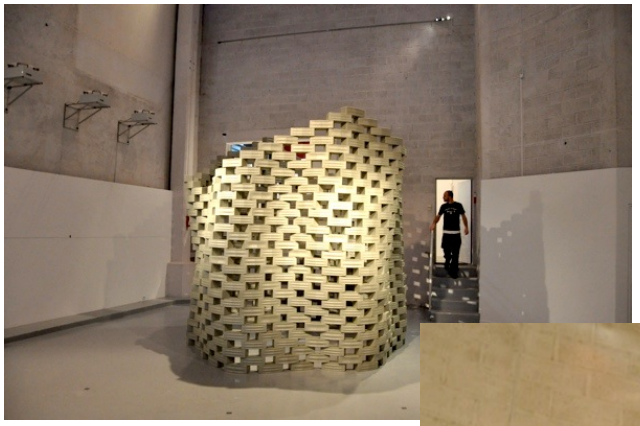


Long Endurance Wave Glider w/ submersible payload

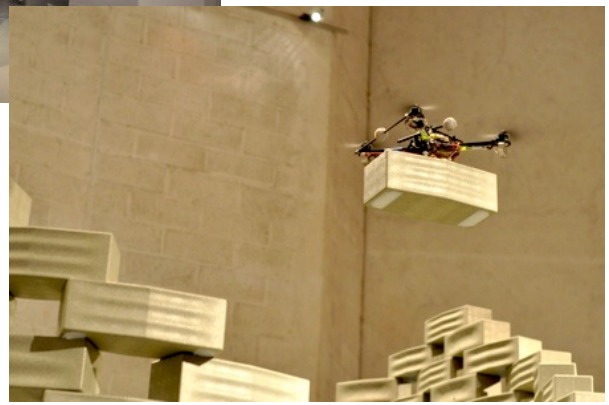
Air/low earth space…



low altitude and cost alternative to conventional satellite systems



Unmanned flight assembled architecture



On to Our Panelists…

- Dr. Paul Eremenko, Director, Tactical Technology Office (TTO), Defense Advanced Projects Agency (DARPA)

- Mr. Jeff Jackowski, Deputy Program Manager, Robotic Systems Joint Program Office

- Dr. Paul Muessig, Chief Technology Officer, Marine Corps Warfighting Laboratory

The Future Environment: Policy, Budget Issues and Constraints

NDU Seminar on Robotics in Contingency Operations

Michael Toscano

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UAS Today

- Global UAS R&D and procurement expenditures: $5.9 billion in 2011 (Teal Group)
- The U.S. Air Force operates 50 combat air patrols over warzones today
- UAS are increasingly being used for civil/commercial applications

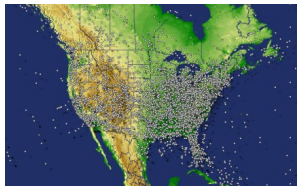
And Tomorrow…

Emerging UAS Applications	
Cargo Delivery	Precision Agriculture
News/Media	Firefighting
Passenger Transport	Wildlife Monitoring
Communications	Event Security
Infrastructure Monitoring	Aerial Filmmaking
Real-estate	Mineral Exploration

One day even…

Challenges to Overcome

- Export Control
- Budgetary Concerns
- Increasing competition
- Liability/Insurance Coverage
- Access to airspace
- Public/Societal Acceptance



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Driverless Cars – Why are they Important

- Reduce accidents & injuries
- Reduce Congestion and traffic
- Mobility for the elderly
- Impaired driving

Driverless Cars Tomorrow

- Safer roadways
- Less traffic congestion
- Cleaner environment
- Reduced fuel consumption

Challenges to Overcome

- Insurance
- Legal Issues
- Cultural Acceptance
- Infrastructure Challenges
- Communications
- Security

Where are we today

- Six states have introduced driverless car legislation
- Passed in Florida and Nevada
- Google has driven 250,000 driverless miles
- Ford plans to have "auto pilot“ capabilities introduced in its vehicles by 2017
- The X PRIZE Foundation is working to develop a $10 million Auto Auto Prize

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Unmanned Maritime Systems Today

- Disaster Response
- Oceanic Exploration
- X PRIZE Ocean Explorer Platform
- Increased DoD applications

And tomorrow…

- More AUVs/ROVs supporting the offshore oil and gas sector
- AUVs and USVs being used for coastal and port security
- More oceanic research being conducted via unmanned maritime systems than ever before

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Commercial Robots Today*

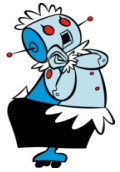
- Number of robots purchased in 2010: >2.2M
- Estimated purchases in 2011-2014: >14.4M
- iRobot Roombas: > 6 Million sold
- Da Vinci Surgical Systems: >1000 sold

*International Federation of Robotics World Service Robots Survey 2011

And Tomorrow…

- Robot Telepresence
- Robot- assisted living for the elderly
- More automation in healthcare
- Robots completing chores at home
- Robots in the workplace

The Global Robotics Revolution



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Unmanned Systems – If we don't field…we fail

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