

Establishment of a Center for Defense Robotics

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ABSTRACT

This paper presents an overview of the newly formed Joint Center for Unmanned Ground Center (JC-UGV) located at the Army's Detroit Arsenal in Warren Michigan. The center will provide a focus to ground vehicle robotics by bringing together research and development as well as acquisition and sustainment to manage the life cycle of defense robotic systems. The central mechanism the center will use to bring together all of these aspects is a system integration laboratory (SIL) environment. The robotics SIL will include both hardware and simulation and be based upon a distributed simulation environment. This will allow researchers, industry and Government partners all over the country on very complex problems. By bringing together university, industry and Government to advance defense robotics our customer, the war fighter will be ultimately well served in the end.

INTRODUCTION

As the field of ground vehicle robotics has matured, an increase in interest in military applications has been apparent. The most notable examples have been the DARPA grand challenges and the inclusion of ground robotics in the Future Combat Vehicle program. Ground robotics has also played a vital role in operations Operation Iraqi Freedom (OIF) augmenting the soldier's ability to stand off from numerous threats with over 4000 robots currently in theater. During the 2005 Base Realignment and Closure (BRAC), the Department of Defense consolidated (ground vehicle development and acquisition, including ground robotics to the Army's Detroit Arsenal in Warren Michigan. As part of that action, the Robotic Systems Joint Program Office (RS-JPO) located at the Redstone Arsenal in Huntsville Alabama will be relocated to the Tank-Automotive and Armaments Command at the Detroit Arsenal by 2009 (ref 1). This relocation along with the robotics research and development activities already existing at the Tank-Automotive Research and Development Center (TARDEC) will consolidate much of the ground robotics life cycle within the Army and Marine Corp to a single location.

The concept of life cycle management and support within the department of defense is a critical concept to manage defense material solutions from concept to the end of its life. This has been also called cradle to grave management. As ground robotics matures within the department of defense, the technologies and tools needed to successfully manage these complex systems is required. To this end, a Joint Center for Unmanned Ground Vehicles (JC-UGV) has been established to bring together the ground vehicle robotics life cycle community. The mission statement of the center captures the vision: *"Serving as the U.S. focal point for all military ground vehicle robotics and to provide support across the life cycle spectrum (research, development, acquisition and sustainment) for all current and future military unmanned ground vehicles and robotic platforms"*.

The JC-UGV goals for 2007 focus on facilitating transition of the RS-JPO to the Detroit Arsenal, developing university curriculum and research initiative as well as industrial outreach. Future goals will include the continue to develop these near term objectives as well as comprehensive support of the Life Cycle Management Command (LCMC) at TACOM.

Another very important aspect of the center is to foster university and industry research and development and allow them to participate with ground vehicle system development is the robotics system integration laboratory (SIL). The SIL will allow researchers and engineers from across the country to try out new ideas, concepts and systems over the distributed network which hosts the robotics SIL. This concept of providing an infrastructure or framework for live and virtual integration of components and technologies will allow very complex systems to be pulled together to see how

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they behave as a system. The SIL also allows parametric studies to be conducted allowing trades in these complex environments to be made.

DESIGN OF THE JC-UGV

The JC-UGV was established in 2006 to provide focus and facilitate the life cycle tools for defense ground robotics. Dr. Jim Overholt was named director of the center, developing the vision and implementing the policies. Dr. Overholt was selected for this position based on his long career with ground vehicle system, especially unmanned robotic topics.

The center is organized with the director and advisory board consisting of stake holders from various organizations directly supported by the center. University, industrial, life-cycle and RS-JPO focused initiatives are lead by various members of the JC-UGV staff. The structure for the organization is shown in figure 1. As the mission of the JC-UGV evolves, so likely will the structure evolve. As the interfaces to other robotic organizations such as the Army Research and Development Command (RDECOM) and the Office of the Secretary of Defense's (OSD) Joint Ground Robotic Enterprise (JGRE) mature the structure of the JC-UGV may evolve.

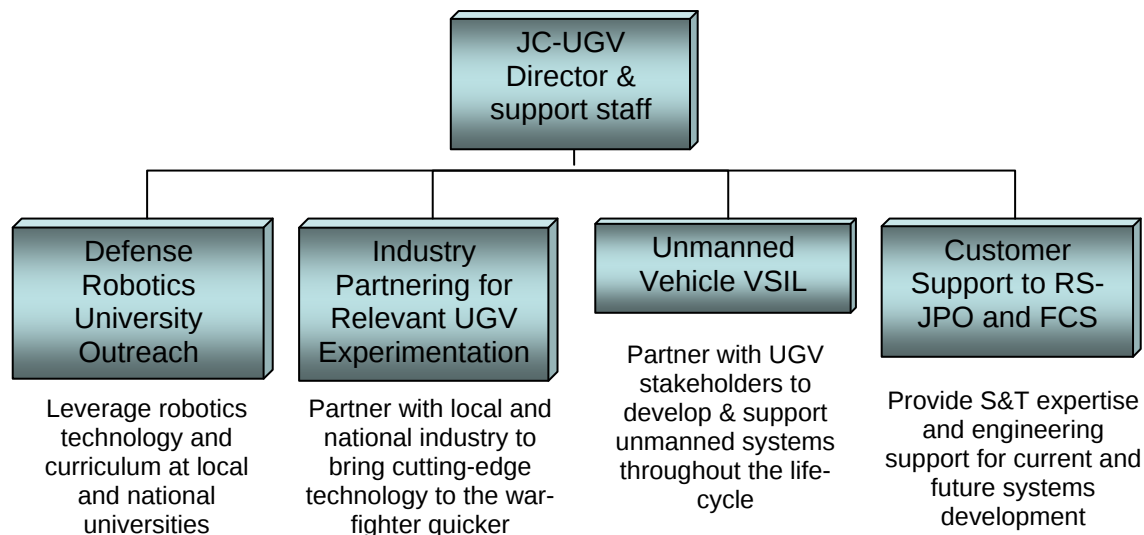


Figure 1.

MANNED VS UNMANNED VEHICLES

An important theme that guided the 2005 BRAC process was to consolidate missions, which created centers of mass. Consolidation of the robotic Development and Acquisition activities from Redstone Arsenal to the Detroit Arsenal focuses Army and Marine Corp robotic research through sustainment activities in a single location. The Detroit Arsenal also is home to many of the core vehicle platform research and development in the department of defense. Survivability, mobility, power and energy and intelligent systems are but a few of the technical focuses at the Detroit Arsenal which are common to both manned and unmanned ground vehicle systems. Figure 2 show some of the detailed areas which support manned and unmanned systems.

The vision of the JC-UGV is to facilitate common use of technology across manned and unmanned vehicle systems to reduce the overall sustainment burden of fielded systems. Other common areas of interest that the center is planning to facilitate are ground vehicle reliability, safety and condition based maintenance initiatives. With commonality of components and logistics, the ability to produce, field and sustain robotic systems will be greatly enhanced.

Many of the tools that are being developed for the robotics SIL are components that have been used for manned vehicle systems or will be developed for robotics but applicable to manned vehicles. The SIL will be a powerful environment to consider deployment strategies to bring certain emerging robotic technologies, such as driving aids to the manned vehicle fleet.

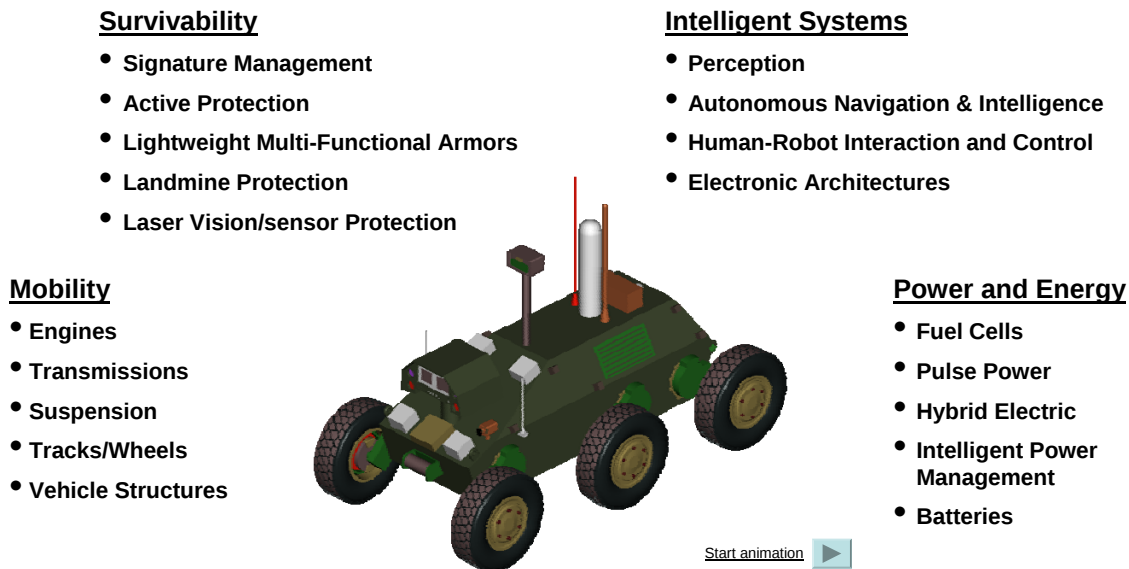


Figure 2.

ROBOTICS SYSTEM JOINT PROJECT OFFICE RELOCATION

As part of the BRAC 2005 decision, the Robotics Systems Joint Project Office located on Redstone Arsenal in Huntsville AL will be moved to the Detroit Arsenal. This move is expected to be completed by 2009 with approximately 40 positions involved. The reason provided for the move was to consolidate the development and acquisition (D&A) of ground vehicle, to include ground robotics in Detroit. With over 50 engineers from the Army's Research and Development Command (RDECOM) current at the Detroit Arsenal working robotics technology base programs a center of mass of nearly 100 Government civilians will exist in the same building. This consolidation provides a centralized life cycle capability in ground robotics at a single location. This is important in the context of the Army's initiative to

establish and grow life cycle commands which focus on the big picture of the life cycle of the product rather than each phase of the life cycle individually in a vacuum. The JC-UGV's mission is to support the life cycle of defense robotics. To that end, the center is the conduit to help facilitate a successful transition of the RS-JPO and support the life cycle aspects of defense robotics when the move has been completed. Initial support for the transition is focused on planning and personnel support at the Detroit Arsenal. Establishment of office areas at the Detroit Arsenal is also being lead by the JC-UGV.

The goal of the JC-UGV SIL environment will be to provide services to the JPO office to assist in integration studies, tradeoff analysis and concept exploration to programs of record. The SIL will also link the geographically dispersed partners, some remaining at the Redstone arsenal while others which exist across the country. The key to success of integration of increasing complex defense robotics is a clear understanding of how these systems work and function in the complex network environment. Simulation and system integrations labs are key to understanding these problems.

LIFE CYCLE MANAGENT

The TACOM LCMC unites all of the organizations that focus on soldier and ground systems throughout the entire life cycle. The TACOM LCMC consists of the U.S. Army Tank-automotive and Armaments Command, Program Executive Office Combat Support & Combat Service Support, Program Executive Office Ground Combat Systems, and Program Executive Office Soldier. Three partners work with the LCMC to create the life cycle vision. These are the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC), U.S. Army Armaments Research, Development & Engineering Center (RDECOM), and the Natick Soldier Center (NSC) (fig 3). The LCMC has the lead and mission to bring all the players together that develop, acquire, and sustain ground and soldier systems. The result is to increase speed of products to the soldier while minimizing the overall life cycle costs. The processes the LCMC bring to the community will create a greater understanding of life cycle ownership, which will result in a greater effectiveness and efficiency.

The JC-UGV will work to develop life cycle products for unmanned robotic systems. Figure 4 shows some of the areas the center will focus on. The clear sense of beginning to end is well represented in this figure. Early stages of concept development where determination of material solutions are identified and the requirements that the war fighter defines are critical to the success of a robotics program. It is at this point the value of the LCMC is clear. Requirements and technical solutions that consider the total cost of ownership throughout the life of the robotic system is most easily influenced here.

In developing the JC-UGV plan over the next five years, investment must be shared between each phase of the life cycle. To this point in ground robotics, the majority of investment has been in the technology development area. This is to be expected because of the complexity of creating a robotic system that can "see and think" for itself and perform militarily significant roles. It is now time to consider the necessary infrastructure to produce, deploy and support these systems as a next logical step in the life cycle process.

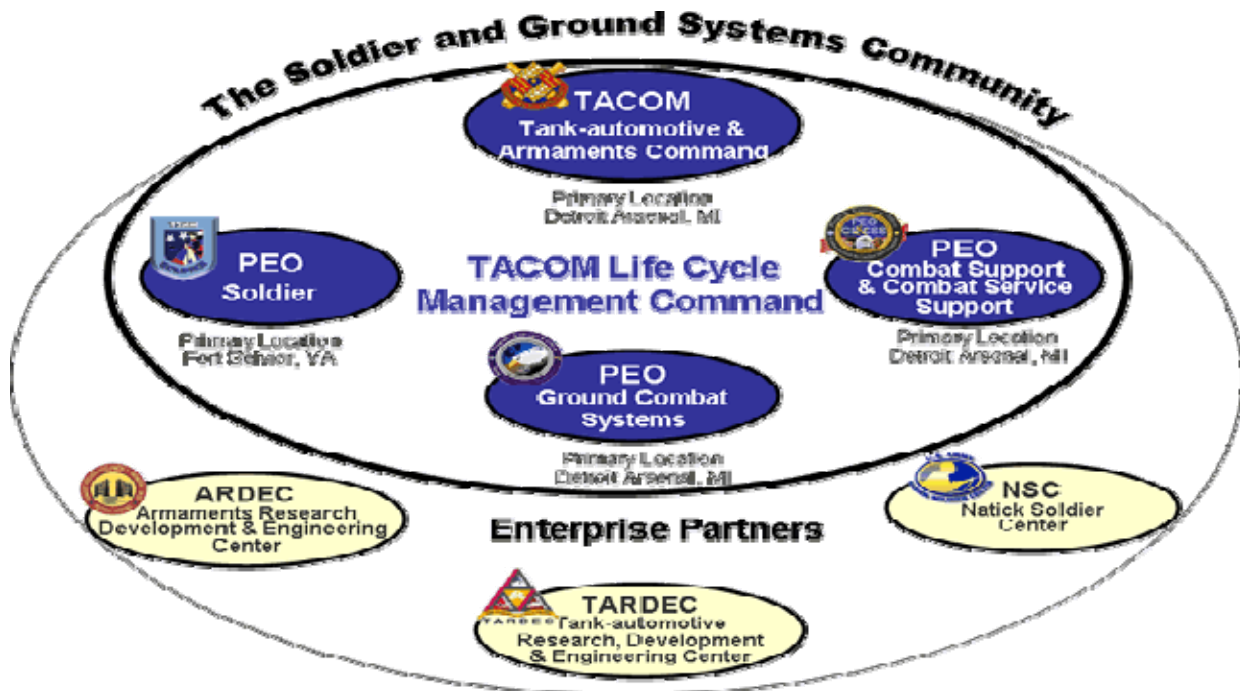


Figure 3.

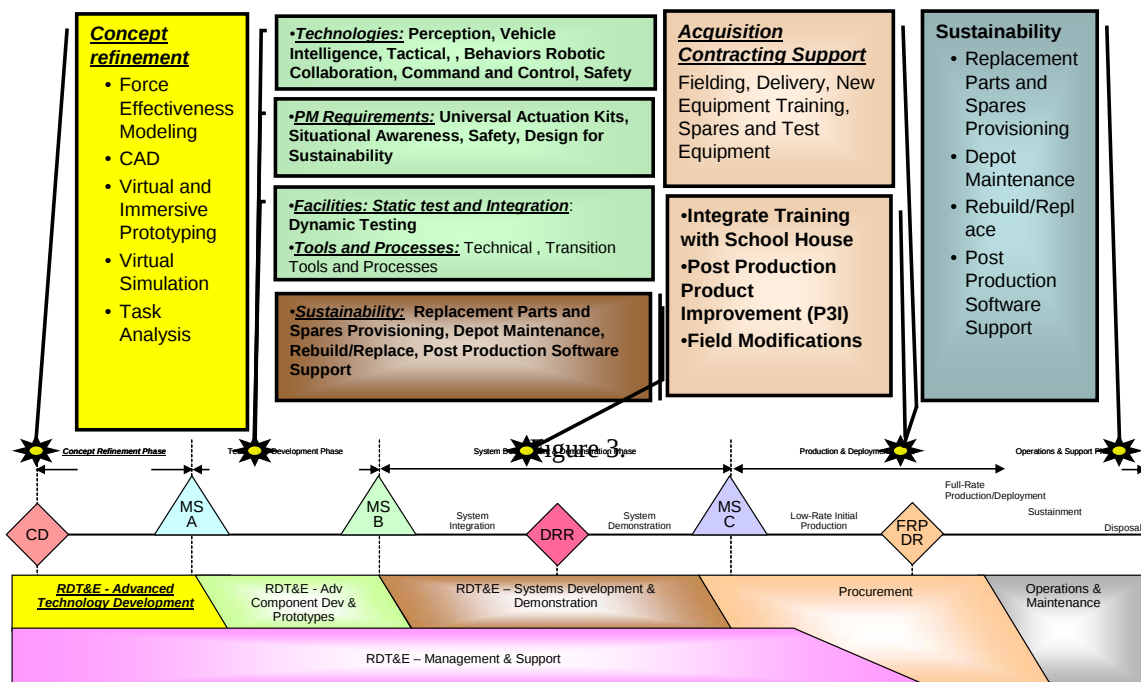


Figure 4.

UNIVERSITY OUTREACH

University research is key to the future of ground vehicle defense robotics. The university environment is an ideal place to solve many of the most difficult problems facing robotics today. Leading gaps include perception, mobility control, power and energy, behavior development and learning are but a few of the current issues under investigation. The JC-UGV plans to seed university initiatives in critical areas to fill gaps in emerging areas.

Another area the JC-UGV plans to focus is development of defense robotics curriculum. With the rapid growth in defense robotics comes a need for highly qualified engineers, scientists and researchers to support this growth. Over the next few years, the center will work with universities to develop curriculums to meet the emerging needs.

INDUSTRY OUTREACH

The ability for industry to respond to solicitations for development and production of military robotics is important for the fielding of defense robotics. The industry needs both system houses that can pull together large complex systems through robust system engineering processes and large production capabilities as well as suppliers that specialize in sub-system components and advanced and emerging technologies. The JC-UGV will work with industry to develop partnerships and invest in gap technologies that fills holes in the overall ability for industry to respond to future requirements.

The military's experience with small business innovative research has demonstrated that investment in targeted technology gaps pay significant dividends. To this end, the JC-UGV will explore the opportunity to leverage existing programs to fill militarily critical gaps which will feed both current and emerging programs. The center will also look for ways to partner industrial suppliers and our major defense contractors together to balance innovation and agility of small business with the capabilities to bring major defense systems to the hands of the soldiers.

The JC-UGV system integration lab will also provide a key component to bring in and develop industrial partnerships from across the country. Because of the distributed nature of the SIL environment, it will be possible to plug and play components such as sensors and algorithms into the SIL as components and services to the larger distributed experiment.

JC-UGV PILOT PROGRAMS

The JC-UGV plans to support a focused initiative, which may lead to an emerging requirement or early fielding of a ground robotic system. This will have the effect of focusing interest in the defense robotic industry and move technologies into the hands of the soldier. A number of potential programs are under investigation to start in the 2007 fiscal year. Once the project is selected, the TACOM LCMC community will work together to insure a well thought out solution from the life cycle perspective is produced. Partnership is key to the success of the pilot project.

The key to early fielding is to leverage existing technologies both in the defense community as well as commercial industry. The automotive market holds a great deal of promise with low cost, mature technologies already in use in the commercial markets. Automotive tier suppliers have a number of existing and emerging products in the area of active safety which assist the driver with automations. Many of these same automations can be used for unmanned platforms to perform safety operations such as guarded teleoperation or crash avoidance.

By leveraging near term commercial and military technologies to existing gaps in the field, the vision of lower cost, dual use applications can be achieved. In addition, bringing automotive supply system, such as just in time supply to the military markets will support the overall vision of a streamlined LCMC process for unmanned robotic systems.

THE FIVE YEAR PLAN

The goals of the JC-UGV over the next five years are focused on consolidation of the robotics activities at the Detroit arsenal, university and industry development and the integration of all these elements to support the TACOM LCMC in defense robotics. It is expected that the growth of ground robotics will continue to grow at an increasing rate. It is expected that the investments and products developed by the center will grow at this same pace. As the department of defense fields ground robotics, the burdens on the fielding and sustainment will increase. A greater emphasis will be placed on the center to insure the tools required to support ground robotics and their unique challenges are developed. The center has the unique role of supporting and facilitating the life cycle processes and to that end will develop a framework bring together the required tools. This vision is a major undertaking that is planned over the next five years which require input and components from the entire life cycle community.

Specifically, the center plan for the next five years will develop university defense robotic curriculum, invest in technology gaps both in industry and academia, sponsor and partner pilot projects for early opportunity for fielding and develop the first stages of the robotics SIL. These initiatives, although focused on the LCMC at the Detroit Arsenal will reach out across the country to partner with industry, academia and Government labs to meet the vision.

SUMMARY

This paper outlined the genesis of the new Joint Center for Defense Robotics and its mission of serving as a focal point for supporting life cycle management of ground robotics. The center is focused and committed to developing those enabling elements in Government, Industry and the University environment and connecting them into the LCMC.

The center will continue to grow as the need for defense robotics continues to expand. Initiatives by the defense community, OSD, DARPA in its robotic challenges and this center will continue to move robotics into the hands of our soldier, saving lives and supporting a more effective fighting force.

REFERENCES

1. Department of Defense Base Closure and Realignment Report, Part II, Technical Joint Cross Services Group, May 2005.

BIOGRAPHIES

Dr. Jim Overholt

Dr. Overholt has been with TACOM/TARDEC for over 20 years. He has held numerous lead research positions at TARDEC including the Government Director of the Automotive Research Center (ARC) at the University of Michigan (1997-2001) and part of the development team for the Omni-Directional Inspection System (ODIS) robot. In addition, he was a member of the government planning and assessment team for USMC Gladiator and the DARPA Learning Applied to Ground Robotics (LAGR) programs. He is currently serving in a 120 day detail assignment as the Systems and Control Program Manager at the Army Research Office (ARO). Dr. Overholt is also the author of over 60 papers and was recently awarded the Bronze Medal for co-authoring the best paper at the 2006 Army Science Conference.

Mr. David J. Thomas

Mr. Thomas is the Associate Director for Intelligent Ground Systems at the US Army RDECOM-TARDEC in Warren Michigan. He is responsible for managing the robotics, manned crew station development and embedded simulation technology base activities with over 40 people in his organization. He has been involved with various programs at TARDEC over the last 25 year focused on ground vehicle survivability topics. Mr. Thomas holds a BS in electrical engineering from Michigan Tech University and a MS in computer Science from Wayne State University.