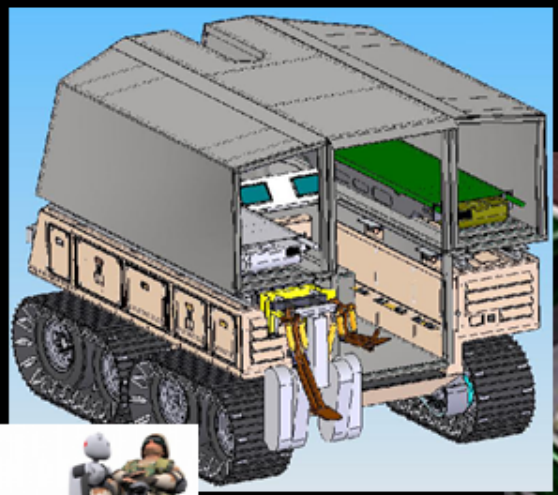
U.S. Army Medical Research and Materiel Command (USAMRMC)
Telemedicine & Advanced Technology Research Center (TATRC)

Big BEAR: A Disruptive Process for Developing Disruptive Robotic Technologies





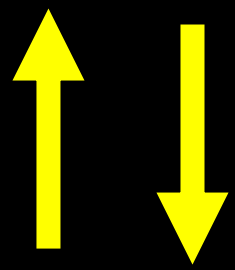

NDIA Disruptive Technology Conference

4 September 2008

Gary R. Gilbert, PhD
Georgetown University ISIS Center
USAMRMC TATRC
Fort Detrick, MD 21702

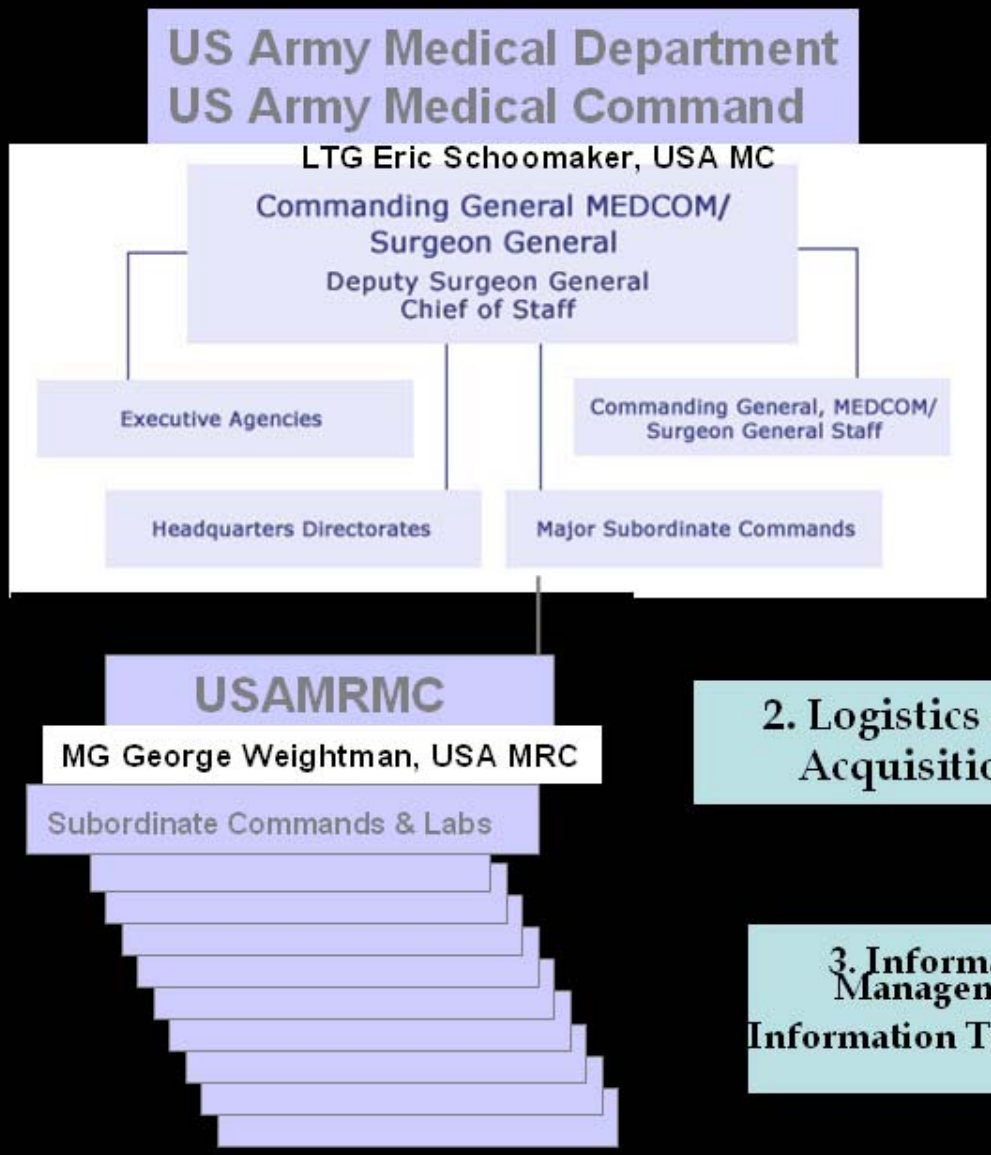
Agenda

- US Army Medical Research & Materiel Command (USAMRMC) Telemedicine & Advanced Technology Research Center (TATRC) Overview
- Coordination with Combat Developers and OSD Robotics RDTE organizations.
- TATRC Robotics & Unmanned Systems RDT&E efforts
- Battlefield Extraction Assist Robot (BEAR) Simulation and User Assessment Exercises at Fort Benning Maneuver Battle Lab



- Disruptive methodology for creating and validating Tactics, Techniques, and Procedures (TTPs) for subsequent development of Operational Capabilities Documentation and Technical Design Requirements.

US Army Medical Research & Materiel Command (USAMRMC)



Core Capabilities

1. Medical Research and Development (DoD EA)
2. Logistics and Acquisition
3. Information Management/ Information Technology
4. Advanced Technologies
5. Congressional Special Interest Research Programs

Medical Research and Development Core programs

- Military Infectious Diseases
- Combat Casualty Care
- Military Operational Medicine
- Medical Chemical and Biological Defense

(under Defense Threat Reduction Agency - DTRA)

Six Major Laboratories--

Walter Reed Army Institute of Research (WRAIR)

U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID)

U.S. Army Medical Research Institute of Chemical Defense (USAMRICD)

U.S. Army Institute of Surgical Research (USAISR)

U.S. Army Aeromedical Research Laboratory (USAARL)

U.S. Army Research Institute of Environmental Medicine (USARIEM)

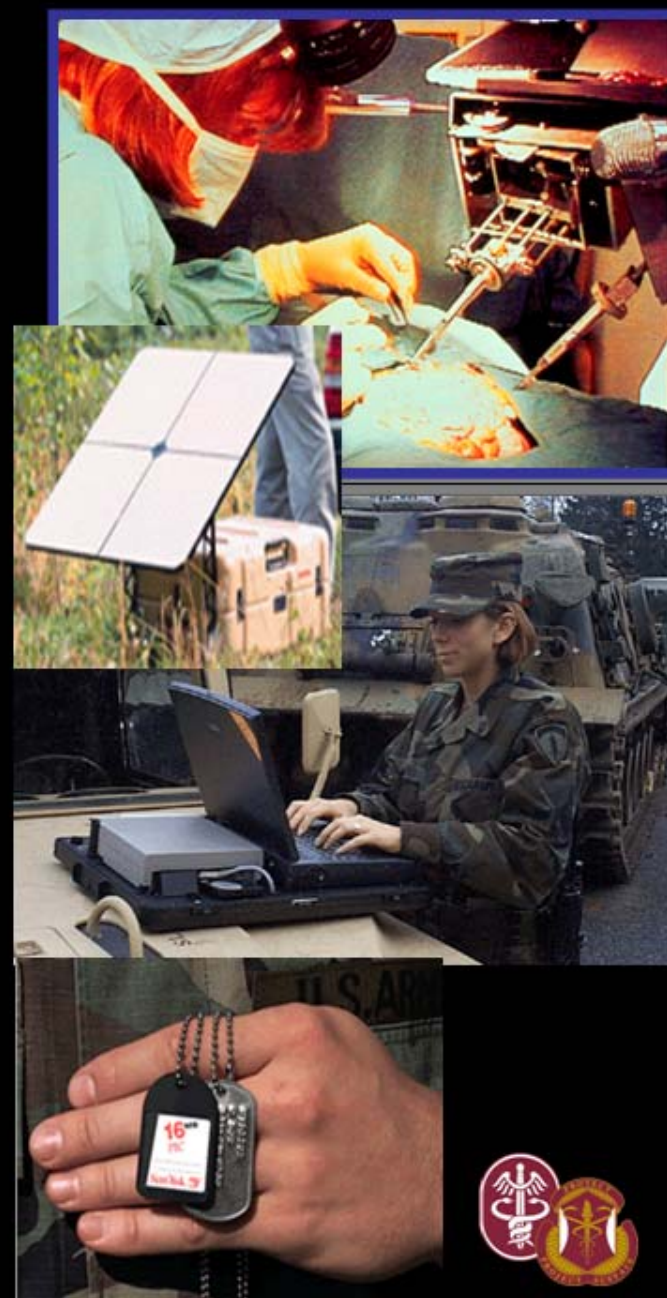
Telemedicine and Medical Technology Program

Mission

Apply … medical knowledge ……information and telecommunications for … enhancing operational and medical decision-making, improving medical training, and delivering medical treatment across all barriers.

Program scope…. identify, explore, and demonstrate key technologies ……

Department of Defense,
Joint Warfighting Science and Technology Plan, Chapter IX, Joint Readiness and Logistics, 1999



USAMRMC Robotics R&D Strategy

- **Develop technologies that contribute to long term Autonomous Combat Casualty Care vision.**
- **Work with Combat Developers to formulate capability needs & JCIDS (Joint Capabilities Integration and Development System) documentation.**
- **Collaborate with Army and DoD Organizations.**
  - US Army Tank Automotive Research Development & Engineering Center (TARDEC) - Tactical Amphibious Ground System (TAGS) and BEAR
  - Infantry Center Soldier Battle Lab - BEAR
  - US Army Aviation Missile Research Development & Engineering Command, (AMRDEC), US Navy Space and Warfare Systems Center (SPAWAR) , and Army Research Lab (ARL) - Combat Medic Unmanned Air System (UAS)
  - Army Research Lab (ARL) (ODU & UWB SBIRS and BIRRRD Congressional)
  - DARPA - Trauma Pod & Nightingale
- **Leverage DOD Science & Technology funding programs including:**
  - Small Business Innovative Research & Technology Transfer Programs (SBIRs and STTRs)
  - Congressional Directed Research Programs.
- **Transition combat casualty care robotics efforts to**
  - Robotics Joint Program Office (JSJPO)
  - Army Future Combat Systems Program (FCS)
  - Joint & Advanced Capability Technology Demonstrations, *e.g.:*
    - Joint Medical Distance Support and Evacuation (JMDSE)

Dec 06 Biomedical TARA Report to DDRE requested RDTE POM line for Medical Robotics

DEPARTMENT OF THE AIR FORCE
AIR FORCE RESEARCH LABORATORY
WRIGHT-PATTERSON AIR FORCE BASE OHIO 45433

DEC 2 8 2006

MEMORANDUM FOR ODUSD (S&T)
ATTN: DR ROBERT E. FOSTER
DIRECTOR, BIOSYSTEMS
3080 DEFENSE PENTAGON
WASHINGTON DC 20301-3080

The Combat Casualty Care Subarea will expand pre-clinical and clinical studies in hemorrhage control and accelerate the development of multiple solutions for blood products. Promising drugs for pharmacologic resuscitation will be accelerated. Applied research in resuscitation will receive increased emphasis. Basic research in bone and soft tissue trauma will be broadened. Biomarkers and other physiologic parameters for neurotrauma diagnosis will receive additional investigation. A new program in medical robotics will be funded. Development and fielding timelines for internal hemostatic dressings will be reduced. A program will be initiated for improved blood products that can be used "far forward" in the field. Advanced development of a "point of use" oxygen generation technique will be initiated. An applied research program of the diagnosis and treatment of explosive blast-induced polytrauma will be undertaken. Additional work in regenerative and rehabilitative medicine will begin.

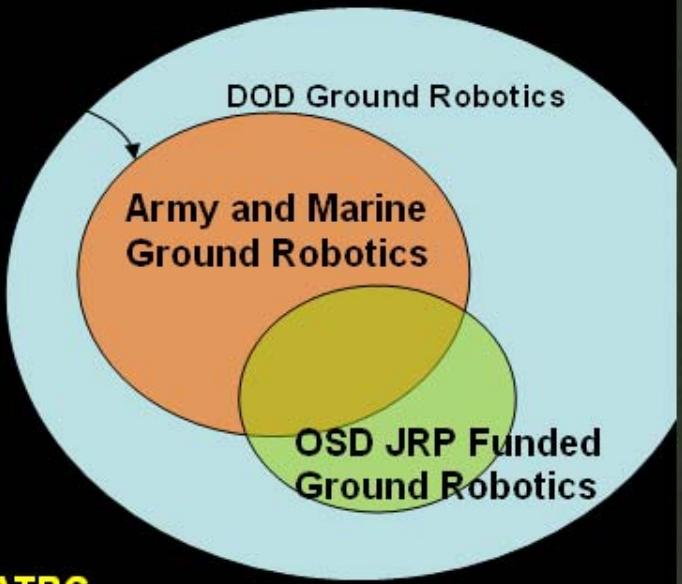
HENDRICK W. RUCK, PhD, SES
Director
Human Effectiveness Directorate

Army – Marine Corp Ground

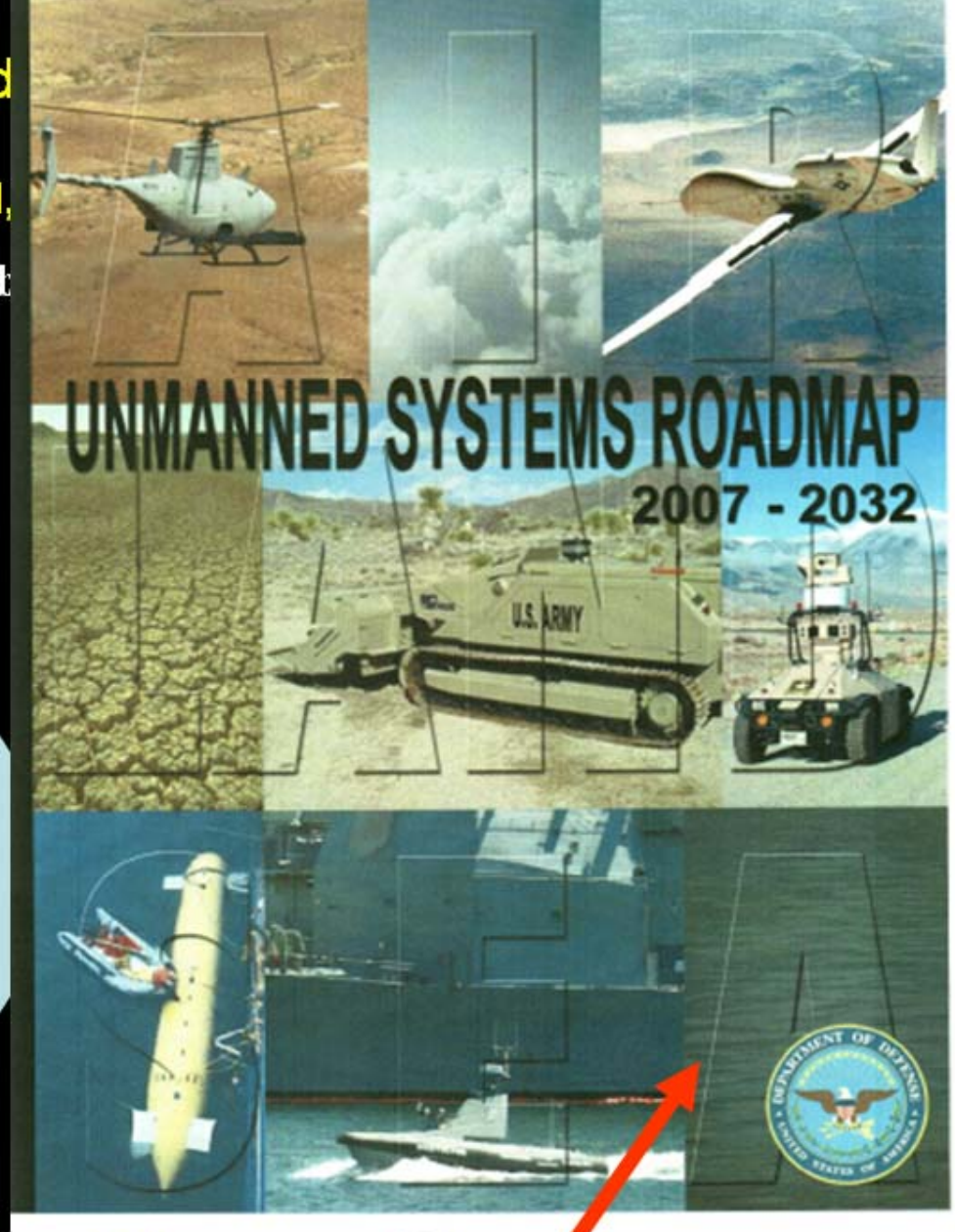
DOD Robotics Joint Program – Warren MI,

For Army and Marine Corps Ground Rob

Feeds: OSD Unmanned Systems Roadmap 2007-2032



- **MCWL**
- REF
- RS JPO
- PM FPS
- AMRDEC
- **TARDEC**
- ARDEC
- ARL
- OSD JRP
- **CASCOM**
- **MRMC – TATRC**
- **DCDD AMEDD C&S**



Robotic Unmanned Force Health Protection & Combat Casualty Care Systems and Supporting Technologies

UAS Systems

- Combat Medic UAS System for Resupply & Evacuation

UGV Systems

- Autonomous CASEVAC & Enroute care System (ACES)
- Battlefield Casualty Extraction Robot (BCER)

Technologies

- Battlefield Extraction Assist Robot
- Robotic Extraction, Evacuation & Enroute Combat Casualty Care (RE3C3)
- Trauma Pod
- Robotic Force Health Protection Payloads for UGVs

Capability Gaps & Requirements

Maritime Forces 2030
Free Form Medical Deterrent System

- **MF2030 advanced battlefield transport will make use of unmanned autonomous Vehicles**
- **Advanced life support systems such as the Army's LSTAT will improve enroute care**
- **Telemedicine, including robotics-enhanced surgery, will serve as a force multiplier**

TRADOC PAM 525-66
Future Operating Capability 09-06
Global Casualty Care Management & Evacuation

Future Soldiers will utilize unmanned vehicles, robotics and standoff equipment to recover wounded and injured Soldiers from high-risk areas, with minimal exposure:

- ***Recover wounded Soldiers***
- ***Facilitate immediate evacuation & transport…***
- ***Automated… servo-controlled Sensor/Actuator systems for life support***
- ***Advanced storage systems and transportation devices…***

Public Law 109-364 SEC 941 – Enacted 17 Oct 06
John Warner National Defense Authorization Act for Fiscal Year 2007

The Secretary of Defense shall develop a policy, to be applicable throughout the department of defense, on research, development, test and evaluation, procurement, and operation of unmanned systems.

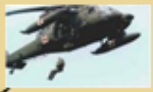
- **An identification of mission and mission requirements, including mission requirements for the military departments and joint mission requirements, for which unmanned systems may replace manned systems.**
- **A preference for unmanned systems in acquisition programs for new systems, including a requirement under any such program for the development of a manned system for a certification that an unmanned system is incapable of meeting program requirements.**
- **The integration of unmanned and manned systems to enhance support of missions identified in paragraph (1)…**

USAMRMC Combat Casualty Care Robotic projects included in OSD FY07 Unmanned Systems Roadmap

TRADOC Pam 525-66 Future Operating Capabilities (FOC) supporting AMEDD Robotics

- **FOC-09-06: Global Casualty Care Management and Evacuation.**
  - **Utilize unmanned vehicles, robotics, and advanced standoff equipment**
    - **Recover wounded Soldiers from high-risk areas, with minimal exposure.**
    - **Facilitate immediate evacuation and transport, under the harshest combat or environmental hazard conditions.**
    - **Medical evacuation platforms must provide "enroute care"**
    - ***Note: all Evacuation platforms must be attended when transporting casualties per AMEDDC&S***
  - **Automated and semi-automated servo-controlled sensor/actuator systems for life support.**
  - **Advanced storage systems and transportation devices to ensure temperature integrity and in-transit visibility.**

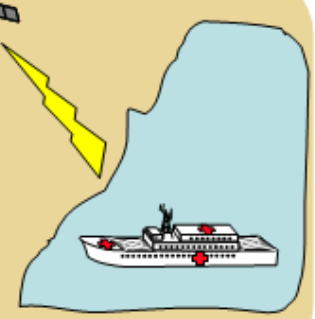
Overview of USJFCOM Joint Medical Distance Support & Evacuation (JMDSE) Joint Capability Technology Demonstration (JCTD) Capabilities



1. Joint Distance Support and Response – Medical (JDSR-Med)

Battlefield/At Sea Telemedicine

- Remote Casualty Care on the battlefield and at sea
- "Virtual" triage (monitoring and automated casualty care)
- Comms between CASEVAC ("doc" in the air) and caregiver through real-time audio and video
- Care stations connected to litter (wireless and direct) and to CASEVAC force at a distance
- Stations remotely monitor vitals, dispense fluids and medicine as directed by "doc" in the air



2. Joint Precision Airdrop System - Medical (JPADS-Med)

- Ultra Light Weight (ULW: 250-700 lbs) Medical logistics delivery
- Micro Light Weight (MLW: 10-150 lbs) Robot/Sensor/Psyop delivery
- Test Platforms: HH-60, CH-53, C-130, C-17, V-22, UAS

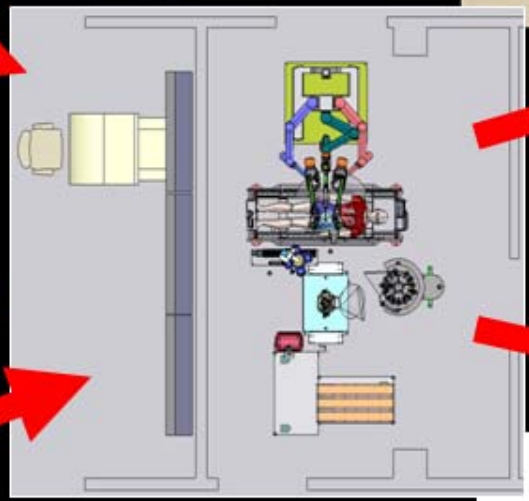
3. Joint Unmanned CASEVAC Capability (JUMC)

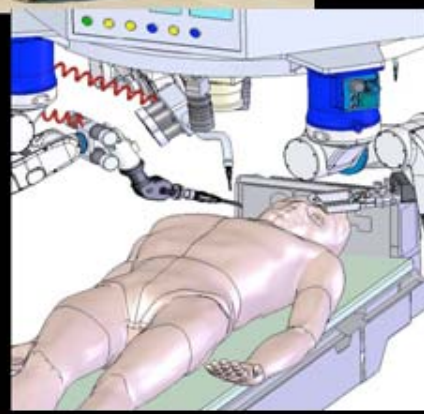
- Collaborate with MCWL to perform technical demonstrations to validate capability
- Develop CONOPS and TTPs for future technical solution
  - *UAS short distance evacuation of critically injured from denied/remote area*
  - *UAS medical supply/equipment delivery*
  - *Capability integrated into existing UAS programs; NO NEW TRUCKS*

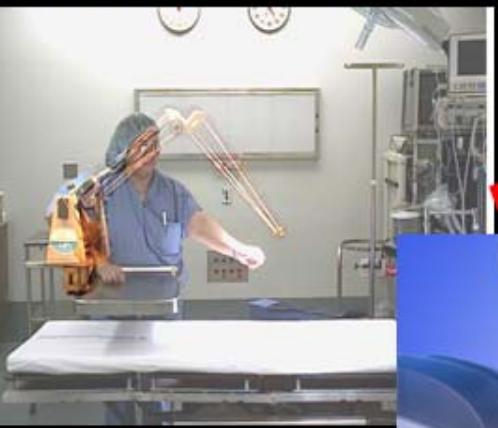

DARPA

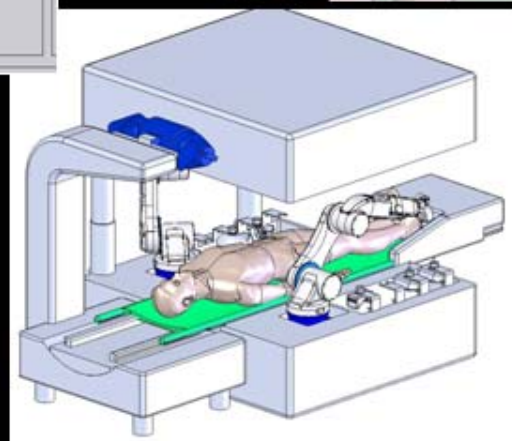
DARPA & MRMC Leveraging Civilian Telerobotics research: Teleoperated Trauma Pod inside Combat Medical Vehicle

Phase I Trauma Pod Concept





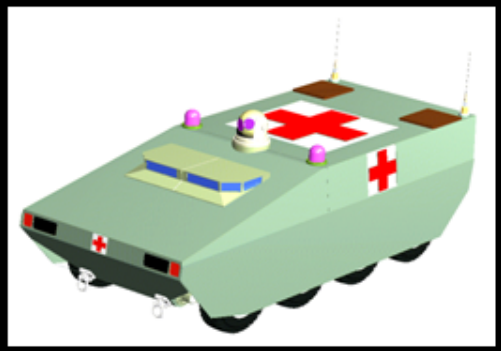




Phase II Trauma Pod Concept

Proof of Concept *for Leveraging Army Future Combat System Unmanned Ground Vehicles for Medical Applications*

FCS Medical Evacuation & Treatment Vehicles (MTV)

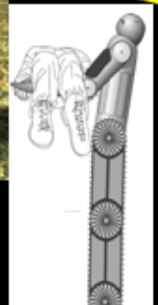


Tactical Amphibious Ground System (TAGS)

Armed Recon & Assault Vehicle (ARV)

Multifunction Utility Logistics Equipment (MULE)

Small Unmanned Ground Vehicle (UGV)



Robotic Combat Casualty Extraction & Evacuation (RCCE&E)

Army Phase II SBIR

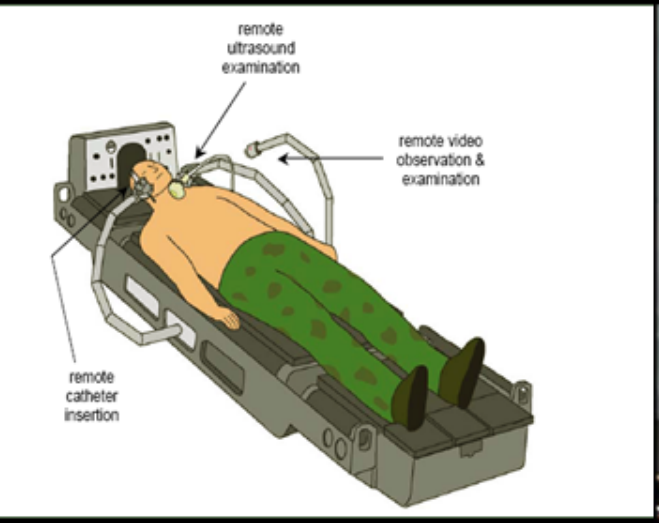
Applied Perception, Inc.

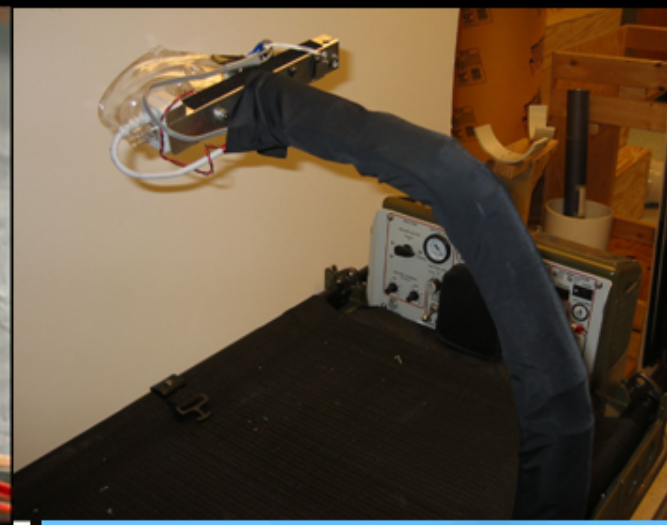
US Army Medical Research & Materiel Command
US Army Tank Automotive Research, Development, & Engineering Center
OSD Joint Robotics Program

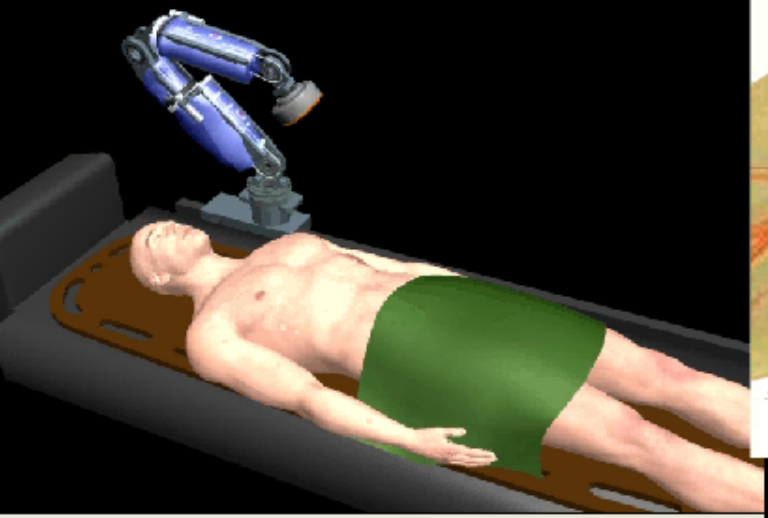
Toward Autonomous Combat Casualty Care

System of systems

Carnegie Mellon University
Serpentine Army/LSTAT Integration







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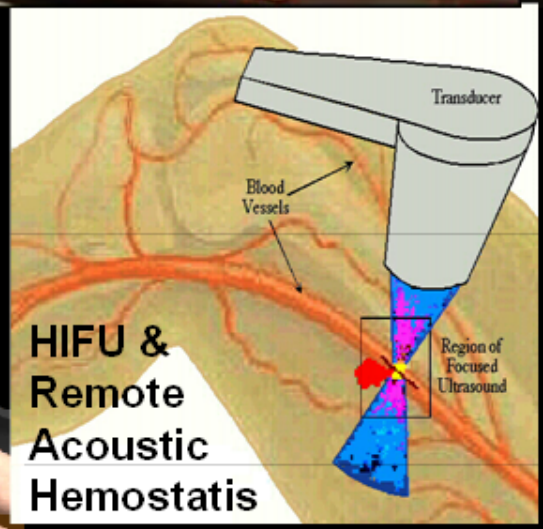
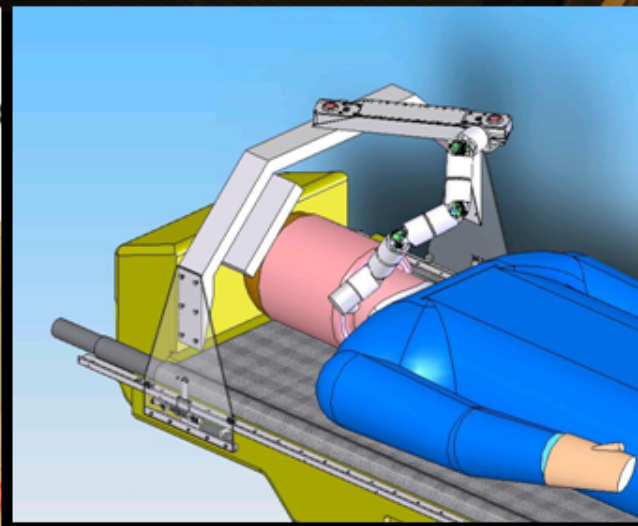


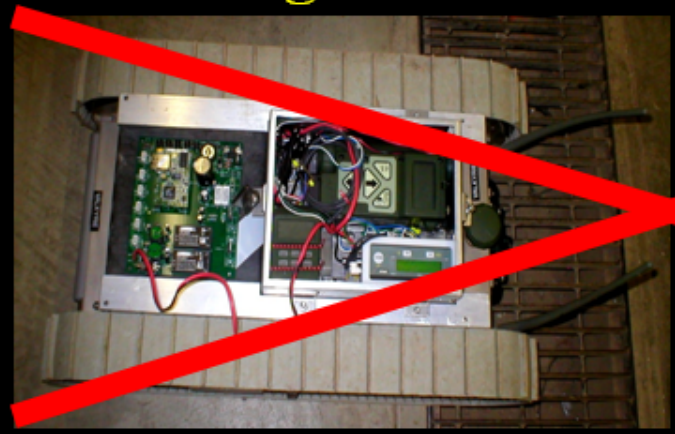


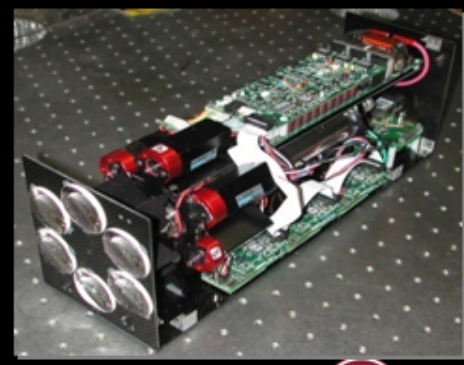
Army Phase II SBIR
Focus Surgery HIFU /LSTAT Integration

Robotic Detection & Diagnosis of Chemical &Biological Agents

CHARS/CUGR

CHemical Weapons
Hazardous gases
Radiological Sensors



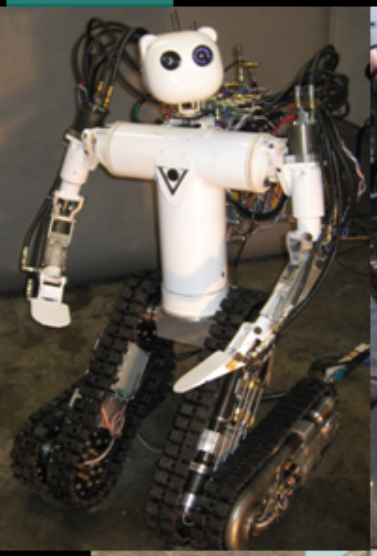


Raman Spectroscopy Chem/Bio Explosive (IED) Detectors

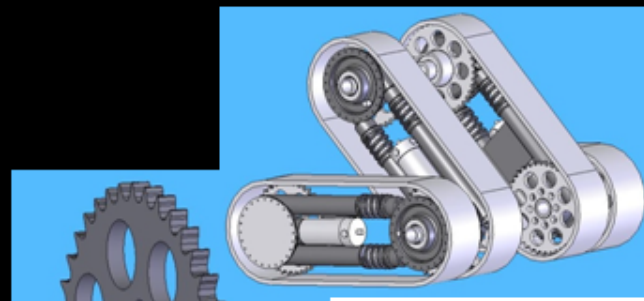
ChemImage Phase II Army SBIR

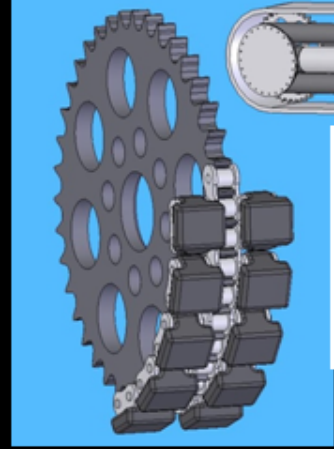
Photon Systems Phase II Army STTR

Battlefield Extraction - Assist Robot (BEAR)



Operational Prototype Objective Configuration





Separately articulatable "legs" with inside/outside sure-grip tracks

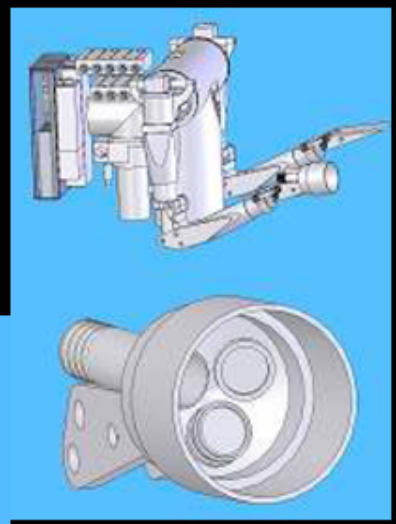
Human – Robot Interface Initiatives
Anthrotronix Inc.
ARL Phase II Plus SBIR

BEAR VIDEO

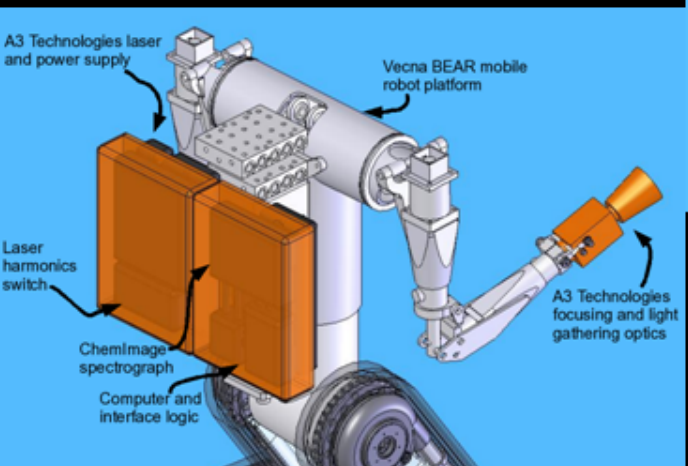
Extensions of BEAR Capabilities

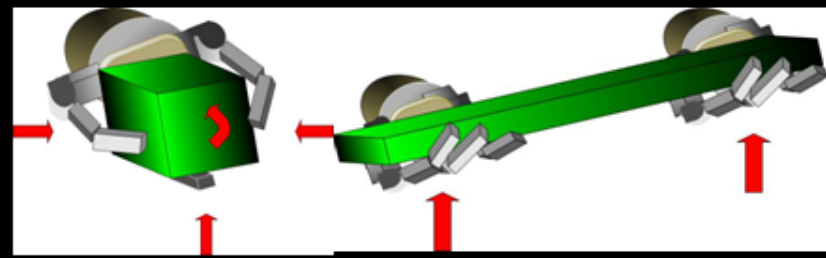
Semi-Autonomy
Congressionally funded project

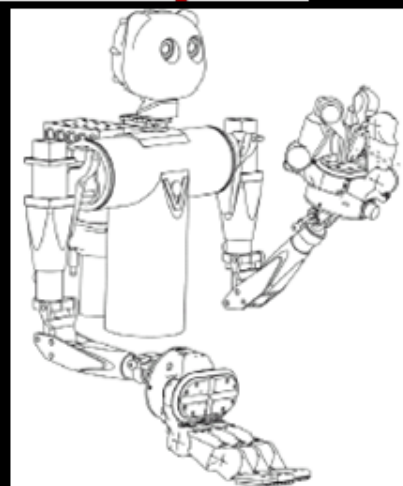
Simulation & Operational Assessment
JGRE funded project at Infantry Soldier Battle Lab



Chem/Bio & Explosive Detection Stand-off LIBS/Raman Spectroscopy
Phase II Army SBIR

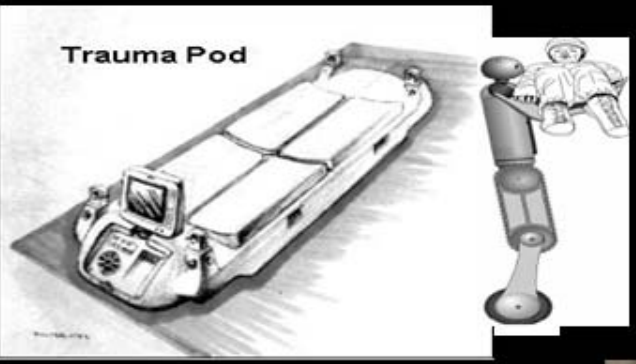




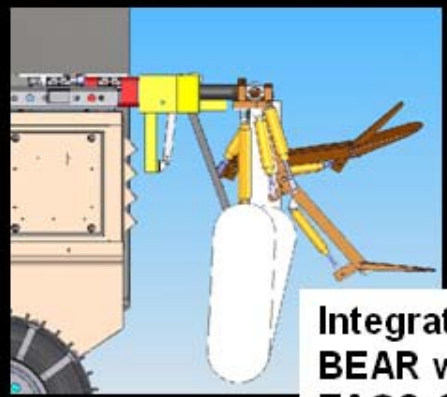


Manipulators on the Battlefield
"finger" type end-effectors
JGRE funded TARDEC project

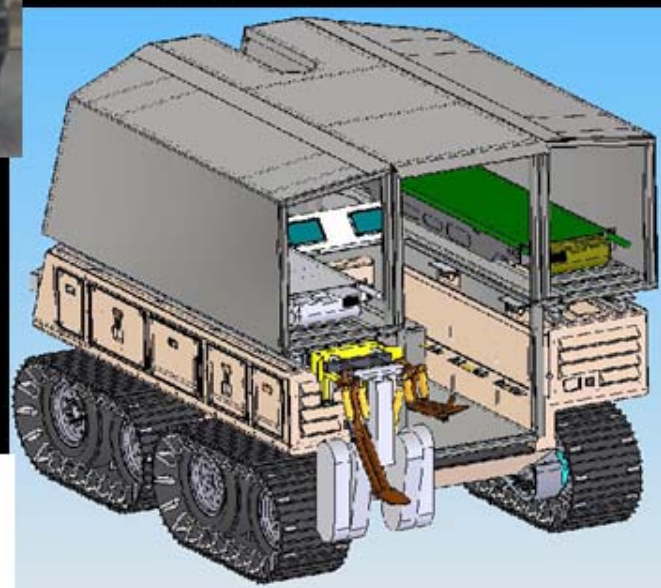
TARDEC Skunkworks
Multi-mission Reconfiguration



Joint Architecture for Unmanned Systems (JAUS) -compliant payloads allow for easy mission reconfiguration



Integration of BEAR with TAGS-CX



DARPA 2005 “Nightingale” Study

Bottom Line: SPAWAR determined feasibility, but DARPA Director decided it was not ‘DARPA hard’

David Rousseau, USN SPAWAR Systems Ctr, San Diego

Capability Gaps & Requirements

UAS -Combat Medic Collaboration for Resupply & Evacuation (CASEVAC)
SBIR OSDO6-UM8

- Most Combat Medic Casualties Occur Treating Soldiers Under Fire
- Many Soldier Casualties Occur When Providing Buddy Aid
- Prevalence Of Urban Operations In Peace Keeping/Humanitarian Missions

- Operations In Hazardous and Contaminated Areas Due To Increased CBRNE Threat
- 1/3 Of Ground Combat Vehicles Should Be Unmanned By 2015 and 1/3 Of Deep Strike Aircraft Should Be Unmanned By 2010 (Congressionally Directed Goal)
- Robotic Vehicles Reduce Deployment Weight, Volume and Requirements For Airlift

Life Support for Trauma and Transport (LSTAT G5)

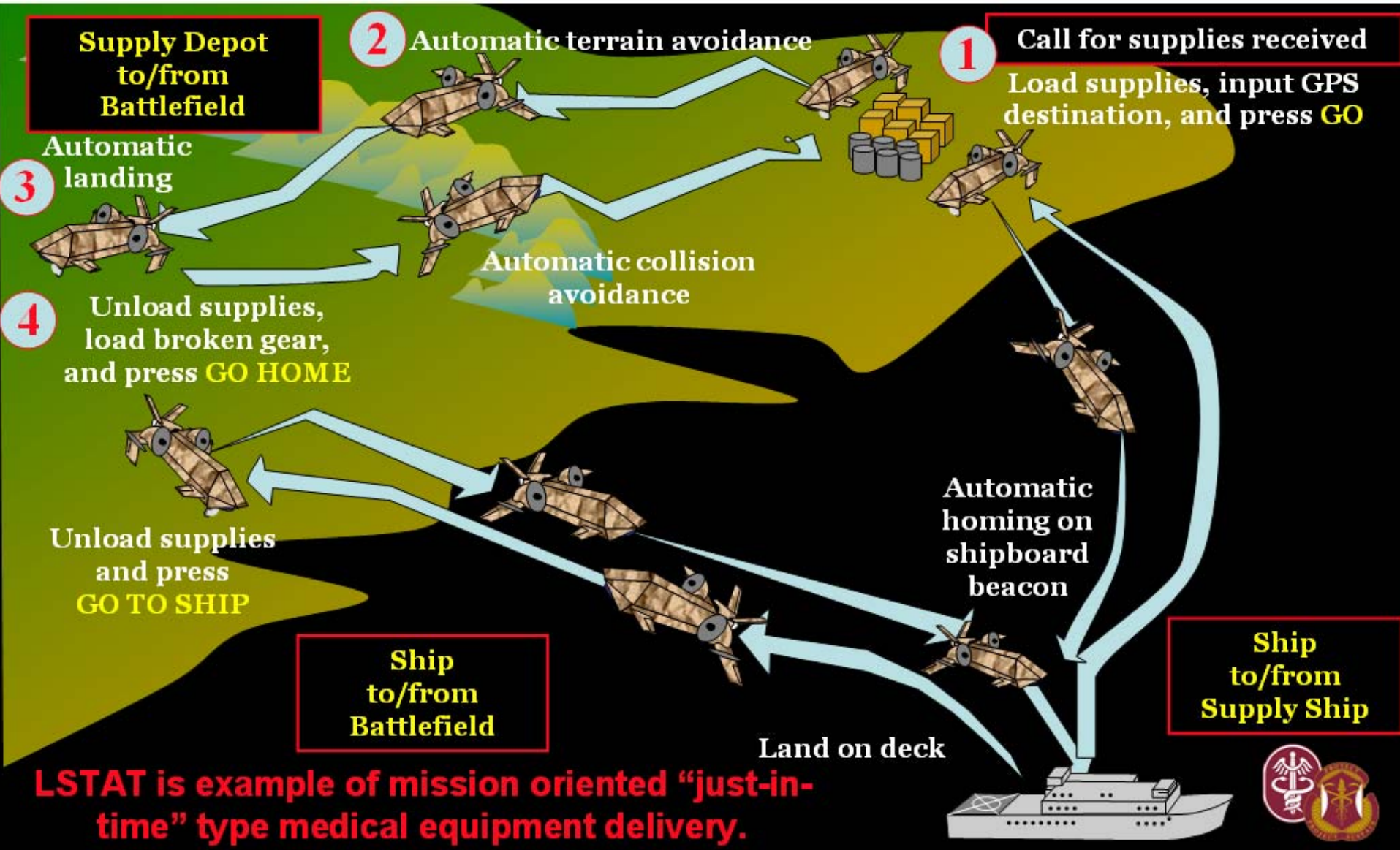
A former DARPA Project

LSTAT Lite

Autonomous VTOL UAS for:
- **Logistic support directly to unit (e.g. "just-in-time" LSTAT delivery)**
- **Rescue and transport of combat casualties on LSTAT**

(Notional) Concept of Operations – LOGISTICS

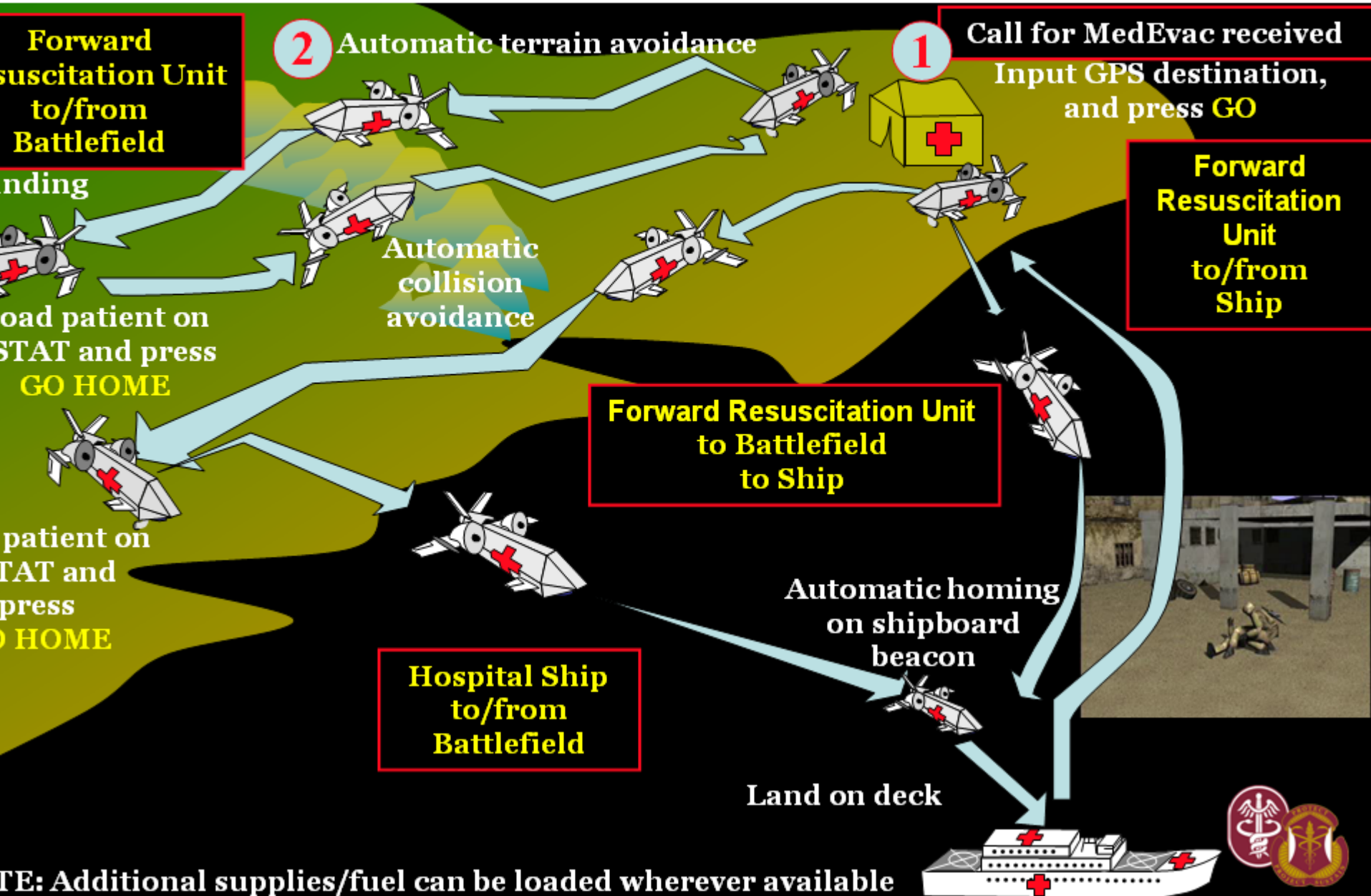
Autonomous transit from supply depot, to destination, and back using GPS and/or beacon



LSTAT is example of mission oriented "just-in-time" type medical equipment delivery.

(Notional) Concept of Operations – CASEVAC

Autonomous transit from medical unit, to pick-up point, and back using GPS and beacon



UAS -Combat Medic Collaboration for Resupply & Evacuation SBIR

To design, develop and demonstrate enabling technologies for delivery of critical medical supplies and Life Support For Trauma and Transport (LSTAT) Systems by UAS to combat medics for treatment, stabilization and subsequent evacuation of combat Casualties from hostile situations. The key research foci of this SBIR Topic are advanced technologies for:

- ***Autonomous UAS Take-off, Landing, and Navigation In Urban and Wooded Terrain***

- ***Collaboration and Coordination Between Medics and UAS Ground Crew*** to effect safe and timely delivery of medical supplies and LSTAT systems so appropriate first responder care and evacuation can be performed during the so called “Golden Hour” of combat casualty care

Status

- SBIR Phase I Complete (5 companies) – Sep 07
- SBIR Phase II Downselect by OSD DDR&E Complete (2 companies) – Oct 07
- SBIR Phase II Started – Feb 08

Dragonfly Pictures

Solution: Complete Pathway to an Autonomous, Mission Capable, Tandem Rotor Aircraft Capable of Carrying Designated Payloads Internally

- Proposes Using Own Aircraft (DP-6, DP-5X) to Demonstrate Autonomous Flight, Collision Avoidance, & Autonomous Landing (risk reduction)
- Most Practical Near-Term Landing Site Designation Approach with Least Risk
- JAUS & STANAG 4586 Compliant
- Leveraging External & IRD Funding including ARL FY2008 BIRRRD (Beneficial Infrastructure for Rotorcraft Risk Reduction Demonstrations) Congressional.

Phase II Flight Demonstration: DP-5XT Developmental UAV w/Sufficient Payload

Dragonfly Pictures Aircraft

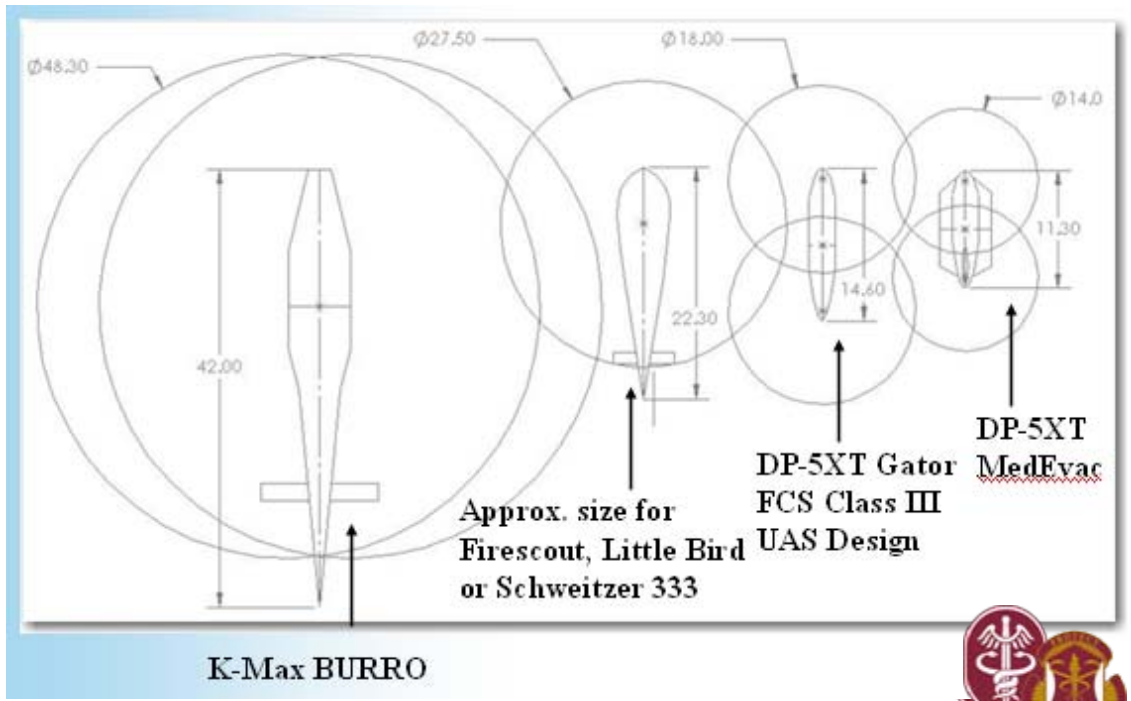
DP-6 Whisper: (DPI commercial UAV) Phase II Autonomy demo

DP-5X Wasp: (DPI original class III DARPA/FCS UAV) Phase II medical payload & autonomy demo

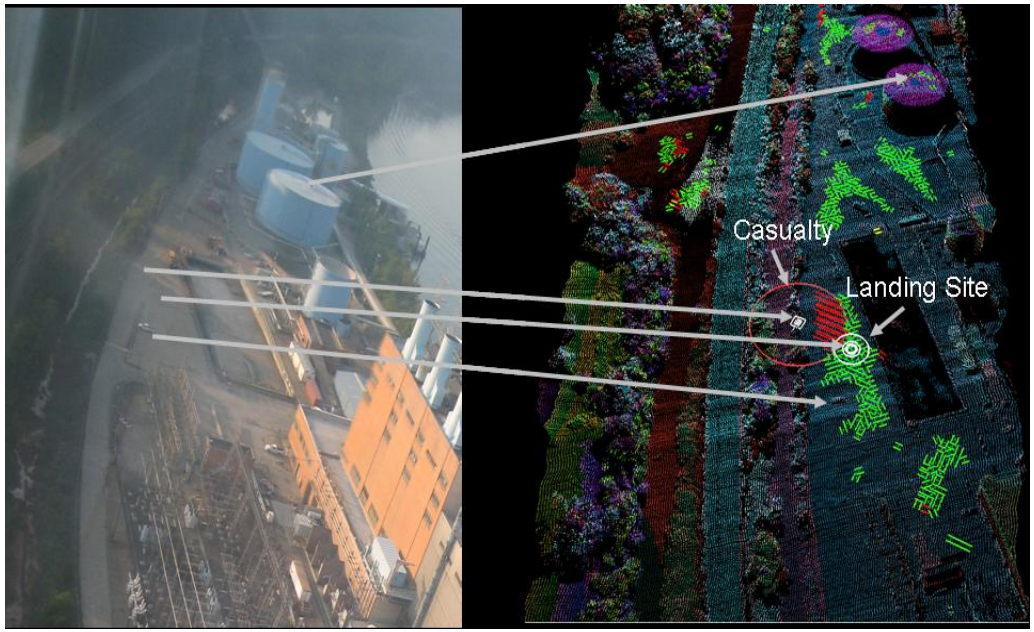
DP-5XT MedEvac: (Objective configuration; design only based on FCS Class III)

DP-5XT MedEvac Characteristics

- Gross Weight = 2310 lb
- Empty Weight = 1040 lb
- Useful Load = 1270 lb
- Fuel Weight (200 n-mile) = 235 lb
- NAV/COMMS Payload = 35.33 lb
- Combat Medic Payload = 1000 lb
- HP max = 525
- MEDEVAC Tandem Dimensions:
  - Rotor Diameter = 14 ft
  - Length Fuselage = 11.3 ft
  - Height = 7.0 ft
  - Width Fuselage – 5.0 ft



Piasecki Aircraft



Solution: Very Impressive Autonomous Landing Site Selection & Landing Technology Based on Carnegie Mellon & Drexel University Work

- Phased Approach Employing Proven UAV & Man-Rated Version of that Aircraft Followed By The Development of a Unique Four-Engine, Ducted Fan UAV

Phase II Flight Demonstration: Boeing Unmanned Little Bird UAV* w/Sufficient Payload

* Same UAV Platform as Targeted MCWL LOE 5 Platform

BEAR-Battlefield Extraction-Assist Robot Characterization and Evaluation

DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY INFANTRY CENTER
FORT BENNING, GEORGIA 31905-5000

REPLY TO ATTENTION OF

ATZB-WC (70) 18 January 2008

MEMORANDUM OF AGREEMENT
BETWEEN
THE U.S. ARMY MEDICAL RESEARCH AND MATERIEL COMMAND
AND
THE SOLDIER BATTLE LAB, FORT BENNING, GEORGIA

SUBJECT: Soldier Battle Lab (SBL) support for live, virtual, constructive experimentation with the Telemedicine Advanced Technology Research Center (TATRC) Battlefield Extraction-Assist Robot (BEAR), 22 January 2008-30 September 2008.

1. This support will be executed in response to a TATRC request for support for experimentation with the BEAR.

2. Purpose: This agreement defines the roles and responsibilities of TATRC and the SBL for the period 22 January 2008-30 September 2008.

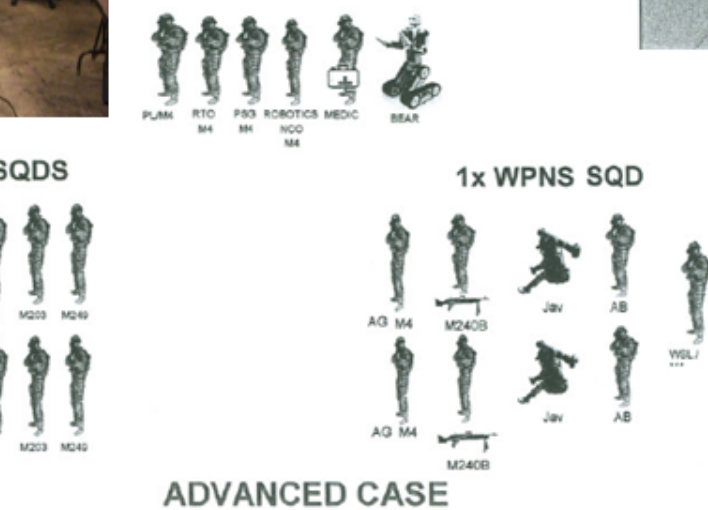
- **Task- Characterize and evaluate the BEAR.**
- **Purpose- Determine the characteristics, capabilities, and limitations of the BEAR and solicit Soldier feedback on utility and effectiveness to facilitate further development and make the BEAR more soldier friendly.**

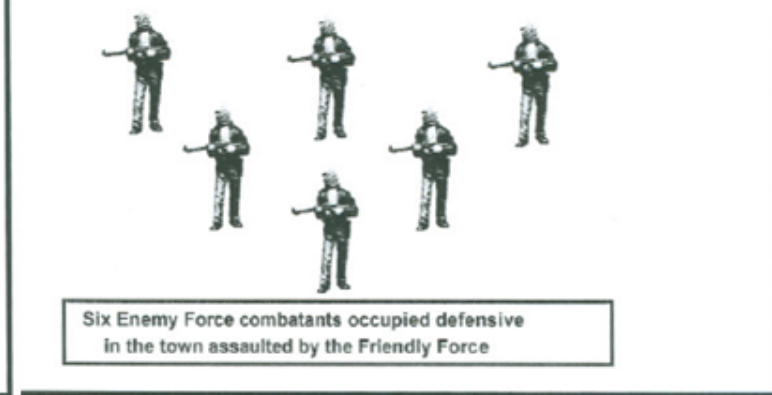
Challenges

Integration of BEAR Modeling and Simulation software into Battlelab SIM environment.

- Initial SBL scope and level of effort with TATRC included in MRMC-SBL MOA.
- Full function BEAR simulation model cost to be determined (PEO STRI)
- SIM and live exercise dates (3rd Quarter FY08 with live exercise to follow in 1st QTR FY09).

Maneuver Battle Lab (MBL) Initial Simulation Effort
9-13 June 2008





Maneuver Battle Lab (MBL) Initial Simulation Effort 9-13 June 2008

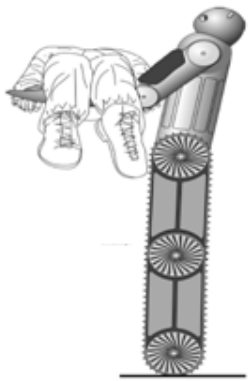
MANEUVER BATTLE LAB PROJECT NO. 0206

MANEUVER BATTLE LAB

BATTLEFIELD EXTRACTION ASSIST ROBOT

SUMMARY REPORT

JULY 2008



- Ran several simulations.
- Useful information obtained for developing operational and technical requirements, and Tactics, Techniques, and Procedures (TTP).
- In order to maximize value of simulation runs, a fully functional ONESAF model of each robot being evaluated is needed.
- Actual JAUS OCUs to be used with robots should be used in simulation runs by robot operator to simulate command and control of robot.
- Interspersion AND integration of simulations and live exercises is recommended and planned for BEAR.
- MBL recommended inclusion of non-CASEVAC uses of BEAR in future simulations and live assessments.

BEAR - One SAF Integration Architecture

Config File(s)

Control Data

BEAR location / orientation, joint articulations, sensor parameters/settings

OCU

BEAR Model (Mobility, Sensor, etc)

Image Generator (CAVE)

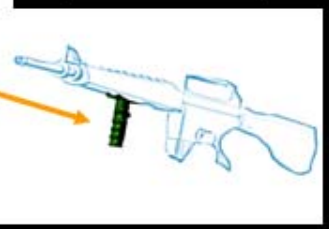
Status Data

Controller(s)
Playstation,
M4 Rifle Grip
iGlove

3D Model

State Information

Terrain Data



NIU
Network Interface Unit

DIS/HLA

OneSAF

Challenges

Technology

- **Autonomy**
- **Adequate actuator motors and/or segmented precision hydraulics**
- **Secure Broadband Communications**
- **Power**
- **Standards (e.g. STANAG 4586 and JAUS)**
- **Noise suppression**
- **Safety and comfort**

Casualty Extraction

- **Casualty Location**
- **Casualty movement and stabilization**
  - Current technology requires self-loading or buddy loading of casualties
  - Insufficient for isolated casualties who are unconscious or too gravely wounded to move themselves
  - Danger of inflicting additional injury if broken and/or partially amputated limbs are not properly stabilized prior to movement
- **Speed of operations**
- **Providing "human touch" to calm and reassure casualties**

Enroute Care

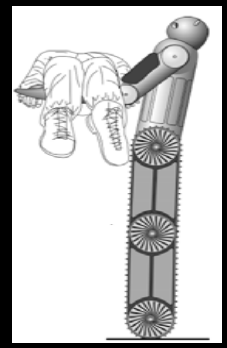
- **Medical knowledge to guide robotic assessment and selection of appropriate treatment options**
  - Identification of appropriate prognostic and diagnostic markers for trauma
  - Modeling of human response to trauma and therapeutic interventions
- **Advanced imaging and anatomic modeling to appropriately direct physical interventions**

Capabilities Needs Documentation & Doctrine

- **Policies & Doctrine:**
  - **2005 AMEDD C&S policy memo on unmanned CASEVAC**
- **Joint Capabilities Integration & Development System (JCIDS) documentation**
- **POM Funding; e.g. Dec 2006 ASBREM/TARA Recommendation**

U.S. Army Medical Research and Materiel Command
Telemedicine & Advanced Technology Research Center
Cutting Edge Medical Technology

Robotic Combat Casualty Care Extraction & Evacuation S&T Programs



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