Ground Mobility Robotics Systems
Integration Skunk Works

Inspiring Joint Robotic Programs

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### Ground Mobility Robotics Systems Integration Skunk Works

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#### SPONSOR/MONITOR’S ACRONYM(S)
- TACOM/TARDEC

#### DISTRIBUTION/AVAILABILITY STATEMENT
- Approved for public release, distribution unlimited

#### SUPPLEMENTARY NOTES
- The original document contains color images.
Robotics Skunk Works Briefing Outline

- What’s TARDEC Skunk Works?
- Historical Foundation – TATRC SBIR contract & collaboration
- Skunk Works work directive contract & collaborative opportunities
- 1st WD – ARDEC / TARDEC TAGS weapons integration
- FIRRE Spiral Technologies
- 2nd WD – NCDIR / TARDEC TAGS mechanical arm integration
- MANSCEEN / TARDEC chem / engineer robotics
- Summary of Collaborative Opportunities
Robotics Skunk Works

Objective: Establish In-house quick reaction, ground mobility, robotics systems integration capability

Approach:
- Create a fleet of heterogeneous lab robots
  - JAUS compliant common controls,
  - Standard navigational sensors
  - plug & play payload hardware & software interfaces.
- Integrate, demonstrate and evaluate ground mobility robotic technologies.

Benefits:
- Increase Collaborations
  - ILIR/SBIR Tech Transition Teams
  - Externally with ARDEC, SPAWAR, JPO, OUSD, Academia (Vetronics Inst.)
- Showcase Capabilities/Accomplishments
  - Field Experiments / User Interface
  - Conference Displays / Demonstrations
- Define Program Requirements
- Improve Tech Transition to ATO & PM

Problem: No formal process to evaluate ILIR & SBIR component technologies at system level prior to transitioning to ATO & PM programs

Schedule

<table>
<thead>
<tr>
<th>Event</th>
<th>FY 2006</th>
<th>FY 2007</th>
<th>FY 2008</th>
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<tr>
<td>AFI Work Directive Contract</td>
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<td>Md-1 TAGS Weapon Robot</td>
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<td>Ft. Knox VIT Joint Operations</td>
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Robotic Evacuation Vehicle (REV)
Applied Perception, Inc. SBIR Contract

- High gain wireless Ethernet radio comms.
- Laser ranging sensor for obstacle detection
- Dual patient bays
- Integrated GPS / INS for localization and navigation
- Color camera on pan/tilt mast
- Life Support for Trauma and Transport (LSTAT) litters
- Walking beam suspension for traversing rough terrain
- Designed for high-speed, long range patient transport
- Vehicle based on amphibious TAGS-DM platform
Robotic Extraction Vehicle (REX)

Applied Perception, Inc. SBIR Contract

Color, thermal, RF, and UWB Radar sensors for patient detection

Manipulator for patient grasping and loading.

Integrated GPS / INS for localization and navigation

REX is transported in a marsupial fashion to the field by the REV

NATO stretcher for patient transport

Designed for short range patient extraction

Vehicle based on ANDROS Wolverine platform
Robotics Skunk Works
Applied Perception, Inc. SBIR Contract

- Sole Source, 3 yr, Work Directive (WD) contract:
  - Acquire COTS or use GFE mobility platform
  - Modify platform to meet specified mission
  - Integrate JAUS compliant:
    - Standard auto-navigation sensors
    - Mission specific sensors & payloads
    - Common controls and plug & play interfaces
- First WD: Joint TARDEC/ARDEC program
  - TAGS-DM mobility platform
  - Non-lethal & lethal weapons integration
Robots Skunk Works
TAGS Weapons Integration

Work Directive 1 – Contract Awarded

❖ Joint Funding-TARDEC & ARDEC
❖ Lethal & Non-Lethal Weapon
❖ API Systems Integrator
❖ Dumur Industries Support
❖ Leverage Remotec IRAD

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<td>Engine (Hp)</td>
<td>100 HP Turbo charged diesel</td>
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<tr>
<td>Max Payload (lbs)</td>
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<td>Speed (Kph)</td>
<td>Up to 48 Kph</td>
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Robotic Skunk Works
TAGS Weapons Integration

Picatinny Lightweight Remote Weapon Station with M240 (7.62) MG

System Capabilities:
- M240/M249 (7.62/5.56mm)
- Weight goal: <150 lbs including gun and 200 rounds
- Slew rates: 90 deg/sec in Az and El
- 2-Axis Stabilization, 5Hz, 20 Db goal
- Continuous 360 Degree rotation
- Elevation Range +45 to -15 degrees

Non-Lethal Integration:
- FN-303 Less-Lethal Launcher
- Acoustic round detection integrated with PLWRWS
Robotics Skunk Works
FN-303 Less-Lethal Launcher

**Technology**
- Compressed air powered launcher designed to fire 0.58 caliber 8.5 g less-than-lethal projectiles
- Allows for greater engagement range (100m), higher accuracy, and higher rates of fire than any currently fielded non-lethal capability
- Both stand-alone & under-barrel (M16/M4) versions are available.

**Capabilities of Item**
- Disperse a crowd between 10-20 meters
- Stop, confuse, disorient an individual from 20-100 meters
- Stop, confuse, disorient a crowd of individuals from 20-80 meters
- Deny an area to personnel
- Stand alone or under-barrel version

**Status**
- Rapid Equipment Fielding of 30 systems to CTF-180 (Bagram AB, Afghanistan)
- ONS expected for 600 systems for CFLCC – G3 Looking to approve 80
- Add-on Safety Testing Scheduled within next month (bullet impact testing).
Robotics Skunk Works
PLWRWS with M240 & FN-303

Picatinny CRADA with FN HERSTAL to modify FN-303 with electric trigger

.68" projectiles, 8.5g weight, polystyrene body & granular non-toxic bismuth forward payload

200 bar pressure bottle, 110 round
Robotics Skunk Works
Applied Perception, Inc. SBIR Contract

- **Std. Sensor Suite:** Scanline and scanning Sick, 6 radars (front, rear, 2 left/right), DGPS/Gyro positioning system, roll and pitch rate gyros, color omnicam, 35 lb capacity pan tilt, 3 color cameras, 1 320x240 FLIR, comms,
- **Operator Control Units (OCU):** Hand Held PDU & Laptop Computer
- **JAUS Compliant Software**
- **Programmable Mission Scenarios** (e.g., come to me, GPS waypoint, OD/OA,...)

TAGS-based Weapons Platform
JAUS compliant ARDEC
Weapons Integration

Technology Transition to FIRRE Phase III
Robotics Skunk Works
TAGS-DM modifications

➢ Top surface:
  • Span full width of vehicle to outside track edges
  • Structural I-beam rail mounts to allow weapons placement and operation in forward, rearward and central vehicle locations

➢ Marsupial / Payload bay:
  • Electric / hydraulic access panels (vertical surfaces in bay)
  • Widened to transport tracked wolverine-based robot.
  • Locking mechanisms to secure marsupial robot into the bay.
  • Loading ramp made of perforated/grate type material & flare open at base
  • Manuals controls accessed through password protected touchpad.

➢ Engine and hydrostatic drive systems - moved forward.
➢ Semi-active suspension & two speed Poclain wheel motors
➢ Fuel tank & filler - sized & positioned for 200 km mission & safe easy access.
➢ JAUS compliant GFE weapons integration

Technology Transition to FIRRE Phase III
Robotics Skunk Works

- Status: Contract award 26 Sept., 2005
- Coordination: TARDEC/ARDEC meeting with MANSCEM to discuss robot & non-lethal/lethal requirements
- Initial WD Program Objectives:
  - (VTI) joint operations technology demonstration in July, 2006
  - Technology transition to ART ATO, FCS ARV & PM-FPS FIRRE
  - Obtain joint funding for Needs-Based Robotic Demonstrators (Expand Skunk Works Capabilities)
Unmanned Systems
Advanced Technology Assessments

- Provide Prototype Experiment Support to the MANSCEN Futures Center, Military Police, Chemical, and Engineer Schools to Modernize the Current Force and Develop Future Force Requirements.

- Provide Prototype Experimentation Support to Joint Robotics Program (JRP) to Develop, Evaluate, and Support Unmanned Systems Throughout the Life Cycle.
Teams of Robots Provide Collaborative Semi Autonomous Tactical Decontamination in Forward Combat Areas.
Robotics Skunk Works
NCDR / TARDEC Collaboration

NCDR developed JAUS Compliant Hydraulic Arm to be Integrated with TARDEC TAGS Robotic Vehicle using Plug & Play I-Beam Rail System
Robotics Skunk Works
TAGS Robotic Bridger Demonstrator

- TARDEC Tech Director funds
  - TAGS Robotic base-platform
  - Funds required for
    - Robotic retrofit
    - GFE bridge integration

- Bridging Group in Engineering
  - Two BAA contracts for bridging demonstrators
  - GFE bridge for TAGS integration

- Advanced Concepts – TAGS Integration of either
  - Aluminum/Composite Expansion Bridge
  - Fascine Deployment Bridge
Robotics Skunk Works Funding Issues

- **Skunk Works 1st Work Directive**
  - Tech Director funds get tele-operated TAGS vehicle
  - **OUSD JPO** funds semi-autonomy & autonomous capabilities, as well as JAUS compliant weapons payload integration & support

- **TAGS Robotic Bridger Demonstrator**
  - Tech Director funds TAGS vehicle, with vehicle payload modifications & teleop / waypoint following capabilities
  - Funding required for OD/OA capabilities and Bridge Integration
  - **Interim capability demonstrator:** MANSCEM Anti-mine or Decontamination Robot payload integration support

- **Decontamination effort might be co-funded by National Center for Defense Robotics (NCDR)**
**Description:** TARDEC & ARDEC joint program to integrate lethal and non-lethal weapons onto the Tactical Amphibious Ground Support (TAGS) vehicle. Vehicle mission includes sentry perimeter security operations. Plug & play hardware and software concepts being applied to demonstrate vehicle mission reconfiguration. Alternate mission being considered under joint TARDEC & TATRC program for robotic combat casualty evacuation & extraction (RCCE&E), for which the TAGS would have removable patient bays.

**Utility:** Provide Customer Robot Mission Application Demonstrators

Sole Source, 3 yr, Work Directive contract to:
- Acquire COTS or use GFE platform
- Modify platform to meet specified mission
- Integrate JAUS compliant:
  - Standard auto-navigation sensors
  - Mission specific sensors & payloads
  - Common controls and plug & play interfaces
- Integrate marsupial casualty extraction & modular patient bays for evacuation.

**Customers:** Customers include PM-Force Protection Systems and Maneuver Support Center

**Partners:** Armaments Research Development and Engineering Center (ARDEC) and Telemedicine and Advanced Technology Research Center (TATRC)

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**Funding:**
- **FY05 = $850K**
- **FY06 = $229K**

**Lethal / Non-Lethal Considered:**
- Picatinny Lightweight Remote Weapon Station with M240/M249
- FN-303 Less-Lethal Launcher
- Acoustic round detection integrated with the PLWRWS