**U.S. ARMY 96.2**
**SUBMISSION OF PROPOSALS**

***Topics***

The Army participates in one solicitation each year with a coordinated Phase I and Phase II proposal evaluation and selection process. The Army has identified 179 technical topics for this solicitation which address the Technology Areas in the Defense Technology Plan and the Army Science and Technology Master Plan. The commercial potential for each of these topics has also been identified.

***Operating and Support Cost Reduction (OSCR)***

The U.S. Army spends a large part of its overall budget, directly or indirectly, on the operation and support (O&S) of equipment ranging from small generators to large, sophisticated weapon systems. O&S costs cover a broad spectrum of items including spare/repair parts, fuels, lubricants, and the facilities and people involved in training operators and mechanics. The Army is seeking ways to reduce these costs as a broad Acquisition Reform initiative. To this end, the Army has implemented the Operating and Support Cost Reduction (OSCR) Program.

This solicitation includes 35 topics which address specific OSCR concerns identified by the Army's research and development community. In addition, a broad, generic topic has been included to ensure that any OSCR ideas can be submitted and evaluated. Please note that any proposals submitted against this generic topic must be structured within the Phase I/Phase II framework, must address an Army OSCR issue, and must provide an excellent opportunity for commercialization of the concept beyond the SBIR program. The OSCR topics have been grouped together at the end of the Army topics to benefit offerors who are specifically interested in cost reduction applications.

***Technology Areas***

Each Army SBIR topic is tied to one of the 20 technology areas, listed below, which are described in the Army Science and Technology Master Plan.

1Aerospace Propulsion and Power
2Air Vehicles
3Chemical and Biological Defense
4Clothing, Textiles, and Food
5Command, Control, and Communications (C3)
6Computing
7Conventional Weapons
8Electronics
9 Electronic Warfare/Directed Energy Weapons
10 Environmental Quality and Civil Engineering
11 Battlespace Environments
12 Human-Systems Interface (HSI)
13 Manpower, Personnel, and Training
14 Materials, Processes, and Structures
15 Medical

16 Sensors
17 Ground Vehicles
18 Software
19 Manufacturing Science & Technology (MS&T)
20 Modeling and Simulation (M&S)

***Proposal Guidelines***

The maximum dollar amount for Army Phase I awards is $100,000 and for Phase II awards is $750,000. Selection of Phase I proposals will be based upon technical merit, according to the evaluation procedures and criteria discussed in this solicitation document. Due to limited funding, the Army reserves the right to limit awards under any topic and only those proposals considered to be of superior quality will be funded. To reduce the funding gap between Phase I and Phase II, the Army follows a disciplined milestone process for soliciting, evaluating, and awarding superior Phase II proposals. Phase II proposals are invited by the Army from Phase I projects which have demonstrated the potential for commercialization of useful products and services. Invited proposers are required to develop and submit a commercialization plan describing feasible approaches for marketing developed technology. Cost sharing arrangements in support of Phase II projects and any future commercialization efforts are strongly encouraged, as are matching funds from independent third-party investors, per the SBIR fast track (see Section 4.5). Commercialization plans, cost sharing provisions, and matching funds from investors will be considered in the evaluation and selection process. Phase II proposers are required to submit a budget for a base year (first 12 months) and an option year. Phase II projects will be evaluated after the base year prior to extending funding for the option year.

Proposals not conforming to the terms of this solicitation and unsolicited proposals will not be considered.

***Submission of Army SBIR Proposals***

All proposals written in response to topics in this solicitation must be received by the date and time indicated in Section 6.2 of the introduction to the DoD solicitation. Be sure that you clearly identify the specific Army topic which your proposal addresses. All Phase I proposals (one original plus four copies) **must be submitted to the Army SBIR Program Office at the address shown below:**

Dr. Kenneth A. Bannister
Army Research Office--Washington
Room 8N31
5001 Eisenhower Avenue
Alexandria, VA 22333-0001
(703) 617-7425

***Recommendation of Future Topics***

Small Businesses are encouraged to suggest ideas which may be included in future Army SBIR solicitations. These suggestions should be directed at specific Army research and development organizations.

***Inquiries***

Inquiries of a general nature should be addressed to:

LTC John Peeler
Army SBIR Program Manager
HQDA
OASA RDA
Pentagon, Room 3E486
Washington, D.C. 20310-0103
(703) 614-7298

Dr. Kenneth A. Bannister
Army SBIR Program Coordinator
Army Research Office--Washington
Room 8N31
5001 Eisenhower Avenue
Alexandria, VA 22333-0001
(703) 617-7425

# ARMY SBIR PROGRAM
# POINTS OF CONTACT SUMMARY

## U.S. Army Materiel Command

| | | | |
|---|---|---|---|
| ARDEC | E. Serao | (201) 724-7349 | A96-001 thru A96-016 |
| ARL | D. Hudson | (301) 394-4808 | A96-017 thru A96-033; A96-145 thru A96-152 |
| ARO | M. Brown | (919) 549-4336 | A96-034 thru A96-043; A96-153 thru A96-154 |
| ARO-W | K. Bannister | (703) 617-8392 | A96-179 |
| AVRDEC | A. Smith | (804) 878-0155 | A96-044 thru A96-054; A96-155 |
| CECOM | J. Crisci | (908) 427-2665 | A96-055 thru A96-081; A96-156 thru A96-159 |
| ERDEC | R. Hinkle | (410) 671-2031 | A96-082 thru A96-083; A96-160 thru A96-161 |
| MICOM | O. Thomas, Jr. | (205) 842-9227 | A96-084 thru A96-086; A96-162 thru A96-172 |
| NRDEC | G. Raisenan | (508) 233-5296 | A96-087 thru A96-089; A96-173 thru A96-175 |
| STRICOM | A. Piper | (407) 380-4287 | A96-090 thru A96-093; A96-176 thru A96-177 |
| TACOM | A. Sandel | (810) 574-7545 | A96-094 thru A96-105; A96-178 |
| TECOM | R. Cozby | (410) 278-1481 | A96-106 thru A96-112 |

## U.S. Army Corps of Engineers

| | | | |
|---|---|---|---|
| COE/CERL | M. Marlatt | (217) 373-7290 | A96-113 thru A96-114 |
| COE/CRREL | S. Borland | (603) 646-4735 | A96-115 thru A96-116 |
| COE/TEC | J. Jamieson | (703) 428-6631 | A96-117 thru A96-118 |
| COE/WES | P. Stewart | (601) 634-4113 | A96-119 thru A96-120 |

## Deputy Chief of Staff for Personnel

| | | | |
|---|---|---|---|
| ARI | J. Psotka | (703) 617-5572 | A96-121 thru A96-123 |

## U.S. Army Space and Strategic Defense Command

| | | | |
|---|---|---|---|
| SSDC | E. Bird | (205) 955-4871 | A96-124 thru A96-130 |

## Surgeon General

| | | | |
|---|---|---|---|
| MRMC | H. Willis | (301) 619-2471 | A96-131 thru A96-144 |

# DEPARTMENT OF THE ARMY
# PROPOSAL CHECKLIST

This is a Checklist of Requirements for your proposal. Please review the checklist carefully to assure that your proposal meets the Army SBIR requirements. Failure to meet these requirements may result in your proposal being returned without consideration. Do not include this checklist with your proposal.

_____1.The proposal is limited to only ONE ARMY solicitation topic.

_____2.The proposal is 25 pages or less in length. (Excluding company commercialization report.) Proposals in excess of this length will not be considered for review or award.

_____3.The Cover Sheet (Appendix A) has been completed and is PAGE 1 of the proposal. The actual RED COPY of Appendix A is included on the original proposal.

_____4.The proposal budget may be up to $100,000 and duration does not exceed six months.

_____5.The Project Summary Sheet (Appendix B) has been completed and is PAGE 2 of the proposal. The actual RED COPY of Appendix B is included on the original proposal.

_____6.The Technical Content of the proposal begins on PAGE 3 and includes the items identified in Section 3.4 of the Solicitation.

_____7.The Technical Abstract contains no proprietary information, does not exceed 200 words, and is limited to the space provided on the Project Summary Sheet (Appendix B).

_____8.The proposal contains only pages of 8 1/2" x 11" size. No other attachments such as disks, video tapes, etc. are included.

_____9.The proposal contains no type smaller than 11 point font size (except as legend on reduced drawings, but not tables).

_____10.The Contract Pricing Proposal (Appendix C) has been completed and is included as the last section of the proposal.

_____11.The final proposal is stapled in the upper-left-hand corner, and no special binding or covers are used.

_____12.An original and four copies of the proposal are submitted.

_____13.The Company Commercialization Report, if required, in accordance with Section 3.4.n.

_____14.A self-addressed stamped envelope and a copy of the Notification Form (Reference A) in the back of the solicitation book, if notification of proposal receipt is desired.

_____15.The proposal must be sent by registered or certified mail, postmarked by June 28, 1996, or delivered to the Army SBIR Office no later than July 5, 1996, 2:00 p.m. local time as required (see Section 6.2).

# SUBJECT/WORD INDEX TO THE ARMY SBIR SOLICITATION

# INDEX OF ARMY FY96 TOPICS

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A96-023Artificial Intelligence Enhanced Information Processing

A96-024Parallelizing Visualization Algorithms for Interactive  Computational Analysis

A96-025Information Assimilation Error Measurement for Digital Displays

A96-026Virtual Reality Battle Management Tool for C3 Nets

A96-027Induction Bonding of Composite Armor

A96-028Intelligent Wire Bond Pull Station for Microelectronics

A96-029Machine Translation of Battlefield Messages

A96-030Information Processing Applications for Cooperating Microrobotics Systems

A96-031Integrated Soldier Interface for Hands-off Control of Head Mounted Display Information

A96-032Laser Cross Wind Sensor

A96-033Display Device Development

## U.S. Army Research Organization

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A96-035Chemical Hydride Hydrogen Sources for Small Fuel Cells

A96-036Milli-Robotics for Remote, Minimally-Invasive Surgery

A96-037Design and Synthesis of Novel Nanolaminate Materials

A96-038Hierarchical Polymer Bonded Ceramic Structural Composites

A96-039Novel Polymeric Membranes for Reverse Osmosis Water Purification

A96-040Multi-Body Dynamics and Control for Land Vehicle Simulation

A96-041Laser Speckle Interferometry

A96-042A Multi-Parameter Snow Sounding Probe

A96-043Reactor for Control of Fugitive Emissions of Toxic Gases

## U.S. Army Aviation Research, Development, and Engineering Center

A96-044Incrementally Adjustable Helicopter Rotor Blade Tracking Tab

A96-045Advanced Materials for Helicopter Propulsion Systems

A96-046Computer Modelling and Simulation for Helicopter Pilotage Tasks

A96-047Human Performance with Decision Aiding Systems: Training for Trust and Measuring the Benefits

A96-048Aerodynamic Analysis of Unsteady Airfoil Geometry in Unsteady Flow

A96-049Turboshaft Engine and Rotorcraft Drive System Technology

A96-050Graphical User Interface for Comprehensive Rotorcraft Analysis Software

A96-051Three-Axis Fiber Optic Gyroscope

A96-052Display of Aircraft State Information for Ambient Vision Processing Using Helmet Mounted Displays.

A96-053Smart Data Links for Unmanned Aerial Vehicles

A96-054Universal Cargo Net with Release Feature

## U.S. Army Communications and Electronics Command

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A96-0583D Visualization of RF Propagation in Terrain

A96-059Intelligence Preparation of the Information Battle Space

A96-060Wideband Fast Switched RF Synthesizer

A96-061Integrated Low-Cost Ku Band Transmit/Receive Module

A96-062Low Light Level Solid State Sensors

A96-063High Power Tunable Output Filters for Electronic Attach (EA) Systems

A96-064Non-destructive Real-Time In-Situ Analysis of Vacuum Grown and Processed Infrared Materials and Sensor Arrays

A96-065Integrated Detection & Location of Buried Metallic and Non-Metallic Targets

A96-066Software Architecture, Tools, and Modules for Soldier Education and Training

A96-067High Performance Miniature Antennas for Hand-Held Personal Communication Systems (PCS)

A96-068Intelligent Display of Laser Radar, FLIR and Visible TV Imagery

A96-069Double-Sided High Temperature Superconductor(HTSC), Coated Single Substrate (thin-film), for Electronic/Microwave Components & Devices

A96-070Soldier Situation Awareness and Well-Being

A96-071Moving Target Indicator (MTI) Radar Target Tracking using Context Constraints Derived from High Resolution SAR Imagery

A96-072Cost Effective Micro-Cell Communications and Situational Awareness using Spread Spectrum and Global Positioning System (GPS)

A96-073Automatic Target Recognition (ATR) for Infrared Hyperspectral Imaging Technology

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A96-077Remoteware for Split-Based Operations

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A96-080Information Display for Battle Damage Assessment (BDA)

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A96-083High Performance Aerosol Collectors

## U.S. Army Missile Command

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## U.S. Army Natick Research, Development, and Engineering Center

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## U.S. Army Corps of Engineers Research Laboratory

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A96-116In-flight Aircraft Icing Prediction Detection System

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A96-120Static Laser Profilometer and Holographic Visualization Tool

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A96-122Network Based Training and Feedback to Improve Staff Performance

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A96-128High Temperature Materials Testing and Development Using High Energy Lasers

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A96-139Development of an Sensitive and Specific Antigen-Detection System for "Strongyloides Stercoralis" and Hookworm Infections

A96-140Development of a Light Weight Portable System for the Determination of Infection Susceptible Patients and Early Detection of Infection

A96-141Rapid Confirmation Assays Against Specific Toxins and Infectious Disease Pathogens

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A96-149Detector/ Amplifier/ Mixer Array for a Low Cost Imaging Ladar

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A96-151Advanced Technology Concepts and Components for Rotorcraft Drive Systems

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A96-155Honeycomb Structural Sealant

A96-156Active Harmonic Suppression Motor Controllers

A96-157Heavy-Duty Lightweight JP-8 and DF-2 Fuelled Engina(s) With Power Range 6-200 HP for Mobile Power Generation Equipment

A96-158Migration of the Joint Task Force Communications Planning and Management System (JCPMS) to Current Commercial Technologies (NDI/COTS) and Standards

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A96-161Nanotechnology and Microelectromechanical Sensors

A96-162Imaging Automatic Gain Control (AGC) for Target Acquisition, Automatic Target Recognition (ATR), and Tracking

A96-163Infrared Background Clutter Metrics

A96-164Virtual Reality Scene Generation By Means of Open Standards

A96-165Plastic Encapsulated Microcircuit Storage Accelerated Age Model

A96-166Low Energy Impact Damage Evaluation of Thin Walled Composite Structures

A96-167Demonstration of Optical Control of Steerable Array Antennas

A96-168Pulse-Coupled Smart Pixel Array

A96-169Doppler LIDAR Using Edge Technique

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A96-171Generic Ducted Rocket Test Facility Combustion and Flow Prediction/Analysis System

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A96-173Wide Span Structures Using Pressurized Airbeams

A96-174Rapid Inflation Systems for Inflatable Structures

A96-175Diesel Fuel Preheater

A96-176Non-system Training Devices and Training Instrumentation Systems/Technology Advancements

A96-177Advancements in Instrumentation Technology for documentation Systems/Technology Advancements for Threat Targets, Threat Simulation

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A96-179Reducing Army Operating and Support Costs

**DEPARTMENT OF THE ARMY**
**FY 1996 TOPIC DESCRIPTIONS**

## U.S. Army Armaments Research, Development, and Engineering Center

A96-001TITLE:Dual-Effect (Lethal and Non-Lethal) Weapons

CATEGORY: Exploratory Development

OBJECTIVE: To design, analyze, develop and demonstrate new, advanced concepts that provide both lethal and non-lethal target effects from the same direct fire weapon system/munition. The non-lethal capability will temporarily incapacitate/immobilize personnel targets without lethality, serious injury, or irreparable effects. Concepts should be dual use applicable to law enforcement or with other direct technology transfer capability to private/commercial sector.

DESCRIPTION: Reduction of potential logistics burden created by multiple different types of non-lethal munitions/armament systems may be essential considerations in fielding of future weapon systems which will be used in both combat and OOTW missions. Novel, advanced concepts that specifically address dual-effort (lethal and non- lethal) capable weapon systems/munitions where one weapon system and/or munition can be used in both lethal and non-lethal scenarios, based on operation controlled/activated mechanism (either manual or automatic) are of interest. Advanced concepts which address integrated mechanisms for adjusting projectile velocity, shape, or in-flight target impact performance, and the resultant target effect (lethal/non-lethal) use are of specific interest. Concepts must be applicable to one or more of the following calibers, listed in order of expected prevalence: 5.56mm, 20mm, 40mm, 12 gauge and 9mm.

Ideally, concepts will address one or more of the following attributes:
1. Near instantaneous, real-time, pre-firing selection of loaded ammunition (i. e., chambered ammunition, attached magazine, or muzzle launched) for either lethal or non-lethal target effect.
2. Lethal and non-lethal target effects from same system/munition at effective ranges comparable to standard ammunition or 10 meters minimum and 500 meters maximum.
3. Fool-proof/fail-safe selection/activation of desired target effect for the scenario such that a lethal round is not fired in a non-lethal situation, or vice versa.
4. Ability to automatically cycle weapon and chamber next round even after firing in the non lethal mode.

PHASE I: Conceptualize and design, as a minimum, and build and test prototype item(s) with above attributes. Demonstrate vitality of concept through analysis and/or simple prototype fabrication/lab test. Obtain contingent provision of funding commitment for potential Phase III effort.

PHASE II: Develop, construct, test and deliver one or more working prototypes for government verification of concept performance.

POTENTIAL COMMERCIAL MARKET: Future weapon systems/munitions for federal and local law enforcement.

A96-002TITLE:Analysis Of X-Ray Images Using Wavelet & Fractal Methods

CATEGORY: Advanced Development

OBJECTIVE: Develop an x-ray data analysis system in which fractal and wavelet analysis methods are integrated with more traditional methods of analysis for analyzing x-ray multi-spectral images for identification of objects, object positions, and composition.

DESCRIPTION: The Army needs a limited but fairly numerous set of parameters that could be quickly calculated from x-ray radiographic images. The set of parameters must be adequate to identify and differentiate with a very high level of probability a host of materials both man-made and natural as seen in the radiographs.

The proposal should address the following unique attributes of the radiographs. An x-ray radiographic image is the superimposed shadow of all materials between the x-ray source and the imaging device. To a large extent the pixel value or density is a function of the distance through an item normal to the image plane. Curvature of an item can be extracted from the change in the pixel values across an item. The edge of an item often is seen as a sudden change in the rate of change of intensity across the image. The complex effect of superposition may be partially calculated out through careful logic. Natural substances should portray a different fractal content than man-made objects. Consideration should be given to combining wavelet transformations with fractal analysis, and calculations of first and second order changes in intensity across image segments. The images to be analyzed are actually a set of images, each image consisting of a different spectral band. The different spectral images are all spatially registered.

PHASE I: The Phase I proposal must include a first set of parameters to be calculated and the basis for their choice. The proposal must demonstrate familiarity with radiographic images. The proposal must show a logical and realistic approach to determining an all encompassing set of parameters for identification of objects in radiographs. The Phase I objective will be to calculate the proposed set of parameters for a representative set of radiographs to be provided by the Army; to demonstrate how well they identify and differentiate items in the radiographs; and to propose a more appropriate and thorough set of parameters to be worked on in Phase II.

PHASE II: Develop, construct, test and deliver a complete set x-ray data analysis algorithms which meets the objective of the solicitation. All of the algorithms must be interfaced as a set of functions to the National Institute of Health's "NIH IMAGE" program and placed in the public domain. A second version must be interfaced to an Army custom x-ray image processing system. All algorithms must be designed to process both eight and sixteen bit data, and to process images of mega-pixels in size. Algorithms must be very fast.

POTENTIAL COMMERCIAL MARKET: Potential military and commercial applications include radiographic and tomographic inspection of munition items, vehicle components, manufactured items, and medical diagnosis. Algorithms developed for radiographs should have use for analysis of visible light and infrared images as well. Applications would include machine vision, target identification, robotics and similar image analysis areas.

A96-003TITLE:Fire Detection and Warning System Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop a low cost compact system that detects fire at an early stage and provides early warning for ammunition, fuel, and other hazardous material storage safety applications to enhance soldier survivability.

DESCRIPTION: Ammunition storage areas are not equipped with a fire warning system because no such system is available. Subsequently, many lives and vast quantities of property and material are lost as a result of fire due to accidents or enemy actions. The accident that occurred at Camp Doha, Kuwait after Desert Storm is a good example. That accident was initiated by a fire and caused the loss of millions of dollars worth of weapons and ammunition, and the loss of several lives during the cleanup operation of scattered munitions. That accident could have been prevented if the fire was detected at an early stage and quickly extinguished. Significant progress has been made in light sensor technology in the past decade. Various types of high quality light sensors have been developed to detect different light spectrums and are producible at very low costs. A system can be developed exploiting the technology advances in sensors (light or other) and early warning equipment to detect a fire in its initial stage and initiate a warning signal. The technical issues of the fire detection and warning system include: the ability to detect and locate fires quickly and cover a large area (from 1000 square feet to several square miles) over a wide field of view, robust design, function indoor and outdoor at the same temperature ranges required for ammunition (-60 to +165 degrees F), operate with standard Army and commercial batteries as well as 115 volts (AC), generate an audible warning signal that can be heard within 100 yards of the ammunition storage area, environmentally safe, compact, and lightweight.

PHASE I: Investigate new and innovative sensors to detect fires at an ammunition storage area. Establish preliminary design criteria for the sensor and audible warning system. Select the types of sensor and audible warning system technologies that are potential candidates for system development. Determine physical and performance characteristic required of the total sensing and warning system. Determine the configuration of the assembled sensors and warning system.

PHASE II: Develop test hardware, and plan for the detection and audible warning system components (sensor and warning mechanisms) and total system. Fabricate prototype test hardware, conduct testing on the prototype, and provide a final report that includes the specification of the system, unit cost, and test results.

POTENTIAL COMMERCIAL MARKET: The technology developed under this program may be utilized in any commercial storage and warehouse situation. The system will provide early detection and warning against fire and will aid in the prevention of life and property loss.

A96-004TITLE:Ground Vehicle Classification by Acoustic Emission Exploitation

CATEGORY: Exploratory Development

OBJECTIVE: Develop improved signal classification capability utilizing advanced, programmable pattern recognition (PPR) techniques.

DESCRIPTION: The Army is currently developing and/or employing acoustic sensors for surveillance, intelligence gathering, and target acquisition functions (detect ion, classification, tracking, etc.). Low-cost, computationally powerful, Digital Signal Processing IC's are now widely available that can execute sophisticated signal processing techniques that extract and exploit information from acoustic emissions of, for instance, ground combat vehicles.

The identity, or more generally, the classification of an acoustic emitter is essential for assessing the threat it imposes to friendly forces. Contemporary classification techniques employed to categorize ground combat vehicles have, for the most part, been statistically based and have exhibited acceptable performance cap abilities in a medium to high signal to noise ratio scenarios. However in the low SNR situations, such as a vehicle at extended range, or a collection of vehicles, the performance of these same algorithms is substantially degraded.

The development of robust and innovative signal classification algorithms that employ advanced pattern recognition based signal processing is desired. Such processing would be capable of extracting recognizable features from acoustic emissions produced by ground combat vehicles. The prospective pattern recognition algorithm might exploit features from multiple processing domains, i.e. time, frequency, spatial, parametric. The algorithm must be robust enough to encompass normal variation of signal pattern descriptors. The approach should be flexible enough that signatures of observed sources can be incorporated into the algorithm without extensive modification. The algorithm should be innovative in that it should extend the capabilities of existing classical pattern recognition algorithms or be an entirely different and novel approach.

PHASE I: Develop methodology and algorithmic approach to novel PPR concept. Demonstrate the basic capability and effectiveness of the chosen approach, preferably, by playing the algorithm against existing tactical vehicle acoustic data available from the sponsor.

PHASE II: Refine the chosen PPR approach. Assemble the necessary hardware to demonstrate a real-time PPR capability. Expand the capability of the algorithm to discriminate multiple sources simultaneously and/or operate in a noise contaminated environment.

POTENTIAL COMMERCIAL MARKET: Rotating and reciprocating machinery diagnostics, failure mode prediction. Classification of small engine fixed-wing aircraft for drug trafficking surveillance/interdiction. Medical diagnostics, for example, fetal heart and umbilical bloodflow abnormality detection and identification. Voice detection/recognition.

A96-005TITLE:Computed Tomography Algorithms for Helical Scanned Data

CATEGORY: Advanced Development

OBJECTIVE: Develop algorithms for high-speed Computed Tomography (CT) scanning and reconstruction with helical and pseudo-helical geometry.

DESCRIPTION: In order to increase throughput, computed tomography requires the part under inspection be continuously moving, rather than incrementally moving. The result is a helical scan. In order to decrease the size of the equipment, a non-circular x-ray source and sensor configurations are being employed. This solicitation is for algorithms for computing the tomographic slices from the helical scanned data coming from non-circular geometry. The algorithms must reconstruct 256,000 pixels or more, with limited artifacts, must compute rapidly (in milliseconds), must run on available processing equipment, must process raw data of up to fifteen bit accuracy.

PHASE I: Research and simulate algorithms for reconstruction of tomographic slices from helical scanned data taken with non-circular geometry. Attention must be given to freedom from artifacts, accuracy of dimensions and densities, spatial resolution, and techniques that can be accomplished at high speeds with reasonable processor hardware costs. Demonstrate the algorithms will meet the requirements. Obtain funding commitments for potential marketing and production.

PHASE II: Develop, construct, test and deliver one or more working prototype complete systems including all hardware, software, etc. The system will create tomographic images from helical scanned data taken with non-circular geometry. The algorithms must reconstruct 256,000 pixels or more, with limited artifacts, must compute rapidly (in milliseconds), must run on available processing equipment, must process raw data of up to fifteen bit accuracy.

POTENTIAL COMMERCIAL MARKET: Potential military and commercial applications include non-destructive inspection of munition items, vehicle components, manufactured items, and medical diagnosis.

A96-006TITLE:Advanced Nonlinear and Hybrid Systems Control Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate high performance nonlinear, adaptive, and hybrid systems control technology for precision multi-target/ multi-platform fire-on-the-move applications including armor, air defense and aircraft system applications.

DESCRIPTION: Recently progress has been made in demonstrating major accuracy improvements for both aircraft and combat vehicle weapon systems using advanced digital processing together with LQG/LTR and H-infinity design approaches. Further improvements in weapon accuracy and targeting performance are anticipated through the development of improved robust nonlinear and adaptive control laws, and hybrid control laws that account for both continuous as well as logical components of the system state vector. This project will address the broad spectrum of issues associated with the development of control law design tools and methodology, modeling, simulation, real time hardware/software implementation, and sensor/actuator technology.

PHASE I: Develop methodology for design and implementation of high performance robust adaptive, nonlinear and hybrid system control laws for precision weapon stabilization, tracking and targeting. Formulate specific stabilization, tracking and targeting control laws/decision strategies for multi-input, multi- output nonlinear plants, incorporating distributed smart senor/actuators, along with friction, backlash, resonant modes, high impulse periodic disturbances, nonlinear compliance, sensor noise, and multi-target sensor input. Determine performance and robustness characteristics with respect to model errors associated with both continuous and logical components of the domain model. Provide analysis of hardware/software implementation requirements to achieve real time performance, including sensor/actuator trade-offs.

PHASE II: Develop a fully integrated design and prototyping environment for advanced nonlinear, adaptive and hybrid control systems. Provide a real time programmable digital control module with on-line data analysis capability and I/O capability and sensor/actuator component hardware necessary for laboratory test bed evaluation. Optimize module hardware/software and algorithm design based on test data and provide complete documentation of algorithms and hardware/software architecture.

POTENTIAL COMMERCIAL MARKET: This work has a very high probability of being commercialized. The methodology, design environment, prototyping tools and component technology developed in this SBIR are applicable to manufacturing, machine tool, process control, engine control, transmission control and automation applications, including automobile and commercial aircraft manufacturing, robotics applications, precision instrumentation systems, flight controls etc. These applications are characterized by the presence of non linearities, parameter variations, backlash, friction, saturation and resonant modes, while large scale automation requires consideration of hybrid discrete event and continuous time system dynamics. This technology also has broad DOD applications, particularly in the area of affordable controls; distributed, multi-platform fire control and targeting; intelligent,multi-agent, cooperative systems; defense manufacturing, etc. The impact of the technology is two-fold: increasing performance through improved control software while reducing cost by reducing hardware cost and complexity and improving reliability and fault tolerance.

A96-007TITLE:Intelligent Sensor Based Robotic Control System Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop a generic multi-adaptive robotic control module and development environment for mobile manipulator systems for ammunition handling, resupply and logistics applications. Module must address task level as well as servo level functionality and be architectured to accommodate variations in manipulator/ platform configurations and task requirements.

DESCRIPTION: Significant progress has been made recently in developing advanced sensor based servo control systems for high performance robotic manipulators. Specifically, a high speed 386 based multi-processor robotic control module and software development environment was developed which permits a broad range of adaptive and compliant motion control strategies to be implemented for arbitrary manipulator configurations. Extensions of this technology are required, however, to deal with fundamental problems of mobility and base motion effect, flexible task level control, multi-sensor integration, dual arm coordination associated with fusing ammunition in a moving resupply vehicle, and depalletizing and transferring ammunition to and from resupply vehicle and loading ammunition in a moving platform environment. Technical issues of interest include robust and adaptive controls, compliant motion control, visual servo control, voice natural language interface for control, dual arm control strategies, world modeling design environment, real time, knowledge based task level control and control from moving base including path planning, navigation and obstacle detection/ avoidance and component based software architectures.

PHASE I: Develop methodology and algorithmic approaches to intelligent sensor based robotic control systems for applications to materiel handling and loading. Perform preliminary modeling and simulation studies to determine performance/ robustness characteristics of the control laws and algorithms, real time processing requirements and sensor requirements. Provide analysis for evaluating control laws and provide control processor design and system hardware specifications.

PHASE II: Develop controller hardware/software and development environment for interface with laboratory test bed manipulator systems. Develop test scenarios and scaled down mock-ups to demonstrate controller performance capabilities. Provide fully integrated prototype module with documentation source code and development environment and evaluate in laboratory tests.

POTENTIAL COMMERCIAL MARKET: The technology developed under this program can be utilized on any production line performing product handling, part mating and product transferring applications. The technology is also applicable to automated warehousing, handling of hazardous materials, security, law enforcement and medical/ surgical applications. Particularly, for the Army, this technology can be used in programs like FARV-A and Crusader to perform ammunition fusing, depalletizing, handling and loading during re-supply operations.

A96-008TITLE:Development of New Catalysts for Synthesis of Energetic Materials

CATEGORY: Basic Research

OBJECTIVE: Design of novel catalysts to facilitate synthesis of energetic materials and commercially viable products.

DESCRIPTION: In the research and development stages of new explosives and propellants as well as in the production of these materials, enormous amounts of toxic and hazardous waste materials are being generated as by-products. Disposal of these toxic materials causes serious problems for the DOD operations. Novel catalysts can be used to remove these toxic waste by-products, as well as to increase the yield of the chemical reactions in the synthesis of explosive and propellant molecules. Catalysts, which are generally used in very small amounts, enhance chemical reactions but can be recovered from the reaction intact. Therefore, it is proposed that studies be conducted on the adsorption properties of individual contaminant species such as heavy metal cations and other toxic waste by-products on various catalytic surfaces. New molecular modeling techniques provide relevant information about how chemicals react at the molecular level and thus facilitate the application of new catalysts to fit specific chemical need. Therefore, it would be of considerable interest to design new catalysts and apply their catalytic potential to

remove metal cations and other hazardous by-products from toxic waste materials. This includes adsorption and ion exchange to catalyst such as clay and ion exchange resins.

PHASE I: Investigation of adsorption and ion exchange properties of catalysts using molecular modeling techniques. Based on these results, develop new catalysts and surfactants for removal of heavy metal cations and other hazardous by-products from toxic waste. Optimize the catalytic reactivity of these catalysts by conducting relevant experiments.

PHASE II: Upon successful completion of Phase I of this program, apply these new catalysts in reducing hazardous by-products from toxic waste. Develop a data base to determine which catalysts is most suitable to type of operations on interest to Army. Based on these data, develop methodology and algorithmic approaches to identify suitable catalysts. Optimize the catalytic reactivity of these catalysts by conducting relevant experiments

POTENTIAL COMMERCIAL MARKET: Novel and cost effective methods towards the elimination of heavy metal cations and other by-products from toxic waste materials generated in chemical industry. Another potential application is to use in chemical weapons disposal technology, where detoxification of chemical weapons can considerably reduce the environmental and safety concerns.

A96-009TITLE:Low Cost Radio Frequency Smart Tags & Applicator

CATEGORY: Exploratory Development

OBJECTIVE: Develop low cost Radio Frequency (RF) smart tags or labels which can be remotely programmed and remotely read-out that contains thousands of bytes of information and a machine to apply the tags to bags and crates of arbitrary shape and material covering.

DESCRIPTION: Smart tags are presently used for a number of applications in the civilian and military sectors, including item identification, toll passes, and barrier identification. Such tags are relatively expensive (several dollars) and are limited in the amount of information they can carry. The Army needs tags costing a few cents that can be affixed to individual items. The tag must recognize and respond to external RF interrogation signals. The external RF interrogator will be in the vicinity of one meter from the tag. The contents of the tag must be read out or written to through the RF link. Improved designs should include simple local interface for acquiring data from local sensors such as temperature and pressure. Along with the tag, the contractor should develop an applicator to apply the tag to packages, bags, boxes, and crates, of various thickness and stiffness while they are being conveyed by a conveyor at fairly rapid but consistent rate. The tag must be applied to the item as it is moving. The exact orientation and position of the item to be tagged can be arbitrary. The items conveyed past the applicator can be in any order, shape or size. The material covering the item can be cloth, metal, paper, or wood. The covering may be soft or firm. The applicator must keep up with conveyor speeds of two hundred feet per minute with items as close together as three feet.

PHASE I: Create and deliver designs for the low cost remotely accessible RF smart tags. Demonstrate that the designs will meet the requirements, preferably by building a simple prototype tag and data access device, or a laboratory demonstration. Prepare a preliminary design of the proposed tag applicator. Carry out a feasibility study by demonstrating experimentally that the applicator concept works. Obtain funding commitments for potential marketing and production.

PHASE II: Develop, construct, test and deliver one or more working prototype smart tag systems including tags and remote reading apparatus and tag applicator.

POTENTIAL COMMERCIAL MARKET: Due to their low cost applications include tagging individual items where the tag can be disposed of when the item is put into use. Potential military applications include tagging individual weapons, munitions or pieces of equipment, crates, and other inventory. Potential civilian uses include tagging luggage on aircraft, tagging parcels, packages, crates, and individual items, employee identification, vehicle identification.

A96-010TITLE:On Site Bioaccumulation of Heavy Metals

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate biological methods for the on-site treatment and/or removal of heavy metals from contaminated soils. The approach should have the ability to treat contaminated soils to reduce metal concentrations below regulatory standards within a time frame of 1 - 5 years of treatment. The method should be applicable to the treatment of a range of different heavy metals, site characteristics and geographical areas.

DESCRIPTION: Heavy metal contaminated soils in many areas, including military sites, represent substantial volumes of solid material. Conventional treatment methods either do not remove the metal from the site, or require soil excavation and treatment or disposal, with significant associated costs. Low cost, on-site methods are needed to treat metals in soils to reduce their concentration and environmental impact without extensive excavation and off-site disposal. Recent developments in the identification of biological processes that accumulate heavy metals may be applicable to the treatment of contaminated soils at the low costs associated with bioremediation methods for the removal of organic contaminants.

PHASE I: Identify methods for the uptake of heavy metals from soil by living organisms in amounts that could lead to the treatment of contaminated sites. Develop methods for evaluating treatment efficiency on actual contaminated soil.

PHASE II: Field test the biological approach at a DOD related site and identify an economical method for treating and disposing of the metal-containing biomass.

POTENTIAL COMMERCIAL MARKET: A large civilian and Federal Agency market exists for low-cost methods of treating heavy metal contaminated soils. Closed CONUS and OCONUS military sites, formerly used defense sites (FUDS), petrochemical facilities, smelter deposition areas and battery recycling sites are examples of potential heavy metal contaminated locations. This technology may also be expanded to the treatment of radionuclide contaminated soils at DOE facilities.

A96-011TITLE:Software Infrastructure/ Reuse Technology For Embedded Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop design, analysis and prototyping tools and technology to support specification, implementation and evaluation of standard software reference architectures and application components for embedded/smart weapon applications.

DESCRIPTION: Embedded software will be a key cost driver in next generation smart and brilliant weapon/ fire control systems due to increased computational and software complexity, stringent hard real time computational constraints, and the high cost associated with software testing, verification, validation, and software maintenance and support. A key enabling technology for managing and controlling software cost and complexity is the development of standardized reference or product line architectures and supporting infrastructure technology, tools and design methodology. Progress to date includes the development of an architecture schema and architecture description language which provides a formal mechanism for describing architecture components and interconnections, together with preliminary repository tools for storing, manipulating and visualizing schema data. Further extensions of this technology is required, however, to provide complete end-to-end software development support for embedded weapon applications. Specific requirements exist for (1) domain modeling and analysis tools and methodology which are tailored for extracting reference architecture requirements (2) architecture description languages that provide sufficient expressive power to represent component functionality, component interface connections, control and data communication paradigms, etc. and support detailed analysis of architecture behavior/performance (3) a repository tool with graphical user interface that supports storage, manipulation, browsing and retrieval of application architecture descriptions and components and the composing of new application systems from existing or reengineered components. (4) development of reference/ product line architecture specifications for embedded weapon/ fire control systems that facilitates reuse of components within the application domain (e.g. smart mines, smart mortars, intelligent artillery crew associates, armor, etc.) (5) development of generic architecture/application components that conform to reference architecture specifications to include real time data base management, real time, intelligent multi-processor/multi-tasking os, MMI, digital mapping, real time planning, resource management/allocation, hybrid systems control, etc. (6) application generators. (7) metrics for determining conformance of

application architectures to reference architecture specifications (8) high level technical architecture standards and guide lines that extend the Army C4I TA to embedded weapon applications.

PHASE I: Assess maturity and capability of existing tool environments to support an end-to-end architecture based software development process for embedded weapon applications. Develop preliminary requirements for an integrated tool environment that fully supports an architecture driven software development process. Identify high level technical architecture standards and guidelines for embedded weapon/ fire control applications.

PHASE II: Develop tools and supporting design methodology for executing, as a minimum, critical process threads associated with (a) reference architecture extraction from domain models, (b) representation, analysis and archiving of application architecture descriptions, (c) requirements tracking, (d) application generation based on composing reusable/reengineered components, from component repositories, with possibly new components produced via component generators. Demonstrate and validate technology by populating a baseline reuse component repository and composing a laboratory application prototype. Identify/assess existing ACOE and commercial components compatible with embedded weapon system requirements.

POTENTIAL COMMERCIAL MARKET: This topic will provide enabling technology that supports component based software development, reuse and interoperability of all large scale, distributed, real time software systems such as those associated with factory automation, command and control, health services, banking, environmental monitoring, communication networks, smart highway systems, air traffic control, law enforcement networks etc.

A96-012TITLE:Label Applicator for Arbitrary Surfaces

CATEGORY: Engineering Development

OBJECTIVE: Develop a machine to apply fairly stiff labels and tags to bags and crates of arbitrary shape and material covering.

DESCRIPTION: The Army needs a machine which can apply labels of various thickness and stiffness to packages, bags, boxes, crates, and containers being conveyed by a conveyor at fairly rapid but consistent rate. The label must be applied as the item is moving. The exact orientation and position of the item to be labeled can be arbitrary. The items conveyed past the labeler can be in any order, shape or size. The material covering can be cloth, metal, paper, or wood. The covering may be soft or firm. The machine must keep up with conveyor speeds of up to several hundred feet per minute with items as close together as three feet. The applicator must be able to handle and apply Radio Frequency (RF) smart tags without destroying them.

PHASE I: Prepare a preliminary design of the proposed system. Carry out a feasibility study by demonstrating experimentally that the concept works. Obtain funding commitments for potential marketing and production.

PHASE II: Develop, construct, test, demonstrate and deliver a full scale prototype complete system.

POTENTIAL COMMERCIAL MARKET: Potential military applications include tagging individual weapons, munitions or pieces of equipment, crates, vehicles and other inventory. These applications could be in support of stockpile surveillance or inventory control. Commercial and military market includes logistics, trucking, shipping, checked-in airline luggage, mail--any industry which stores, moves, and delivers an arbitrary mixture of sundry products.

A96-013TITLE:Development of New Alternate Synthetic Procedures for 1,3,3-Trinitroazetidine (TNAZ)

CATEGORY: Basic Research

OBJECTIVE: Research toward finding and developing a high yielding alternate synthetic procedure for TNAZ.

DESCRIPTION: TNAZ is a new steam-castable, superior performing explosive under development by the Army. Applications of TNAZ as a demolition and anti-armor explosive, and as a component in LOVA propellants, are being explored. It is markedly more powerful than LX-14, the Army's most powerful in-service explosive formulation. TNAZ is currently prepared by an inefficient and environmentally unfriendly five-step batch process, with an overall yield of about 15%; or by an alternate process, under development by Los Alamos National Laboratory, with higher yields, but producing large quantities of hazardous waste. In view of the desirable properties of TNAZ and its prospect to be fielded in the near future, there is an urgent need for its production in large amounts via a high- yield process. This is the focus of this topic.

PHASE I: Conduct basic research to: find a new high yielding and environmentally friendly procedure for synthesizing TNAZ; or, develop economically viable methodologies to recycle the N,N'-dialkylhydrazine and triphenylphosphine oxide produced in the Los Alamos process.

PHASE II: Scale up the new procedure to demonstrate low-cost 1 - 50 pound batch production of all intermediates and TNAZ. Provide process engineering drawings for a large scale plant. Develop optimized process conditions on pilot plant equipment.

POTENTIAL COMMERCIAL MARKET: TNAZ should find applications in propulsion of non- military items, e.g. commercial rockets. It is expected to be a superior commercial demolition explosive. DNAZ nitrate, a chemical precursor to TNAZ, is water soluble and should find applications as a commercial blasting agent superior to currently used Ammonium Nitrate/Fuel Oil in performance.

A96-014TITLE:Cage Molecular Derivatives in Explosive Research for More Powerful Explosives and Civilian Optical Materials

CATEGORY: Basic Research

OBJECTIVE: Prepare more powerful explosives and other potential compounds from cage derivatives for use as liquid crystals or non-linear optical materials.

DESCRIPTION: Cubyl and Adamantyl carbonyl chlorides are near precursors for more powerful explosives. One aspect of this effort would be to prepare more powerful and insensitive explosives based on such cage forms. Octanitrocubane, for example, is a super explosive that is anticipated to provide about 30% more explosive power than LX-14, the military's most powerful current explosive formulation. Chlorocarbonyl derivatives of cubanes and adamantanes have their functionalities in a spherical symmetry and they can be derivatized as star polymers. Star polymers have generally higher thermal stability, higher glass transition temperature and higher solubility than linear (two arms) polymers. They have ability to provide long electric dipoles. These systems are potentially used as liquid crystals and non-linear optical materials. The second aspect, thus, of this effort would be to develop such critically useful civilian materials from the cage derivatives.

PHASE I: Conduct a detailed literature search and computer modeling studies to select model polymeric cage systems that are useful as liquid crystals and non- linear optical materials. Perform synthetic research that would be feasible for obtaining such polymer structures.

PHASE II: Complete the synthesis of the above compounds and conduct an in-depth study of their material properties (e. g. Non-linear optical and liquid crystal). Down select suitable compounds for Phase III work.

POTENTIAL COMMERCIAL MARKET: Non-linear optical materials are very useful in frequency manipulation (e. g. frequency blending, frequency doubling and quadrupling) of laser beams and they are critically useful for military and civilian communication systems. Liquid crystal materials are essential ingredients in military and civilian display devices such as night vision binoculars, intelligent storage etc. The market is very significant in military industry. The market in civilian industry is very large and they would be picked up by the major participants (e. g. AT&T, Sprint, MCI etc.) in communication industry.

A96-015TITLE:Fuzing Sensors and Signal Processors

CATEGORY: Exploratory Development

OBJECTIVE: Develop sensors and signal processing technology and components necessary for next generation fuzing systems and subsystems. Appropriate technology candidates must enhance safety, reliability and producibility in order to be considered for fuzing systems.

DESCRIPTION: Typical fuzes consist of sensor, signal processor, power supply, and safety and arming subsystems. A fuze must not only endure decades of storage in adverse conditions, but must also withstand extreme ballistic launch environments and still function a munition safely and reliably on the intended target. Not only is fuze performance critical to the mission, but cost is also extremely important because fuzes may be produced in large quantities for the military stockpile. Fuze sensors are required that can reliably discriminate targets from the background clutter at selected ranges from impact to 2 km. Sensors of interest include radar (microwave through millimeter wave), active and passive optical, electrostatic (ESS), magnetic, inductive and acoustic types. Components of particular interest include: broadband antennas, antenna arrays, precision time bases and optical assemblies. Small size, gun or missile launch survivability and low cost are principal driving requirements. Sensors must also be able to withstand the appropriate electromagnetic effects environments without causing a safety or reliability failure. Signal processors are required to enhance the ability of sensors to reject false targets, control the burst point, and sense a proper target even when subjected to strong countermeasures. Signal processors may use analog circuits, digital circuits, microprocessors or a combination of these to determine that the desired burst point has been reached. Signal processing may fuse the data from two independent sensors to enhance the probability of detecting a proper target. Miniature signal processors comprised of integrated circuits, or multi-chip modules that are small enough to fit into standard fuze contours for artillery, mortars and medium caliber cannon cartridges are of particular interest.

PHASE I: Identify promising fuzing technologies. Perform a cost and producibility analysis, up front, to predict if it is feasible to fully develop and produce the technologies. Conduct modeling and simulation to predict the performance of selected candidates under realistic conditions. Fabricate breadboards and perform laboratory tests on them to confirm the predictions of the models. Submit samples to the Government for in-house evaluation.

PHASE II: Implement technology from Phase I effort into actual fuze hardware. The fuze hardware will be evaluated by subjecting it to standard fuze laboratory environmental and ballistic simulation tests. If lab tests are successful, another set of fuze samples will be fired from a weapon in an instrumented ballistic field test. The prototype designs shall be optimized for producibility and cost. Detailed design drawings and specifications shall be developed.

POTENTIAL COMMERCIAL MARKET: Fuzing sensors are inherently low-cost and precise standoff sensors that can provide position, velocity and acceleration outputs. These have a wide variety of commercial applications including: accurate altimeters for the last 100 meters of approach to the ground for helicopters and light planes; crash avoidance and backup sensors for automobiles and minivans; measurement of true velocity and distance traveled for accurate application of agricultural chemicals and seed; motion detectors for alarm systems; and position/motion sensors for robotic and automated industrial systems.

A96-016TITLE:Rapid Container Blocking and Bracing Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop a technology that will enable the Military to block and brace munitions and supplies in containers and MILVANs rapidly to meet early entry force deployment and force sustainment requirements.

DESCRIPTION: The existing method of Blocking and Bracing munitions and supplies in containers and MILVANs requires lots of wood and is labor intensive. Many military installations do not have the personnel to block and brace munitions and supplies in containers or MILVANs because of the special skills requirement. The wood used to block and brace munitions and supplies in containers and MILVANs usually cannot be reused because of damages or configuration problem. Sometimes the required wood may not be available. The existing method creates a dilemma during deployment or retrograde of munitions and supplies. A technology is needed to improve the blocking and bracing method. The technology shall be capable of restraining supplies with various configurations at rapid speed, durable, user friendly, reusable and environmental friendly; meet transportation requirements; and at a cost comparable to the existing method.

PHASE I: Investigate new and innovative blocking and bracing materials and systems used by the shipping industry. Based on the investigation, develop a system design that can be used to block and brace military munitions and supplies. The system shall meet the design criteria specified in the DESCRIPTION paragraph above.

PHASE II: Develop and fabricate prototype test hardware for the Rapid Container Blocking and Bracing system. Coordinate with the Government Project Officer to develop a test plan, and conduct testing to verify the system. Develop a performance specification, operation instruction and unit cost. Submit monthly and a final report.

POTENTIAL COMMERCIAL MARKET: The technology developed under this program can be used by the container shipping companies. The system will enable the shipper to block and brace cargoes at reduced time and cost.

## U.S. Army Research Laboratory

A96-017TITLE:Low-Frequency, Ultra-Wideband (UWB) Synthetic Aperture Radar (SAR) Antennas Compatible with Unmanned Aerial Vehicles (UAV)

CATEGORY: Basic Research

OBJECTIVE: Design and development of low-frequency, ultra-wideband antennas of a size commensurate with the size and weight restrictions of an unmanned aerial vehicle.

DESCRIPTION: Detection of concealed, time critical targets is a military need for which there is no current fielded solution. The Army Research Laboratory Microwave Radar Branch is investigating low frequency UWB SAR for the detection of targets concealed underground or by foliage. One of the major hardware limitations of ground and foliage penetration technology today is the size of the antennas required to get the low frequency content and wide bandwidth necessary. The radar design currently being pursued requires antennas with a frequency coverage from 50 MHz to 1000 MHz. The antennas must have a peak VSWR of less than 2.0. with a goal of 1.5 or less, over the entire frequency band. The antennas must have a polarization isolation between co-polarized and cross- polarized channels of at least 20dB within a 35 degree solid angle centered on boresight, and no worse than 15 dB of isolation over a solid angle from 35 to 60 degrees centered on boresight. The radar must be capable of transmitting and receiving the full polarization scattering matrix. The antennas must be capable of transmitting peak powers on the order of 10MW and average powers of 5-10 Watts. The antennas must be designed to be compatible with the size and weight restrictions of a TIER II UAV.

PHASE I: The offeror shall perform study of low-frequency, wideband antenna designs to identify potential solutions. The offeror shall produce a design drawing and specifications for an antenna that meets the requirements stated above. The offeror shall prepare a report including calculations and/or modeling used to develop the design of an antenna meeting the above requirements.

PHASE II: The offeror shall finalize an antenna design, construct a full set of antennas (covering the full scattering matrix), and completely characterize the antennas.

POTENTIAL COMMERCIAL MARKET: There are a large number of commercial applications for low-frequency, UWB radar. Utility companies are interested in methods to non-intrusively locate wires and pipes underground. Construction companies need non-intrusive methods of inspecting roads, bridges, and railroad beds for internal faults. Site remediation firms, performing base closure impact area clean-up for instance, require a ground as well as foliage penetration capability.

A96-018TITLE:Millimeter Wave Solid State Power Device/ Component Development

CATEGORY: Advanced Development

OBJECTIVE: To study, develop, and demonstrate technology and approaches to power generation at Millimeter Wave frequencies (>30GHz) to replace large, high voltage, and less reliable vacuum tube amplifiers.

DESCRIPTION: New military and commercial requirements are emerging for high power transmitters in the millimeter wave band. Several examples include tactical radars, radar electronic countermeasures (ECM), satellite communications, collision avoidance radars, and high data rate communications. Advances in solid-state device technology in the form of High Electron Mobility Transmitters (HEMTs), Heterojunction Bipolar Transistors (HBTs), and Microwave Millimeter wave Integrated Circuits (MMICs) have moved the concept of a reliable, high power, solid-state millimeter wave transmitter closer to reality. The current challenge is combining large quantities of these devices efficiently and reliability to achieve tens of watts of output power. The objective of this project is to develop and demonstrate a practical approach to realize a high power solid state millimeter wave transmitter/amplifier by combining a large number of moderate to high power devices.

PHASE I: Study and develop a millimeter wave power source/amplifier design that addresses reliability, cost, size, and performance using state-of-the-art components and analyze for optimum power combining technique, low-loss, heat dissipation, etc., to achieve the program goals. Suggested performance goals of the Phase I effort are minimum 20 watts CW at Ka-band, 10 watts at V-band, and 5 watts at W-band and the final transmitter/amplifier design suitable for flight testing as part of an electronic warfare/electronic countermeasure (EW/ECM) system. The effort will consist of the transmitter/amplifier design, and will include device selection, power combiner design, combiner interfaces (waveguide, microstrip, probe, microcoax), and prediction of performance such as insertion loss and gain, VSWR, and performance degradation due to phase/amplitude tracking and device failure.

PHASE II: Fabricate, test and deliver the transmitter/amplifier designed in Phase I. A final documents package should be delivered that includes final schematics and drawings, a test plan for the transmitter, test results of the individual modules and combiner/power splitter, and test results of the fully integrated and tested unit. A simple reliability analysis should be performed to provide an approximate prediction of Mean Time to Failure (MTTF), Mean Time Between Failure (MTBF), etc. of the final transmitter. Also a thermal analysis should be performed to ensure adequate heat dissipation and structural integrity of the module. All DC biasing capabilities, voltage sources and turn-on sequencing, will be included in the final module delivery.

POTENTIAL COMMERCIAL MARKET: This technology can be applied to military and commercial communication systems, satellite links and to the emerging commercial cellular video and automotive collision avoidance markets. The high frequency enables wider operational bandwidths thus permitting more data/information to be processed. This is important for high data rates and video information especially since the lower frequency bands are highly congested and limit the frequency band of operation.

A96-019TITLE:High Performance Imagers with On-chip Processing

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate feasibility of performing on-chip signal processing functions on high performance silicon-based imagers using CCD or CMOS technology as appropriate.

DESCRIPTION: Performance of high speed, large format imagers can be significantly enhanced by providing image processing functions on chip. In particular it may be possible to reduce data rates, identify regions of interest, selectively readout the imager for higher speed operation, and perform linear and nonlinear signal processing functions. This research topic concentrates on the incorporation of signal processing functions onto the readout structure of existing or future imagers.

PHASE I: Perform feasibility study to identify proper mix of signal processing to be incorporated on chip and identify chip architecture. Demonstrate on a small scale the manufacturability and operation of such a chip.

PHASE II: Design large scale chip 512 x 512, 1024 x 1024, or larger incorporating signal/ image processing functions of chip and produce a selection of these devices.

POTENTIAL COMMERCIAL MARKET: High performance imagers with on chip processing will have applications in fields including HDTV, Medical Imaging, Film replacement in high speed motion analysis equipment, machine vision, etc.

A96-020TITLE:Multi-functional Thin Film Biomatrices for Biosensors

CATEGORY: Exploratory Development

OBJECTIVE: To research and develop surface matrices as media for biological/ biochemical reactions in micro-sensor applications.

DESCRIPTION: There is a need for the development of biomatrices for use to interface biological/ biochemical reactions with appropriate sensor substrates. The requirements of a matrix are that it should retain high specificity for the intended biomolecular interactions and simultaneously allow signal transduction via the interfacial surface to the sensing mechanism. The matrix should be stable, portable and robust. Conferring functionality to the substrate device may involve covalent bond formation or non-covalent interactions.

PHASE I: Show proof of principle by providing a model surface matrix system. The offeror should show matrix properties, their characterization, and the retention of the desired biological/ biochemical specificity.

PHASE II: Adaptation of the surface matrix system development under Phase I to existing appropriate micro-sensor surfaces. Expansion of the detector system for two or more biological/ biochemical reactions or interactions. Optimize the prototype surface system to give high degree of precision, reliability and ruggedness.

POTENTIAL COMMERCIAL MARKET: The technology developed under this program should have extensive application in the environmental and medical diagnostic industries.

A96-021TITLE:Digital Optic Image Acquisition with Enhanced Performance

CATEGORY: Advanced Development

OBJECTIVE: Develop digital signal processing and hardware designed to work in conjunction with custom aspheric optics in order to improve visible and infrared image acquisition systems.

DESCRIPTION: Image acquisition systems can be enhanced by combining custom optics in conjunction with digital signal processing (DSP) to improve overall system behavior. As an example, the field of view of an optical system can be extended by using a wide angle lens in conjunction with DSP to correct for the added distortion. Without the post digital correction, objects in the periphery of the field of a very wide angle lens are distorted beyond recognition. The DSP compensates for the distortion to make the object recognizable. As a second example, a cubic phase optical element can extend the depth of field of a system when used in conjunction with specialized DSP. Without the digital correction the imagery produced by the cubic system has a large depth of field, but fine featured objects are difficult to discern. The DSP is designed to compensate for the negative effects on the system behavior while maintaining the high depth of field. In both of the above examples, the enhanced performance cannot be easily achieved with only improved optics or only DSP. Rather, the use of the optics in conjunction with DSP enables a new level of performance.

This research topic concentrates on the development of DSP algorithms tailored to work in conjunction with custom aspheric elements to extend the operating characteristics of image acquisition systems. The algorithms should be adaptive in nature to take into account the characteristics of available image sensors. Improved algorithms for the above mentioned extended depth of field and extended field of view systems are of special interest. Entirely new imaging architectures using custom aspherics in conjunction with DSP will also be considered.

PHASE I: Specify the digital optical architecture and the nature of the expected imaging system enhancement (e.g., increase depth of field, extended field of view, increased tolerance to vibration,...). Develop optimized signal processing algorithms that take into account the need for real time implementation as well as the characteristics of available image sensors.

PHASE II: Design and build real-time hardware implementations of the algorithms developed in Phase I. Integrate the hardware with the associated optical imaging system and demonstrate overall system performance.

POTENTIAL COMMERCIAL MARKET: Enhanced digital image acquisition systems have the potential to play significant roles in consumer digital cameras (both still and video), machine vision, and medical imaging applications.

A96-022TITLE:Loom for Weaving Single Layer Net-Shape Fabrics for Composite Structures

CATEGORY: Exploratory Development

OBJECTIVE: The primary objective of this effort is to develop a fully automated computerized loom capable of weaving net shape single layer fabrics that have tailored fill yarn fiber orientations as well as in plane and out-of-plane curvature.

DESCRIPTION: Current production costs of continuous fiber reinforced composite structures are in excess of $100 per pound. However, technology has been developed within the Government that will greatly reduce these costs. Through the use of canted

and adjustable reeds it is possible to tailor fiber orientation of the fill yarn in a fabric. Fabric width can be controlled by changing the location of the warp yarns. Curvature in the fabric is achieved by differential takeup of the warp yarns. It is the objective of this effort to incorporate these technologies into a fully automated computerized loom. This loom will be suitable for producing high quality fabric for creating preforms used in the formation of composite structures. It is anticipated that the loom will operate at several hundred fill insertions per minute requiring minimal operator interaction while weaving.

PHASE I: A computerized loom shall be modified to incorporate differential fabric to demonstrate independent takeup control of each warp yarn. The loom shall be delivered to the Government for evaluation.

PHASE II: Modification to the loom shall be made to accommodate tailored fill yarn orientation and tailored fabric width in conjunction with the differential fabric developed in Phase I. This loom shall incorporate state of the art fill insertion techniques to achieve the high speed operation. The loom shall be delivered to the Government for evaluation.

POTENTIAL COMMERCIAL MARKET: This loom has vast potential applications to military and civilian structural applications. As the cost of fabricating composite structures decreases the potential market for this technology will increase.

A96-023TITLE:Artificial Intelligence Enhanced Information Processing

CATEGORY: Basic Research

OBJECTIVE: This topic solicits research in advanced information processing algorithms as well as hardware architectures focussed on situation awareness and assessment which will support critical Army program areas such as fusion stations, ground stations, C4I workstations and advanced robotic platforms.

DESCRIPTION: The Army has a strong continuing interest in real-time information processing research for inclusion as a next generation C4I workstation. Information processing includes those operations normally performed after signal processing, thus relating to higher levels of abstraction than those addressed by signal processing. Because there will be a plethora of information available to these processing stations, the development of effective algorithms, autonomously fusing this information and supporting situation awareness and assessment software agents which alert human operators and other software agents, is a necessity. Applicable research should relate to high-speed information processing (particularly with AI based enhancement). This topic includes advanced processing architectures (scalable) as well as advanced algorithms.

PHASE I: Innovative algorithms and advanced processing architectures are sought, that improve situation awareness and assessment.

PHASE II: Research resulting in real-time implementation of Phase I algorithms and processing architectures which will show direct relevance to an objective interest area such as fusion stations, ground stations or battlecommand workstations.

POTENTIAL COMMERCIAL MARKET: The technologies related to this topic, Artificial Intelligence Enhanced Information Processing, correspond strongly with a number of commercial or dual-use applications such as aircraft tracking and control for commercial airfields and intelligent highway system applications.

A96-024TITLE:Parallelizing Visualization Algorithms for Interactive Computational Analysis

CATEGORY: Exploratory Development

OBJECTIVE: To develop an integrated package of software tools using parallel computing techniques capable of interactively visualizing very large datasets using state-of-the-art Department of the Defense High Performance Computing (HPC) assets.

DESCRIPTION: An on-going problem for the scientists and engineers is the ability to interactively investigate and visualize the data produced from calculations run on high-end parallel supercomputers. Commercial software vendors have not yet taken the lead in developing advanced techniques to replace traditional, sequential visualization software.

The advent of reasonably affordable parallel computers configured as symmetric multiprocessors will, in the near future, enable advanced government and commercial research groups to perform computational analysis on grids consisting of several million nodes. Unfortunately, the ability to generate these massive datasets has outstripped the ability to visualize them. Many of the algorithms underlying popular visualization techniques are as computationally complex (in both memory and CPU) as the initial analysis. Although batch methods can be used to generate images from very large datasets, productive visualization is inherently an interactive process.

The most attractive option to break the visualization bottleneck is to employ the same techniques used to generate the data: parallelization. Although some efforts have been made to implement parallel algorithms for various visualization tasks, these efforts have been narrowly focused and restricted in application. There currently exists no commercial, general-purpose visualization package that can be used to productively postprocess these extremely large datasets.

The areas of innovative technical development proposed under this project would include: 1) the development, implementation, and evaluation of parallel algorithms (using both task and domain decompositions) for performing various visualization tasks such as particle tracing, isosurface generation, and clipping and cutting calculations. 2) the evaluation of state-of-the-art parallelization strategies such as, but not limited to, shared memory, PVM, and MPI, as a mechanism for applying parallel computing techniques as a postprocessing solution for datasets that are too large to be handled on a single machine. 3) taking advantage of the resulting performance improvements to yield real-time, interactive response for certain operations, such as particle tracing and streamlines, cutting planes, and isosurface calculation.

The main deliverable from this project is robust interactive scientific visualization software which contains parallel algorithms for various tasks which is supported, general-purpose, and portable to a variety of commercially available parallel platforms. In order to promote widespread adoption and usage, this solution would be presented as an integrated, interactive and portable commercially viable product.

PHASE I: Initial development should focus on the evaluation and implementation of a variety of HPG techniques for parallelizing existing visualization algorithms, such as particle traces, streamlines, cutting planes and isosurface generation. These techniques would be evaluated against particularly large, multi-grid datasets.

PHASE II: The second phase of work would incorporate these techniques into a single, integrated, interactive visualization package. The implementation would include a single, cohesive user interface typically associated with graphics applications run on a high-end graphics workstation. The expected interaction between the end-user and the application would typically include, but not be limited to, an implementation of a client-server architecture to connect the end user's workstation to the parallel computing platform where the visualization software is running.

POTENTIAL COMMERCIAL MARKET: Significant. The dual-use impact for government and industry of such parallel visualization software support by a commercial vendor would be significant and immediate. The development of such software would have a wide and immediate impact in the U.S. research and development community since this technology is applicable throughout the entire domain of computational analysis, including computational fluid dynamics, computational structural mechanics, combustion modeling, and electromagnetics. The advent of a portable, parallel commercial visualization package with the ability to handle very large datasets should significantly increase the productivity of advanced users.

A96-025TITLE:Information Assimilation Error Measurement for Digital Displays

CATEGORY: Basic Research

OBJECTIVE: The objective of this effort is to develop and validate a quantitative method for identifying, defining, and classifying recurrent patterns of soldier operator error associated with the assimilation of text and graphics information from visual displays (e.g.,flat panel CRTs, head mounted displays).

DESCRIPTION: A critical process in the soldier-information system interface on the digital battlefield is the soldier's assimilation of critical text and graphics data from the proliferation of digital displays that are being incorporated into future weapons systems and C2 systems. For this process to be conducted successfully, the soldier must be able to rapidly and accurately focus on critical elements of information embedded in a vast stream of digital data expected to flow across the digital battlefield. Often, this process will be conducted within a highly stressful environment involving varying lighting conditions, high noise, vehicle motion, and display vibration. Combining high information volume with a stressful interface environment is expected to produce various error chains that can manifest themselves as poor situation awareness, misinterpretation of events and operational trends, decision delays, and fratricide. While such issues can be addressed in the design of tactical displays, engineers generally lack a detailed understanding of these recurrent error chains and their relationship with specific display characteristics. The proposed effort takes an initial step in furthering this understanding by developing a quantitative method for: 1) systematically observing the soldier's process of rapidly assimilating text and graphics information under stressful conditions, 2) developing a taxonomy of the recurrent error patterns associated with this process, and 3) quantifying the relationships that exist among these error patterns and specific characteristics of the visual displays.

PHASE I: An initial effort consists of a series of systematic observations of the soldier-information system interface conducted within one or more Advanced Warfighting Experiments (e.g., Warrior Focus, Focus Dispatch). As part of these observations, the research will employ the critical event method to document significant error chains associated with the soldier's ability to rapidly and accurately assimilate critical items of information form various digital display devices being used in the experiments. By identifying common elements of the error chains across different display systems and tactical environments, the research will develop the major product of Phase I: a preliminary taxonomy of error patterns associated with digital information assimilation in a stressful environment.

PHASE II: Using the error taxonomy developed in Phase I, the research will develop and validate a quantitative method for assessing assimilation error rates in future experiments. The research shall consider a variety of standardized measurements methods, including, but not limited to, behavioral checklists, behavioral observation scales, and subject matter expert rating scales. The candidate measurement method will be validated in the context of a second series of Advanced Warfighting Experiments by collecting the appropriate error ratings and testing the statistical significance of their relationship with other measures of soldier-system effectiveness.

POTENTIAL COMMERCIAL MARKET: The quantitative method for assessing digital information assimilation error rates has broad applicability to the commercial computer market. As computer hardware-software applications extend to a broader range of work situations involving stressful environments, such methods will be essential for the proper design and testing of tactical information displays. By developing a standardized error taxonomy and associated rating scales, the research contributes to the development of industry design standards for text and graphic displays.

A96-026TITLE:Virtual Reality Battle Management Tool for C3 Nets

CATEGORY: Exploratory Development

OBJECTIVE: Adapt a technique developed by British Telecom (BT) to render a C3 network and its status in virtual reality superimposed on a terrain map. This technique would be invaluable in designing and optimizing the complex data network needed for "digitization" and for real-time battle management of an interactive combat network extending over any number of echelons and types of nets.

DESCRIPTION: Terrain is represented either in platform (2 dimensional) or in 3 dimensions with variable viewpoint (stealth platform) for perspective from a given point in space. The terrain can be represented with conventional, fixed detail or by the variable resolution methodology developed by WTD. The nodes are represented by icons superimposed on the terrain. The icons can be of different colors and shapes to represent different types of node equipment. The links can be represented as colored bands of different thickness depending on type of link and traffic capacity and actual traffic. Status of nodes and links in terms of message delay, message throughput, and message loss can be represented by some visual representation such as bar

graphs of different color and height. Per cent capacity can be represented in proportion of bar graph that is black or some neutral color.

Data links and voice nets can be adapted to this idea. The technique is not limited to number or types of units, given the operators ability to concentrate on any combination of nets, and the ability to tailor data displayed during use. The operator or analyst can then use a flat display or virtual reality goggles to "fly" about the net, examining its status in real time. Such a scheme would allow analysis of digital or analog message or data flow in a tactical net, with traffic perhaps represented by thickness or intensity of the line connecting nodes, message delay by vertical column, net function by color (fire control being red, infantry tactical by blue, logistical by purple, etc.). The analyst in peacetime could assess quickly the performance of a tactical array as a simulated battle progressed, or a battle command manager could, given status reporting by the net elements, actually manage communications in the presence of battle damage, real terrain effects, or ECM, and manage the net to minimize enemy effects and optimize the net performance. For instance, dead ground could be visualize to use terrain masking or antenna sitting to minimize enemy intercept. In a digitized net operating under internet protocol and structure the status of the net would be apparent to battle manager in real-time, allowing work arounds to compensate for battle damage, jamming or virus attack.

PHASE I: Analysis the net types and net status information available to 1) a simulation manager and 2) a battle manager of a digitized force.

PHASE II: Based on any of the terrain visualization methodologies now in use, construct a modular software package to allow superposition of net information.

POTENTIAL COMMERCIAL MARKET: Develop a marketable tool for network management. Care must be taken to either adapt under license the BT package or avoid infringing upon patented or proprietary methods used by BT

A96-027TITLE:Induction Bonding of Composite Armor

CATEGORY: Advanced Development

OBJECTIVE: Development and demonstration of a procedure for bonding of thermosetting polymer composite armor structural parts using diffusion enhanced adhesion and induction heating technologies.

DESCRIPTION: Diffusion enhanced adhesion (DEA) is a process which enables thermoplastic (TP) like fusion bonding of thermosetting composites. In this process, a thermoplastic layer with similar solubility to the TS is co-molded to a thermoset (TS) based composite adhered using a processing technique in which the TP polymer molecules move across the TP-TS interface and entangle with the TS polymer chains prior to complete crosslinking. Upon full crosslinking of the TS polymer, a very strong interface has developed between the TS based composite adherend and the thin TP polymer surface layer. Using this procedure, TS based composites can be fusion bonded using a variety of methods including resistance welding and induction bonding. Induction heated bonding of composites consists of the heating of an interlayer susceptor (such as metallic screen) and the subsequent melting, flow, consolidation under pressure, and bonding of two TP based adherends. The DEA process makes this adhesion technique available to thermosetting polymer based composites since the TS based composite has TP polymer layers on the surfaces to be bonded.

PHASE I: Demonstrate diffusion enhanced adhesion (DEA) and induction heating as a process for joining thermoset based armor composites. Characterize bonding strength and assess cost-related issues relative to other TS composite joining techniques.

PHASE II: Utilize DEA and induction heating in a process to fabricate a TS based composite structure. Demonstrate adaptability to a variety of TS based composite armor structure bonding requirements including thick section, production, and repair. Assess a variety of TS-TP DEA compatible resin systems.

A96-028TITLE:Intelligent Wire Bond Pull Station for Microelectronics

CATEGORY: Advanced Development

OBJECTIVE: This project develops a new generation of bond pull station by combining state-of-the-art optics, machine vision, strain gauge, high speed transport systems and bond pull technologies. This system will have the intelligence and imbedded knowledge of a skilled human operator which will : 1) Automatically search and identify bond wires in microelectronics assemblies with high speed, precision and reliability with no up front set-up efforts to the station; 2) Require no per-programming and verifying of unique part characteristics before each bond pull sequence; 3) Determine and optimize precise location of bond pull site for each wire with no human intervention; and 4) Perform bond pull automatically and document results for Statistical Process Control. The results of this effort will be beneficial to both the military and commercial microelectronics manufacturing arena.

DESCRIPTION: Bond pull testing is a necessary methodology for testing the integrity of wire bonds for microelectronics assemblies. The use of this methodology on military hardware has increased dramatically in resent years and has created concerns with the added labor, throughput delays and precise execution of this process. Most of the bond pull equipment are manual which requires the operator to position the bond hook under each wire prior to the pull test. The semi-semi-automated system requires pre-programming and dry running of the pull sequence prior to pull testing each assembly. This pre-programming and dry running effort is due to the unpredictable tracking characteristics of the bond wires when they were assembled. A new generation bond pull tester which will respond to the unique characteristics of a microelectronics assembly in real time will be developed under this project. Innovative techniques using a combination of the latest sensor based manufacturing technologies and intelligence is expected to be used.

PHASE I: A study and an innovative concept to investigate the feasibility for a totally hands off intelligent bond pull station. This concept must be technologically feasible and meet the objective of reducing hardware system costs, material handling cost, set-up cost, programming time and manufacture throughput time.

PHASE II: Prototype of the intelligent bond pull station outlined in Phase I will be designed and built using the most advanced technologies available. Deliverable would include a complete design analysis, a design documentation package, and a prototype station suitable for test and evaluation, using microelectronics assemblies supplied by the Army. The contractor shall participate in the evaluation test to guarantee the system is working at full capability and provide timely modification as needed to optimize system performance.

POTENTIAL COMMERCIAL MARKET: Low cost production units are planned to replace the manual and semi-automatic systems being used in industry today.

A96-029TITLE:Machine Translation of Battlefield Messages

CATEGORY: Exploratory Development

OBJECTIVE: Identify approaches to machine translation that adequately address the domain of Army Command and Control systems and that can be easily be extended to the variety of languages encountered in coalition operations. Select typical restricted-domain battlefield messages (e.g., operations orders with some structure imposed on the information). Build a parser and machine translation system to accommodate those messages.

DESCRIPTION: The Information Science and Technology Directorate is leading the Army Research Laboratory's (ARL) Digitization and Communications Science trust. One aspect of the digitization effort is the development of methods for providing data for warfare (and operations other than war) to the soldier in a manner that can be readily assimilated and used. On today's battlefield of multi-lingual coalition forces, rapid translation of information from one human language to another is a requirement for total situation awareness. However, current machine translators lack the sophistication and speed required to guarantee understandable information is provided in a timely manner to intended recipients.

PHASE I: A six month effort might produce deliverables similar to the following: analysis of approaches to major technical challenges (e.g., understanding semantics and pragmatics of natural language): identification of restricted language

required for battlefield communication of messages in the Command and Control infrastructure; initial development of lexicons and rules to support robust coalition translation techniques; concept demonstration of an automated translator from English to a selected second language.

PHASE II: A two-year effort might address aspects similar to the following: a prototype English to second language translator; coordination with an ARL testbed to further explore machine translation concepts on restricted domains associated with actual Army systems; development of approaches to evaluation of machine translation systems (e.g., with regard to utility and quality; development of approaches to automated extraction of information from variable format text and discourse summarization; interface with collaborative research involving unification of standardization efforts involving command and control message elements; initial interface to applications (e.g., selected ATD products).

POTENTIAL COMMERCIAL MARKET: This work has enormous potential for improving military C3 and analogous civilian systems. Careful tuning of software to specific missions could improve the quality and timeliness of current machine translation programs. Because language is best evaluated by native speakers, machine translation provides an ideal quid-pro-quo opportunity for research with our allies. Beneficiaries could include any industry requiring international communications and databasing.

A96-030TITLE:Information Processing Applications for Cooperating Microrobotics Systems

CATEGORY: Exploratory Development

OBJECTIVE: This topic solicits exploratory development in hardware and software architectures which will support critical Army application areas for cooperating microrobotic systems in tactical and operations other than war scenarios. Microrobotics in this application is defined as autonomous or semi-autonomous physical agents with linear dimensions of one or two feet.

DESCRIPTION: The Army has a strong continuing interest in real-time hardware and software architecture development for application to microrobotic Army systems having reconnaissance, surveillance, and target acquisition (RSTA) as their primary mission. Sensors, (acoustic, IR and visible) processing and communications will be embedded on these platforms. Applications to cooperating physical and software agents involving both stationary and moving platforms are the main focus of this topic. Examples of information processing in this area are multi-perspective data fusion, target tracking, and situation awareness. Applicable topics should relate to high-speed information processing. This topic includes advanced processing architectures (scalable) as well as advanced algorithms.

PHASE I: Exploratory development of information processing techniques as applied to the RSTA mission for multi-agent cooperating platforms. Developed algorithms are then validated by simulation to be real-time on an advanced processing architecture.

PHASE II: Extension of Phase I processing techniques and computation architectures to multiple (at least two) platforms. Quantitative evaluations must show gains in target acquisition, tracking, and analysis through the use of cooperating agents.

POTENTIAL COMMERCIAL MARKET: The techniques related to this topic correspond strongly with a number of commercial or dual-use applications such as aircraft tracking, vehicle control in the intelligent highway program, and physical security systems.

A96-031TITLE:Integrated Soldier Interface for Hands-off Control of Head Mounted Display Information

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a head mounted display (HMD) system which can be controlled "hands-off". Information would be called-up and displays changed using verbal commands, and editing or menu control accomplished by eye

tracker input. An entire military scenario could be accomplished, using the HMD as the primary soldier interface device, without manual inputs of any type.

DESCRIPTION: Helmet or head-mounted display systems, already common in aviation settings, are now proposed for mounted and dismounted soldiers, for tele-operation of unmanned vehicles, and for tele-maintenance and tele-medicine applications. To realize the maximum potential of these highly portable devices, the users must be provided with a means of interacting with the displays without using their hands. A dismounted soldier using an HMD needs his hands for his weapon; a tank commander or scout using an HMD will need to change the information displayed as the mission evolves without the diversion of entering manual commands at a control console. Voice control offers a natural way to request information to be displayed and some systems under development use this approach. There are many situations, however, where voice control will not be effective. Other technologies such as eye tracking should be applied to permit these display systems to reach their full potential.

PHASE I: A integrated voice control and eye tracking system would be used to control information presented on a head mounted display, but processed by a standard desktop computer. At this point, head weight, equipment volume, and center of gravity would not be important considerations compared to the overall hands-free function of the system.

PHASE II: At the end of the second Phase, a totally portable HMD system would be demonstrated which would feature hands-off control of the information presented, even in high noise, high motion environments. The head mounted portion of the system would be light weight, compact, and fall within acceptable center of gravity limits.

POTENTIAL COMMERCIAL MARKET: The same reasons which make HMD's so attractive for military applications will propel them into wide use in the commercial sector. Likewise, these commercial systems will be most useful if the operator can control the information displayed while keeping the hands free to perform other functions. Mechanics and electricians, for instance, could change the information content of their displays continuously as they progress through the stages of a certain procedure. Physicians could request vital signs or medical information including stored images while in the midst of performing surgical procedures. A hands-off method of controlling information display would be quite beneficial to many physically challenged people and could be their key to entering the work force.

A96-032TITLE:Laser Cross Wind Sensor

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a compact, lightweight, rugged and eye-safe wind sensor capable of measuring cross wind profiles for ballistic wind corrections.

DESCRIPTION: Cross wind, the component of the wind vector perpendicular to the line-of-fire is the largest component in the error budget for sniper weapons used to engage targets at long range. Current technologies to estimate cross wind (and thus the required aim point correction) rely on visual cues (such as the motion of foliage) or on a point measurement of the wind at the shooter's position (from e.g., an anemometer). The cross wind is also assumed to be constant between the shooter and target. These estimates for cross wind deflection are often inadequate. To overcome this deficiency, an innovative laser system is sought that can make real time measurements of the cross wind as a function of distance to a range of 1500 M, with an accuracy better than 1 M/S. The range wind component is also desired but not required. The physical dimensions and function of the system should be compatible with sniper operations, i.e. compact, lightweight and rugged. The system should meet laser eye safe standards. The ability of the sensor to also measure range to target is a very desirable feature.

PHASE I: Concept Validation: Through laboratory and field tests, demonstrate the ability of the employed sensor technology to achieve the measurement performance outlined in the description.

PHASE II: Prototype System Development: Design, fabricate and test a prototype system. Demonstrate the ability to meet performance, size, weight, and packaging requirements. Develop a manufacturing plan for high volume low cost production.

POTENTIAL COMMERCIAL MARKET: A low cost, compact, rugged, eye-safe wind sensor has potential application for law enforcement agencies, for the aviation market as a wind shear and turbulence detector, for the sports market in competitive shooting and sailing and for sensing drift of pollutants.

A96-033TITLE:Display Device Development

CATEGORY: Exploratory Development

OBJECTIVE: This program should address one or all of the following areas for improved functionality for display devices: luminance, color, efficiency, size, resolution, environmental limits, viewability, 3-D viewing.

DESCRIPTION: In the area of light emitting structures and materials for display applications; programs are sought that involve novel devices, methods of preparation, and techniques for the evaluation of materials, films, and structures, a better understanding of the physical processes in display devices, reductions in complexity and/or cost of manufacture. Research leading to ultra low power drive schemes for emissive displays. Significant power is wasted in the drive method, the addressing circuitry and in A-D/D-A converters and video RAM. The effort should include new innovative drive techniques to minimize losses in the display as well as in the drive and associated image processing circuitry. Various applications require growth of display capabilities to larger sizes and higher resolutions for group viewing, high information content, and in some cases stereo for depth perception. Innovative methods for combining images to create displays beyond the size of substrates which can be readily manufactured are of interest. For stereoscopic displays, approaches which do not require the use of glasses are more suitable for military applications.

PHASE I: Develop a selected display device concept through analysis of potential performance and advantages and an evaluation of the feasibleness of proposed fabrication methods. At the end of Phase I, a report of the device design, performance assessment and a description of proposed fabrication methods and issues should be delivered to the government.

PHASE II: Fabricate, evaluate and demonstrate the device concept developed under Phase I.

POTENTIAL COMMERCIAL MARKET: New display technologies are exploding into the marketplace, since they represent the information window between people and the engines of the information age. Technical improvements in any given technology greatly improve its competitiveness in this rapidly growing field.

## U.S. Army Research Office

A96-034TITLE:Innovations in Optics Manufacturing

CATEGORY: Basic Research

OBJECTIVE: Develop new and innovative material and processing approaches to the manufacturing of optical elements and systems.

DESCRIPTION: Identify innovative concepts that offer the potential for radically altering the design and manufacture of optical components. The emphasis is on finding new technologies that afford significantly improved system performance and reduced costs with respect to the current state of the art. Processes that are amenable to flexible manufacturing approaches and small batch acquisitions, especially those that make full use of computer integrated design and engineering concepts, are strongly encouraged. Hence, proposals may involve the demonstration of new materials and processing alternatives, the incorporation of critical material processing characterization techniques for in -line process control. Areas of general interest include: 1) surface-relief diffractive elements and related hybrid optics; 2) refractive gradient index lenses; 3) non-light-emitting

components used in flat panel and projection display technology, including IR scene projection; 4) microlenses and lenslet arrays; 5) reflective (UV and X-ray) optical elements, and 6) optically or electrically switchable elements.

PHASE I: Investigate and demonstrate feasibility of innovative approaches to the manufacture of optical elements that will significantly improve performance or reduce costs in relation to present state-of-the-art materials and approaches.

PHASE II: Implement the innovation, which may include the design and testing of prototype systems. Explore major cost and reliability issues associated with the innovation in the context of commercial viability.

POTENTIAL COMMERCIAL MARKET: Optical components are critical elements in a multitude of commercial and military systems including: cameras, CCD video cameras, CD optical storage players, laser printers, photocopiers, computer displays, simulators, photolithography, optical interconnects, telecommunications and noninvasive medical procedures. This research is intended to introduce breakthrough technologies (new capabilities, enhanced performance, and reduced system size and weight) that significantly reduce system costs.

A96-035TITLE:Chemical Hydride Hydrogen Sources for Small Fuel Cells

CATEGORY: Basic Research

OBJECTIVE: Develop a chemical hydride-based, compact hydrogen source to provide high grade hydrogen to small fuel cell power supplies.

DESCRIPTION: The Army has an ongoing program to develop small (20 watt to 1000 watt) fuel cell power supplies. The development program has made excellent progress in improving the power density of small hydrogen/air fuel cell stacks; however, lack of a safe, reliable, high energy density hydrogen supply is a major impediment to fielding these new power supplies. The Army has explored a number of different approaches to hydrogen sources; the most promising approach to hydrogen supplies containing a few hundred to a few thousand watt-hours of energy appears to be hydrogen generators based on chemical hydrides such as (but not limited to) lithium borohydride or sodium borohydride.

PHASE I: Demonstrate production of hydrogen equivalent (50% efficient fuel cell stack) to several hundred watt-hours from a chemical hydride using a lightweight reactor. The reactor shall be engineered to afford a high degree of safety to the user in the event of a reactor malfunction. The hydrogen source should tolerate being turned on and off several times during the consumption of the chemical hydride. Heat fluxes within the system must be characterized in sufficient detail to permit a meaningful phase II proposal.

PHASE II: Scale up the reactor system developed under phase I to produce hydrogen equivalent (50% efficient fuel cell stack) to 1200 watt-hours from a system weighing less than 2.2 Kg. The system should be attitude insensitive, and should be easy to wear or carry in a pack. The design shall demonstrate concern for user safety. The systems controls should be operable by a use who is wearing gloves. The system should be designed to show that the charge of fuel can be quickly and safely replaced. The final demonstration shall require the hydrogen supply to power a small fuel cell stack.

POTENTIAL COMMERCIAL MARKET: The commercial market for small power sources is growing at a very rapid rate. Laptop computers, cellular phones and other communication devices, and various recreational applications require power levels toward the lower end of the Army's small fuel cell power range. Cordless power tools and more intensive recreational power users require higher levels of power.

A96-036TITLE:Milli-Robotics for Remote, Minimally-Invasive Surgery

CATEGORY: Basic Research

DESCRIPTION: Medical telepresence/teleoperation technologies are essential for many Army and civilian needs, such as delivering fast medical/ surgical help to critically injured soldiers on the far-forward battlefield, urban trauma care, rural health

care, and general surgery. Research is needed that exploits recent advances in micro-electro-mechanical systems to design intelligent, minimally-invasive, medical/surgical delivery systems. The ultimate design will have a surgeon sitting at a telepresence workstation, telerobotically performing complex procedures on a patient, who will be located in a sterile medical van on site. The surgeon will have motor and sensory (visual, tactile, force, auditory) sensations as if she were inside the patient's body. Specific technical areas include distributed, hierarchical control of intelligent micro-mechanical systems, geometric aspects of control design, fault -tolerant and limited bandwidth communication issues, interaction between information and dynamics, non-invasive physiological remote sensors, integrated force and tactile sensing, tele-taction, finer robotic manipulators and instruments specifically configured for surgery, control of telerobotic surgical systems with time delays, telerobotics with sensory enhancements, telepresent and virtual environments for training, man-machine interaction and integration issues.

PHASE I: Research is needed in the areas of distributed, hierarchical control of intelligent micro-mechanical systems, geometric aspects of control design, fault-tolerant and limited bandwidth communication issues, interaction between information and dynamics, non-invasive physiological remote sensors, integrated force and tactile sensing, tele-taction, finer robotic manipulators and instruments specifically configured for surgery, control of telerobotic surgical systems with time delays, telerobotics with sensory enhancements, telepresent and virtual environments for training, and man-machine interaction.

PHASE II: This phase will concentrate on integration issues and the development of prototype telerobotic systems.

POTENTIAL COMMERCIAL MARKET: Hospitals, health care delivery systems, training at medical and nursing schools.

A96-037TITLE:Design and Synthesis of Novel Nanolaminate Materials

CATEGORY: Basic Research

OBJECTIVE: Provide new approaches for the rational design and manufacture of lightweight radhard, acoustic suppressive or chemically resistive materials from novel nanolaminate materials.

DESCRIPTION: Interactive experiment/first principle calculations, in-situ process control, non-equilibrium processing and interphase control with gradient materials in conjunction with suitable design principles can provide unique structural materials surfaces for Defense Materiel. Refractory metal, boron- carbon-nitrogen hierarchial structures are reasonable targets for neutron, gamma and x-ray resistance. Broad classes of ternary and greater constituent number systems have possible applications and can be non-equilibrium processed with in- situ process controls by evolving ion beam, plasma and laser processing as well as more traditional nanostructural processing technologies. Acoustic suppressive materials involve wider use of interactive design techniques combined with acoustical characterization of nanodimensional multimaterial laminate structures. Experience has shown that nanolaminate materials have significantly different properties with respect to bulk materials such as current active materials (ie. Ti-Ni alloys).

PHASE I: Investigate and demonstrate feasibility of innovative approaches to the manufacture and bonding of diverse materials for specific applications to include lightweight radhard, chemically resistive and acoustic suppressive nanolaminate materials. Establish chemical bonding and structure of new materials with HRTEM, XPS, RAMAN etc.

PHASE II: Provide prototype with design and manufacturing approaches and cost information. Demonstrate improvements through prototype evaluations and tests. Identify possible military and commercial markets.

POTENTIAL COMMERCIAL MARKET: Noise and radiation damage resistance are major environmental hazards in both the commercial and military sectors. The research is intended to provide new innovative approaches to minimizing these in industry, medicine and on the battlefield.

A96-038TITLE:Hierarchical Polymer Bonded Ceramic Structural Composites

CATEGORY: Basic Research

OBJECTIVE: Mimic nature's design (synthetic Nacre) for ultra-thin-polymer matrix bonded ceramic "brick and mortar" composite and characterize the mechanical properties.

DESCRIPTION: Nature provides many examples of high strength, high toughness inorganic/polymer nano-composite structures in shells, bones, teeth, and horn which incorporate hierarchical design. Ceramics offer many advantages in strength, hardness, elastic modulus, wear resistance, and chemical resistance at ambient as well as elevated temperatures. A thin organic/polymer bonding film between ceramic grains has been shown to increase toughness and strength in nacre. This research should focus on engineering ceramics such as oxides, carbides or nitrides and should address such concepts as the molecular level adhesion, hierarchical assembly, flexibility, graded structures and method of composite synthesis. The composite should ideally contain greater than 90-95% ceramic phase and consider hierarchical design.

PHASE I: Develop strategy for polymer/ceramic design, fabricate and characterize the microstructure of a prototype composite.

PHASE II: Produce components for advanced mechanical property testing and evaluation.

POTENTIAL COMMERCIAL MARKET: If fully successful, this material would have many military and civilian applications for example; a toughened, wear resistant structural ceramic component having superior acoustic damping, fire resistance, ballistic performance and/or abrasion resistance. In addition to the increased performance, economic factors may favor the low temperature processes envisaged in this work.

A96-039TITLE:Novel Polymeric Membranes for Reverse Osmosis Water Purification

CATEGORY: Basic Research

OBJECTIVE: Develop a new type of polymeric membrane for water purification by reverse osmosis that is more efficient and robust than those currently available commercially.

DESCRIPTION: The U. S. Army has a need for efficient water purification capability in a variety of field settings and uses commercially available reverse osmosis elements in its water purification systems. The capabilities of these systems do not fully meet Army requirements, thus the need for a significant advancement in this technology is evident. Logistics, maintenance time, and cost are all important issues since these systems currently require frequent replacement of ineffective membranes which seriously diminish performance. Poor membrane performance (and even total failure) typically results from fouling and degradation of the membrane due to many factors including bacterial growth, degradation by chlorine, and normal wear. Lengthening the shelf life of replacement membranes is also an important issue since they need to be transported and stored for extended times while exposed to a variety of different environments. This solicitation seeks to solve these problems through the development of a new polymeric membrane for use in reverse osmosis water purification. Approaches could include developing a new membrane formulation based upon new kinds of polymers and combinations of polymers, or improving current membranes through new designs or new methods of preparation and processing. The goal is a membrane that resists fouling, resists degradation due to exposure to contaminants such as chlorine, is physically robust for long- term usage and storage (especially in the dry state), desalinates under standard seawater conditions, and has an improved flow rate. The overall performance of the membrane must exceed current commercial performance. Environmental cognizance is necessary when choosing materials and processing methods.

PHASE I: Demonstrate proof of concept for a new polymeric membrane for reverse osmosis water purification that is resistant to degradation and fouling with substantially increased efficiency and storage life.

PHASE II: Optimize water purification efficiency and cost effectiveness by fine tuning membrane properties. Demonstrate that membranes can be produced with uniform properties during manufacturing.

POTENTIAL COMMERCIAL MARKET: The new reverse osmosis membrane would significantly lower water purification costs incurred by users by increasing system efficiency while requiring less frequent membrane replacement. With an active and growing commercial market already established for water purification systems, the advances proposed here would be of great

value to both vendors and users. The membranes should be developed using environmentally benign materials and processing thus eliminating any negative environmental impact.

A96-040TITLE:Multi-Body Dynamics and Control for Land Vehicle Simulation

CATEGORY: Basic Research

OBJECTIVE: Develop new modeling and computation techniques, control algorithms, and simulation computer codes for constrained structures consisting of interconnected elastic components that occur in large scale mechanical systems such as tanks, trucks, trailers, etc.

DESCRIPTION: Military vehicles and equipment, such as rotorcraft, tanks, trucks, trailers, and weapon systems consist of complex, interconnected multi-body structures. Traditionally, the dynamic behavior of such structures has been modeled and analyzed on the basis of rigid body models. However, certain components of structures subjected to high intensity dynamic loads undergo elastic deformations that influence ride comfort and the state of stability of the vehicle or structure. To design such structures efficiently and effectively, kinematic and dynamic simulations of flexible multi-body systems based on constrained non-linear dynamics are required. Recent advances in computers and computer graphics hardware and software now permit the development of computer generated animation schemes that facilitate and improve the process of designing complex vehicle structures. For general multi-body analysis requirements, research in computational dynamics, inverse dynamics, augmented Lagrangian methods, etc. for constrained mechanical systems will furnish some of the tools required to develop more robust, numerical efficient, and faster than real time simulators. In particular, automated generation of the equations of motion of complex mechanical systems using icon driven pre-processors is a desired methodology. This process would allow the vehicle modeler (who in general is unfamiliar with computational dynamics theories) the capability to assemble and simulate highly complex systems merely by indicated the types of connective elements between primary structures of the system. It is anticipated that successful completion of the proposed development system would need to incorporate elements of vehicle dynamics formulation methodologies, "X-window" type user interfaces and some degree of internal checking schemes for accurate and realistic modeling. This methodology should also allow for a "turn key" capability that will generate optimized code permitting real time (or near real time) simulation capabilities. This code could additionally be ported to physical motion simulators for use in man-in-the-loop simulation excursions. Also, parameter estimation is a useful methodology for validating simulation models versus actual field data. This could be a part of an expert system that attempts to identify model deficiencies in multi-body dynamic systems. It could also be used for model reference adaptive control schemes, where plant dynamics are not precisely known. Research into structural control methodology within the context of this application is necessary to increase performance of such large complex systems in general and to increase efficiency of the many components in particular. Vehicle rollover, for example, is an important consideration in the design and operation of Army vehicles, and improved dynamic stability controls could be used in a real time sense to help prevent vehicle rollover.

Of special Army relevance is the development of high resolution computer based modeling and simulation methodologies for analytical and physical assessment of ground vehicle systems. Research requirements should be focused on automatic formulation of the constrained equations of motion, symbolic equation processing, parameter estimation, generation of computer codes, computational methods, and algorithm optimization for computer architectures, model reduction and error quantification techniques, fluid payload dynamics, suspension systems and control, weapons positioning control, optimization techniques, and non-linear control methods.

PHASE I: Design and implement X-window and PC windows graphical user interfaces to accommodate multiple simulation methods in support of a virtual prototyping initiative. Emphasis in design should be on the accommodation of several alternative simulation methodologies including recursive, redundant, and symbolic/non-symbolic formulations. Implement a representative subset of simulation methodologies, including at least one recursive, non-recursive, and symbolic formulation. Design and implement software interfaces to available commercial animation engines, including, for example, Autocad and 3D Studio, for design visualization. Demonstrate feasibility of faster-than-real-time virtual prototyping for military vehicles.

PHASE II: Develop and implement (1) scalable, multi-processing algorithms for dedicated massively parallel processors; (2) scalable, multi-processing algorithms for heterogeneous computing environments; (3) control and design modules for man-in-the-loop evaluation of vehicle performance. Develop automated sensitivity calculations for optimization of control design and of structural response.

POTENTIAL COMMERCIAL MARKET: Improved multi-body dynamics and simulation techniques and robust vehicle control algorithms will lead to better designed structures and systems that will provide better ride comfort, handling qualities, and safety of land vehicles.

A96-041TITLE:Laser Speckle Interferometry

CATEGORY: Basic Research

OBJECTIVE: Development of a versatile non-invasive reliable tool for the determination of reliability and remaining life of structures under load.

DESCRIPTION: Changes in the sub-microscopic unevenness on the surface of structures caused by anisotropic deformation in the interior can be monitored by and correlated with interference patterns. This technique known as the "Laser Speckle Interferometry" has been developed in the laboratory with Government and Corporate funding over the past few years. In a large variety of structures made of all different kinds of materials, especially under repetitive load, evolution of damage in the interior is extremely difficult to detect and assess. This technique offers a viable approach to the assessment of the effect of evolving damage on the remaining useful life of critical components. Innovative approaches are sought for the purpose of developing a portable field unit for the application of Laser Speckle Interferometry for the health monitoring of critical components of machinery in transportation, manufacturing, construction, farming, and defense related equipment.

PHASE I: Demonstrate the correlation between changes in speckle patterns and type and extent of damage in selected applications-multiple in terms of complexity of geometry, loading conditions and type of material. Concept formulation for a reliable portable unit marketable with respect to cost, maintenance, and use.

PHASE II: Continued product-oriented validation research, prototype fabrication and demonstration. Partnership building, marketing plans, demonstration under widely varying conditions in terms of application, and final engineering.

POTENTIAL COMMERCIAL MARKET: In machinery of different kinds for applications in transportation, construction, agriculture, manufacturing, etc., reliability has often dictated uneconomical downtime and replacement schedules due to excessive safety margins. The availability of a reliable health monitoring technique will eliminate unreasonable logistic burden. The commercial potential is limited only by the imagination of the product developer.

A96-042TITLE:A Multi-Parameter Snow Sounding Probe

CATEGORY: Basic Research

OBJECTIVE: To develop a multi-purpose probe for the purpose of making direct, in-situ measurements, from the surface, of one or more of the following internal snowpack physical parameters: (1) density, (2) temperature, (3) wetness, (4) grain size, and/or (5) cohesion or strength. This probe should be field portable and capable of storing multiple data sets, each representing an individual sounding made up of several channels. The I/O (Input/Output) interface should be compatible with existing desktop micro-computers. In addition, the device should be capable of displaying the most recent sounding or retrieving a previous one.

DESCRIPTION: The performance targets for the snow probe are as follows: density resolution from 5% through 70% ice matrix by volume, with the water equivalent of the total sounding able to be recovered from the density profile; temperature resolution to 0.5C over a range of -70 to +20C; wetness resolution to c. 0.2% for a range from 0.2 to 10% liquid water by volume; and grain size resolution should be < 1-2mm. Strength and indexes of strength or cohesion are not well defined.

However, weak layers in the snowpack that are of interest are often on the order of a few millimeters in thickness, therefore any measure of strength would need to resolve variations at this scale.

PHASE I: Phase I work will concentrate on either of two tasks, depending on whether the initial goal is a single-parameter probe or a multi-parameter probe. In the former case, the Phase I task would be the development of a prototype snowpack probe containing the single parameter measuring capability. Included in this prototype integration should be the necessary sensors, data logging capability, and power supply. This field-portable prototype would be developed and supplied to the Army for field testing at various alpine, winter, and polar sites. In the instance where the objective is a multi-parameter probe capable of measuring at least three of the five desired parameters, the Phase 1 task would be the development of the necessary sub-system technologies associated with each of the selected snowpack properties to be measured by the multi-parameter probe.

PHASE II: For Phase II, the task for the single parameter probe would be the expansion to a multi-parameter capability for the measurement of at least three of the five desired parameters, whereas in the case of the multi-parameter probe, the fully-developed sub-systems would be integrated into a prototype probe. In both cases the fully-developed multi-parameter, field-portable prototype would be supplied to the Army for field testing at various alpine, winter, and polar sites.

POTENTIAL COMMERCIAL MARKET: The commercial market for this technology is high. There is an acute need for the characterization of snowpacks by the military, government agencies, and the civilian winter recreation community. Therefore, a multi-parameter snow probe has significant potential for a worldwide commercial market.

A96-043TITLE:Reactor for Control of Fugitive Emissions of Toxic Gases

CATEGORY: Basic Research

OBJECTIVE: Development a small-scale reactor for the destruction of toxic gases such as volatile organic compounds (VOC's) and hazardous air pollutants (HAP's). Target gases are toluene, xylene, and methylene chloride. Ideally, this reactor would utilize discharge or beam excitation of the contaminated gases and should have the capability to handle relatively low air flow volumes with toxic gas loading in the 1-1000 parts-per-million range, with a 99% or higher destruction efficiency and minimum formation of toxic by-products.

DESCRIPTION: There is a need to control the fugitive emissions of hazardous vapors resulting from operations at Army plants and depots. Typically there are a substantial number of sources for fugitive emissions during such operations as manufacturing, cleaning, paint stripping, and painting. The emissions may be continuous or episodic and are quite variable in terms of toxic gas loadings, covering a large concentration range from parts-per-million (ppm) to parts-per-thousand (ppt). Optimal technologies for VOC and HAP control currently do not exist that offer a high degree of destruction without significant drawbacks. Both high- and medium -temperature (catalytic) oxidation are quite costly and produce large amounts of global warming gases such as CO2 as well as unwanted combustion by-products and filter techniques have problems of saturation and ultimate disposal.

PHASE I : The Phase I work would concentrate of developing a small reactor capable of successful (299%) destruction of parts-per-million range air flows containing toluene, xylene, and methylene chloride. This laboratory-scale reactor will contain infrared and visible ultraviolet windows for tunable infrared laser absorption and visible ultraviolet laser induced fluorescence diagnostics that will be provided at an Army laboratory.

PHASE II: In Phase II, a scaled-up prototype reactor will be developed and tested. This reactor will need to exhibit the following features: (i) Operating life greater than 500 hours before service, (ii) successful destruction of target molecules to the levels required, (iii) quantitative assessment of any by-products, (iv) development of a means of secondary treatment, should the level of toxic by-product production be below the required level.

POTENTIAL COMMERCIAL MARKET: The commercial market for hazardous fugitive gas emission control technology is substantial, both in U.S. and abroad. As regulatory requirements are slowly tightened, the need for such high-performance cost-effective, and versatile technology will increase.

## U.S. Army Aviation Research, Development, and Engineering Center

A96-044TITLE:Incrementally Adjustable Helicopter Rotor Blade Tracking Tab

CATEGORY: Exploratory Development

OBJECTIVE: Incrementally adjustable, non-metallic tracking tab for helicopter rotor blades.

DESCRIPTION: Tracking tabs are used by most helicopter rotor blades to reduce vibration in forward flight. Current rotor blade tracking tabs are thin aluminum plates located on the blade trailing edges. These tabs are adjusted with a calibrated bending tool to alter the track of individual blades in forward flight, thereby compensating for small manufacturing differences between the individual blades of the rotor. When the track of all blades are nearly identical, the once-per-rev vibration of the rotor is minimized, leading to reduced crew fatigue, increased component life, and reduced maintenance for the helicopter. Advanced rotor systems are designed with non-metallic composite materials for fatigue strength and low observable characteristics. Such rotor systems require non-metallic tab materials, however. This presents difficulties in tracking adjustment, leading to complex and inefficient methods such as heating and cooling the tab material. It is desirable to provide the Army with a non-metallic tracing tab which may be adjusted incrementally without the use of special tools or procedures. An incremental adjustment capability would allow the maintainer to know the magnitude of each adjustment, and would result in the minimum number of adjustments to achieve rotor blade track.

PHASE I: Preliminary design and material evaluation.

PHASE II: Full-scale design, fatigue and environmental testing.

POTENTIAL COMMERCIAL MARKET: Applicable to all commercial as well as military helicopters, at least one per blade.

A96-045TITLE:Advanced Materials for Helicopter Propulsion Systems

CATEGORY: Exploratory Development

OBJECTIVE: Develop innovative Gas Turbine and Mechanical Power Transmission materials which would greatly increase the power-to-weight ratio, reliability, and fuel efficiency of current and future helicopter propulsion system components.

DESCRIPTION: This topic focuses upon the development of advanced materials for use in the two major areas of the helicopter propulsion system.

The first area of interest is the turboshaft engine. Increases in power-to- weight ratio and reductions in specific fuel consumption of future Army turboshaft engines dictate that rotor speeds and temperatures will increase significantly. Advanced materials which can accommodate these speeds and temperatures and provide high durability and reduced weight are desired. Materials under consideration include Organic Matrix Composites (OMC's) for inlet housings and casings; Titanium based Metal Matrix Composites (MMC's), orthorombic titanium, and super alpha-2 titanium for use in axial and centrifugal compressor rotors; gamma titanium aluminide for use in the compressor diffuser; high temperature materials such as Ceramic Matrix Composites (CMC's) for use in the combustor liner; and a combination of materials with much greater temperature capability such as fourth generation single crystal alloys, intermetallics and in-situ monolithic ceramics for use in the gas generator and power turbine stages. The application of these advanced materials will necessitate more than a material substitution to take full benefit of the materials. For example, concepts involving replacing disks by rings, utilizing a dual microstructure in the disk, or dual alloy components are currently being pursued. Thus, innovative structural concepts, design methodologies, and the strong desire for an affordable manufacturing process should be seriously considered.

The second area of interest is the helicopter main reduction gearbox. The main transmission of all modern rotary wing aircraft is composed of a set of high precision gears and their supporting bearings which reduces the high speed output of the turboshaft

engine to that required by the main rotor. In order to maximize the payload of the rotorcraft this system must be as light and compact as possible. Due to the flight critical nature of the transmission system it must also be highly reliable. The U. S. Army is interested in the development of advanced manufacturing techniques which would reduce the friction and heat generation created in the surface contact regions of gears and bearings and allow current design allowables for scoring and pitting to be greatly increased. If successful, this technology could result in a large increase in the load capacity of high performance gears and bearings which would translate into reduced weight, volume, and cost or increased reliability. Possible approaches could include the use of innovative surface coatings, heat treatments, and surface finishing methods. In addition, the U. S. Army is also interested in the development of innovative techniques for increasing the strength properties of gear teeth and bearing races through the custom orientation of the material grain flow and structure to match that of the part geometry and stress field.

PHASE I: Proposed efforts should define the operational requirements of the application for which the material/material system is to be applied. Effort should be conducted to evaluate the feasibility of the manufacturing process necessary to utilize the proposed material/material system in the selected component. The critical processing steps should be identified and preliminary bench type testing of the critical steps should be conducted. These tests should be sufficient to evaluate the potential of the proposed material/material for further development.

PHASE II: Efforts in Phase II shall be focused upon the fabrication of a full scale component which can be tested in either a current or advanced development gas turbine engine or rotorcraft main reduction gearbox. The proposed effort should address the development of a complete manufacturing process for the subject material/material system.

POTENTIAL COMMERCIAL MARKET: The technologies used in the propulsion systems of helicopters are common to just about all forms of aerospace propulsion systems. This is especially true for turboprop type commuter aircraft which historically have utilized military engines as the basis for the development of new commercial products. The gears and bearings to be developed here will be directly applicable to the propeller gearbox of the commuter aircraft as well as the many other locations where lightweight highly durable gears and bearings are used. Thus the potential commercial market is quite large for the application of the advanced materials which would result from the materials developed from this topic.

A96-046TITLE:Computer Modelling and Simulation for Helicopter Pilotage Tasks

CATEGORY: Exploratory Development

OBJECTIVE: Develop a methodology to model and simulate a range of flight maneuvers and relate this characterization to the pilot-aircraft response requirements.

DESCRIPTION: Recent research in rotorcraft handling qualities has been fairly good at establishing stability, control response, and coupling requirements for a particular task. This involves using complex ground-based and in-flight simulators to investigate a wide range of controller and stability and control parameters for a specific task; collecting supporting qualitative pilot opinion data using the Cooper-Harper rating scale; and correlating these quantitative and qualitative data to formulate criteria. This iterative and expensive process is valid for the task investigated. If the task changes, the process has to be repeated. The Goal of this SBIR topic is to expand the data base analytically instead of having to investigate every specific mission task element. This will reduce the design-development costs for upgrades to current aircraft and for new aircraft through unifying results and requirements for a variety of tasks/missions.

PHASE I: Requires innovative research in the areas of pilot modeling, rotorcraft inverse modeling, pilot-vehicle-task analysis, and simulation. Sample tasks will be analyzed to develop and characterize the important pilotage -task metrics, pilot workload effects, and vehicle dynamic relations.

PHASE II: Using the sample task characterization, extend the metric to new tasks and validate using ground and in-flight simulation. Extend to all axes of control for day/night and poor weather mission tasks.

POTENTIAL COMMERCIAL MARKET: With the rapid increase in on-board computational power and replacement of current-day control rigging with automatic fly-by-wire control systems, the achievement of tailored flight control laws to improve mission performance, reduce pilot workload, and increase operational capability and safety becomes practical. For

example, improving the capability and reducing the workload for Emergency Medical Services missions in poor weather at night would extend operational capability and reduce accidents which will lead to improved life saving capability.

A96-047TITLE:Human Performance with Decision Aiding Systems: Training for Trust and Measuring the Benefits

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is two-fold: 1. to understand and develop new approaches for any unique requirements that decision aiding systems impose on user training, for example training the user to trust the decision aid properly; and 2. assuming a properly trained user, to develop methods of effectively measuring human performance benefits of decision aiding systems, specifically situation awareness and workload.

DESCRIPTION: Human interaction with decision aiding systems is fundamentally different than interaction with simple machines. One example is trust: effective use of decision aids demands that the human place some degree of trust in the system. Too little trust renders the aid ineffective and possibly counter-productive; too much trust or misplaced trust can have disastrous consequences. And although the user is taught the mechanics of operating the system, little or no training is given on how to trust the system. Also, we do not have well understood, well defined ways to measure a user's trust in a decision aiding system. Another example is the human system interface (HSI) problem of information transfer. The decision aid must transfer the right information at the right time and in the right manner to be of benefit to the human. A decision aid that effectively transfers information produces the benefits of increased situation awareness and decreased workload. In the past, however, measuring these two benefits has been difficult and disappointing. This effort will explore human performance with decision aids from two aspects: user training to build not only proficiency but also proper trust in the system, and measuring situation awareness and workload.

PHASE I: The first phase will identify any unique requirements that decision aiding systems impose on user training, develop method(s) to satisfy those requirements, develop method(s) to measure user situation awareness and workload, and identify a decision aiding system with which to perform the Phase II effort.

PHASE II: Conduct an operational test of the decision aiding system identified in Phase I to implement and evaluate the developed training and measurement methods. Choose the most promising methods, perfect them, and reevaluate them in a second operational test.

POTENTIAL COMMERCIAL MARKET: Decision aiding systems are currently being developed in the medical and combat aviation arenas, with others likely in air traffic control, nuclear power, other combat systems, emergency response, and mining operations. As more and more decision aiding systems are developed and fielded, these training and measurement methods will become crucial, since decision aiding applications are usually with life-critical systems. They will produce better decision aids and better users, and therefore, safer and more reliable life-critical systems.

A96-048TITLE:Aerodynamic Analysis of Unsteady Airfoil Geometry in Unsteady Flow

CATEGORY: Exploratory Development

OBJECTIVE: Development and validation of a computer code for the prediction of aerodynamic forces on airfoil geometries that undergo a change in shape while immersed in an unsteady flow environment. The airfoil to be analyzed may have one or more moving surfaces and/or surface transpiration (blowing or suction) with a prescribed schedule. The character of the onset flow can be described as a mean flow with prescribed unsteady pitching and translation (up-down and fore- aft).

DESCRIPTION: Military and civil helicopter development suffers because of the inability to accurately simulate, during design, the complex aerodynamics that affect the forces on the rotor blade. Each element of the rotor blade sees an ever-changing velocity. The forces generated at the rotor blade are dependent on how the airfoil responds to this changing onset flow. The

changing distribution of pressures over the airfoil can be determined through analysis using unsteady flow modeling. A rotorcraft development is the application of active controls to modify the geometry of the rotor blade for noise reduction, vibration reduction and correlated with predictive analysis. A key element needed to improve the predictive analysis is the development of an aerodynamic analysis that predicts the unsteady effects of changing airfoil geometry in the unsteady flow environment. This analysis will be based on a coupled viscous/inviscid approach with wake modeling to capture unsteady boundary layer separation.

PHASE I: Investigate current computational methods that are efficient and adaptable to a range of airfoil configurations. Investigate intuitive user interfaces for description of the airfoil geometry and unsteady onset flow. Select an efficient and accurate solution methodology. Demonstrate a test case using the selected methods using 'pilot' coding.

PHASE II: Design and implement a final software solution for computer platforms in current use by army aviation engineers and civilian aerospace users. Develop the software with particular attention to the user interface and desired output products. Use existing standards for airfoil file formats where possible. Select a range of validation cases that demonstrate the accuracy of the final analysis. Document the final software for potential users and for future development.

POTENTIAL COMMERCIAL MARKET: This analysis will provide a benefit to a wide range of unsteady aerodynamics problems. Its use is seen in future aviation systems with as wide a scope as sport sailplanes to commercial transports. Its use is also possible in submarine and sailboat applications.

A96-049TITLE:Turboshaft Engine and Rotorcraft Drive System Technology

CATEGORY: Exploratory Development

OBJECTIVE: To develop innovative gas turbine engine and mechanical power transmission component technologies which will provide future Army rotorcraft with engines having increased power-to-weight ratios and reduced specific fuel consumption and drive trains that are lightweight, have lower levels of noise generation and have improved durability.

DESCRIPTION: The general path to increasing propulsion system capability includes, but is not limited to, higher maximum temperatures to increase the output per unit airflow; less weight per unit airflow is required to increase the output per unit weight; and increased component efficiencies for decreased specific fuel consumption while maintaining or increasing component durability and life and maintaining or decreasing cost per unit output. To achieve the necessary future propulsion technology advances, technology strides in the compression systems; combustion systems; turbine systems; controls and accessories; and mechanical systems of a gas turbine engine are required. Specific propulsion technology development areas include high pressure ratio, lightweight compressors; combustors that are lightweight with reduced pattern factors and higher inlet and outlet temperatures; lightweight turbines with increased temperature capability, reduced cooling air requirements, and high work extraction; advanced materials/materials systems and innovative structural concepts to accommodate the stresses developed at the required higher speeds and operating temperatures. Thus, future propulsion systems necessitate further developments in aerothermodynamic design capability for improved component efficiency levels and improved control of heat transfer; and further developments in mechanical designs for application of higher temperature, lightweight materials in conjunction with innovative structural concepts to maintain life and durability. These engines produce high speed/low torque shaft power output. Typically, a reduction gearbox or set of gearboxes is used to change the output to the low speed/high torque conditions required by the aircrafts main rotor. Thus, innovative technologies which can reduce the weight, lower the noise, and increase the reliability of these reduction gearboxes are also desired. This could be accomplished with high capacity spur, helical, and bevel gearing, lightweight ballistically tolerant shaft/coupling concepts, overrunning clutches which can operate at engine output speeds, high capacity rolling element bearings, lubrication methods, and the application of advanced materials to components of the drive system. Incorporation of ceramic and hybrid (ceramic rolling elements and metal race) bearings hold potential for decreasing the weight and increasing the life of rotorcraft drive components. However, there is no simple, accurate and cost effective method of detecting deterioration of these bearings. Thus, development of a health monitoring system for ceramic and hybrid bearings would facilitate incorporation of these advanced bearings.

PHASE I: Define a novel concept or innovative technology which is potentially applicable to future turboshaft engines or rotorcraft drive systems. Based on the technology to be pursued, devise a methodology which addresses and substantiates the feasibility of the proposed approach. Define the potential benefits achievable through the application of the proposed concept/technology.

PHASE II: Pursue further the technology defined in the Phase I effort. Fabrication and component or subcomponent testing should be performed to substantiate the technology and its intended end application. The technology should be suitable for transition into a turboshaft engine or rotorcraft drive system.

POTENTIAL COMMERCIAL MARKET: Aircraft gas turbine engine and drive system technology is vital to the US industry base. Gas turbine engine and rotorcraft drive system technology is applicable to both the military and commercial markets. Potential technologies resulting from this effort would provide significant benefit to future rotorcraft and ensure continued US preeminence in the increasingly competitive international marketplace.

A96-050TITLE:Graphical User Interface for Comprehensive Rotorcraft Analysis Software

CATEGORY: Exploratory Development

OBJECTIVE: Development of an intuitive graphical user interface for finite- element based comprehensive rotorcraft analysis.

DESCRIPTION: Recently developed comprehensive rotorcraft analysis codes permit the rotorcraft industry to perform increasing complex and realistic analyses of rotorcraft phenomena. Unfortunately, these codes are often quite cumbersome to use because of the large quantities of data needed to guide the complex solution algorithms and to define the major structural, aerodynamic, propulsion, drive train, and control system components of the rotorcraft model. A graphical user interface which allows a user to drive the program, rather than be driven by it is needed. The interface paradigm must be internally consistent, must map satisfactorily to the database structures resident in the current program, and be intuitive to an engineer.

PHASE I: Develop an appropriate user interface paradigm and design. Write a demonstration implementation, and demonstrate it on a typical rotorcraft analysis problem.

PHASE II: Implement and deliver code for this user input interface. Deliverables should include code, a completed user manual, and design documentation.

POTENTIAL COMMERCIAL MARKET: Validated comprehensive rotorcraft analysis capability is sorely needed in both military and commercial markets. This software provides finite element comprehensive analysis with a user-friendly, user interface. This capability could be applied to all new commercial designs and product improvements reducing time and design and analysis cost.

A96-051TITLE:Three-Axis Fiber Optic Gyroscope

CATEGORY: Exploratory Development

OBJECTIVE: The principle objective of this effort is to develop and demonstrate a compact three axis fiber optic gyroscope (FOG) possessing a high degree of accuracy and reliability with low drift characteristics.

DESCRIPTION: Emerging FOG technology has demonstrated that the stringent performance required by current and future navigation and alignment systems can be met. This performance, however, comes at the cost of significant size and weight growth, often causing system packaging problems. A smaller, more compact 3-axis FOG system developed under this effort will substantially reduce FOG packaging problems while enhancing reliability, increased performance, and simplicity, but maintaining low production cost.

PHASE I: Research and laboratory development of a 3-axis fiber optic gyro that is innovative in terms of packaging (size and weight) and performance (low drift, stability over temperature, and reliability). The design must be low cost to manufacture and be universal in application.

PHASE II: Manufacture of six (6) 3-axis FOG packages for testing and evaluation to determine the quality of the manufacturing process which will help determine the overall package cost with quantity as well as the fault rate for manufacture of a 3-axis FOG of this design.

POTENTIAL COMMERCIAL MARKET: Because of their low cost and simplicity, FOGs are becoming more desirable for use in a number of navigation and alignment systems. The increase in performance due to technological breakthroughs is encouraging and has prompted gyro users to look once again at this technology. As this technology is pushed more towards smaller packaging with higher performance, much broader applications will be found for the fiber optic gyro.

A96-052TITLE:Display of Aircraft State Information for Ambient Vision Processing Using Helmet Mounted Displays

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this study is to demonstrate and determine any advantages of displaying aircraft state information on a helmet mounted display in a manner which will allow the information to be interpreted by the ambient vision processing mechanisms of the brain, as opposed to the focal vision processing mechanisms.

DESCRIPTION: Methods currently exist for providing helmet mounted display information in a form that requires focal vision processing by the brain for interpretation. New methods, however, must be developed for displaying information that can be interpreted with ambient vision processing and are compatible with the unique requirements of helmet mounted displays. These unique requirements include minimizing the masking of imagery and correlating the displayed aircraft state information with the imagery. In addition, some information may need to be in a form that can be processed by both focal and ambient vision processing mechanisms. Research has shown that ambient vision processing does not require mental attention. The potential advantages of processing aircraft state information using ambient vision mechanisms are reduced pilot mental workload, and a reduced chance of not noticing deviations of aircraft state from the expected state. In addition, research has shown that humans primarily use ambient vision, not focal vision, for attitude and velocity cues while standing, walking or running. Therefore, aircraft state information presented in a manner that can be processed by ambient vision processing mechanisms may be quicker to interpret, with less chance of misinterpretation.

PHASE I: A literature search will be made of the subject area. A report of previous work will be generated. Candidate methods of presenting information will be demonstrated on a workstation monitor.

PHASE II: A method will be developed for presenting aircraft state information on a simulator. The simulator can be low cost workstation. However the simulator must have a rudimentary rotorcraft model driven by a joystick. In addition the simulator must have a helmet mounted display, and head tracker. The simulator must display synthetic imagery of the outside terrain from the pilot's eye point in the model. Aircraft state information must be overlaid on top of the imagery. Aircraft state information must be presented in two ways:

a. Interpretable and optimized for ambient vision processing.
b. Interpretable and optimized for focal vision processing.

The simulator will be flown by U.S. Army pilots. Changes suggested by Army pilots will be implemented and tested. A qualitative and quantitative assessment will be made between the final configurations of the two ways in which information is presented (items a and b above), using experienced Army rotorcraft pilots.

PHASE III: Aircraft state information interpretable and optimized for ambient vision will be displayed on a helmet mounted display on a rotorcraft in flight. Information presented will be world stabilized, requiring a head tracker. The information presented will be correct according to the true state of the aircraft. The aircraft will be flown by U.S. Army pilots. Changes suggested by the Army pilots will be implemented and tested. The final configuration of information optimized and interpretable with ambient vision processing will be qualitatively and quantitatively assessed against information optimized and interpretable for focal vision processing.

POTENTIAL COMMERCIAL MARKET: Providing information in a way that allows ambient vision processing would be useful in all military vehicle crew applications such as rotorcraft, bomber aircraft, tanks, and submarines. These principles would also be useful in law enforcement and medical aircraft. Pilots for underwater remotely piloted vehicles can use this technology (telepresence). Similarly, the principles would be valuable in any virtual reality environment.

A96-053TITLE:Smart Data Links for Unmanned Aerial Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to develop a low cost smart data link system for Unmanned Aerial Vehicles (UAVs). Innovative applications of low cost communication systems along with the use of AI can result in a system capable of navigation and communicating at low levels. The purpose of this work is to explore the potential impact of a low cost smart data link system for UAVs, and to identify the communication/AI technologies and/or deficiencies. The technical issues that require investigation are communication links, integration and AI.

DESCRIPTION: Current UAV systems are limited by their ability to communicate while navigating at low levels. The ability to communicate at low levels could be done by using mission planning algorithms and digital data of aircraft locations to plan positions that would allow for line of sight communication. The smart data link could store critical data and decide the optimum location to transmit that data back to another aircraft. The effectiveness of UAVs could be increased by removing the requirement of constant line of sight communication. The ability to communicate while navigating through and around obstacles is a complex problem that requires the integration of communication systems, mission planning, and Artificial Intelligence (AI).

PHASE I: The contractor shall define (1) the communication systems to be integrated for the selected approach, (2) the mission planning algorithms that will be used, (3) the level of AI that will be used and how it will accommodate various static and dynamic movements simultaneously. The contractor shall demonstrate the system in a simulation environment.

PHASE II: The contractor shall refine and integrate (1) the communication systems to be used, (2) the mission planning algorithms that will be used, (3) and the AI that will be used. The contractor shall demonstrate the system in a hardware in the loop demonstration. The contractor shall identify the target UAV platform. PHASE III. The contractor shall integrate the system onto a UAV platform. The contractor shall demonstrate the system on the targeted UAV platform.

At the conclusion of each of these phases, a final report shall be presented which summarizes the results of each program phase and documents overall conclusions and recommendations supported by the analysis.

POTENTIAL COMMERCIAL MARKET: New knowledge and technology advances resulting from this development will enable UAVs to communicate without extensive communication and support systems. It will provide a stepping stone for much broader applications to dual use of UAVs in the future. This effort also is critical to battlefield dynamics, and warfighting systems.

A96-054TITLE:Universal Cargo Net with Release Feature

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to develop an advanced technology cargo net that will: 1. be made of a more durable material than current nets, 2. attach to a helicopter internal/external cargo (INTEX) pallet, and 3. is capable of being retained by the lifting aircraft after the load is released.

DESCRIPTION: Current 5,000 lb and 10,000 lb cargo nets are made of nylon and require that either the cargo be removed before the lifting aircraft can depart or the net must remain with the cargo when the aircraft departs. Initial concepts for INTEX pallet nets produced a one piece net that was cumbersome and could not release the load on the pallet. A universal cargo net

needs to be developed that can: 1. transport general/bulk cargo like current 5,000 and 10,000 lb nets, 2. be made of a more durable material than nylon, 3. be retained by the lifting aircraft after releasing the general/bulk cargo, 4. attach easily to an INTEX pallet, 5. have the strength to be lifted by a helicopter while supporting the INTEX pallet and its load, and 6. be retained by the lifting aircraft, with the INTEX pallet attached, after release of the INTEX pallet load. This effort will result in: 1. longer life nets with commensurate life cycle cost savings, 2. expanded utility of the INTEX pallet system, and 3. quick delivery of supplies for humanitarian and other missions where landing is either not possible or too risky.

PHASE I: Develop the concept and models of a universal cargo net that can release the load it is carrying as described above. Develop a detailed design of the most feasible concept that provides optimum producibility and cost.

PHASE II: Fabricate a prototype system for demonstration purposes. Demonstrate the capabilities of the universal cargo net.

POTENTIAL COMMERCIAL MARKET: Development of such a system would allow commercial helicopter operations to be conducted at lower cost and less risk to personnel. The result would be reduced operation time and improved efficiency of operations for fire-fighting, delivery of humanitarian supplies, logging, and other critical external lift missions. Profitability would be enhanced due to increased utilization and reduced support crew requirements.

## U.S. Army Communications and Electronics Command

A96-055TITLE:Integration of Voice Traffic with Asynchronous Transfer Mode (ATM) Technology

CATEGORY: Engineering Development

OBJECTIVE: Develop a system for the integration of voice traffic directly with synchronous transfer mode (ATM) technology using commercial technologies and products (NDI/COTS) to allow voice phone calls to be made through an ATM system.

DESCRIPTION: The commercial market for ATM currently utilizes systems such as ISDN and PBX to accommodate voice users. These approaches do not take full advantage of the capabilities of ATM. In many military contingency operations, the ability to utilize a portable integrated system consisting of several voice phones, a workstation platform, and an ATM networking system would be beneficial in the dynamic environment. The direct integration of voice capabilities with ATM switching technologies will add functionality, permit bandwidth efficiency, and can be directly interfaced to the ATM data systems at hand.

PHASE I: Feasibility study, research, evaluation, and demonstration of integration of voice circuits directly into an ATM switch interface for voice connectivity to other ATM-enabled voice users as well as common Public Broadcast Exchange (PBX) and Integrated Services Data Network (ISDN) technology users and supporting imagery and data subscribers using multimedia-enabled workstations.

PHASE II: Demonstration of the integrated ATM system for voice over a tactical communications link, such as Tactical Satellite (TACSAT), while allowing connectivity for the public phone systems using PBX and ISDN technology users and supporting imagery and data subscribers using multi-media enabled workstations.

POTENTIAL COMMERCIAL MARKET: NDI/COTS for ATM systems will allow true ATM voice connectivity. Commercial markets Will support this research. The Department of Defense will also support this research, as the DoD efforts in tactical ATM will also benefit from ATM-enabled voice systems.

A96-056TITLE:Advanced ATR Algorithms for Performance Testing

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this SBIR is to obtain automatic target recognition (ATR) or image processing algorithms that significantly enhance the ability of a human operator to make optimal use of the information available on the modern battlefield and using state-of-the-art sensors.

DESCRIPTION: To date, ATR algorithms have not proved to be robust with respect to the variations in target signatures resulting from field-expedient countermeasures or meteomlogical conditions. As a result, the current view of the ATR is to provide information to the human operator that will provide him with cues and/or other tools that will significantly increase his ability to locate and identify targets. This SBIR seeks to identify algorithms and/or image processing methods that can be applied in real time and that will improve performance of the human operator.

It is assumed that the human operator will have a full set of information available to him. For example, the sensors available could include, but are not limited to, thermal imagers, TV, millimeter wave radar, laser rangefinders, LADAR, acoustic, and seismic devices. In addition, digital map information could be available as could information on the location of self and friendly forces through the transmission of global positioning satellite data. The human operator has a wide variety of information sources at his disposal. The optimal use of this information for effective target acquisition, tracking, identification, and servicing becomes a matter paramount importance.

The task of this SBIR is to provide those algorithms, concepts, tools, or methods that serve this purpose. The algorithm suite could include special modules for detection of moving targets, use of bandwidth compressed data, or the integration of information from several of the on-board sensors. The tools available to the operator could also include selectable edge extraction, local contrast enhancement, zoom, target tracking, model overlays, and other image processing techniques that enhance the ability of the operator to separate targets from background elements or identify vehicle types,

PHASE I: Demonstrate the methods, algorithms, or hardware for improving human operator performance at the NVESD ATR Evaluation Facility. The methods, algorithms, and/or hardware must be fully described at the time of evaluation, including description of the phenomenology being exploited and details of the process. Phase I demonstration shall be done with human operators and should be conducted in near real time. Intermediate results of processing in Phase I may be required for performance assessment and for feedback to the developer for use in optimizing algorithms.

PHASE II: Upon the successful completion of the Phase I effort, a Phase II award may be made. The Phase II effort shall address any and all deficiencies noted in the Phase I demonstration and shall provide the necessary hardware/software for a complete evaluation Of the tools at the NVESD ATR Evaluation Facility. While Phase I may include some notional sources of data input, the Phase II effort requires real data, real information sources, and real time processing. At the time of Phase II evaluation, a description of the algorithm, sufficient for architectural analysis and mapping into open systems architecture will be provided. The use of industry standard busses and chip technology is required. Intermediate results of processing in Phase II will be required for performance assessment and for feedback to the developer for use in optimizing algorithms.

POTENTIAL COMMERCIAL MARKET: The potential commercial market includes use by the transportation industry for the identification of defective materials, aviation warning systems, medical application for the prescreening of radiographs or other pathology reports, and the communications/information transmission industry.

A96-057TITLE:Novel Template Generation and Neural Network (NN) Applications for Automatic Target Recognition (ATR)

CATEGORY: Exploratory Development

OBJECTIVE: An In-House Laboratory Innovative Research (ILIR) IS currently being conducted to explore novel concepts and their application to the problem of Automatic Target Recognition (ATR) using both Synthetic Aperture Radar (SAR) and Forward Looking Infrared (FLIR) sensors. This effort will generate and test three sets of algorithms: algorithms to create templates for ATR; Neural Network (NN) based algorithms that use signal decomposition techniques to enhance classification performance and reduce training time; NN based algorithms that use data compression concepts to help define a robust set of features. In addition, a bayesian algorithm will be implemented to assess the benefits from integrating the declarations from the FLIR and SAR ATR algorithms. The objective of this effort is to continue into a laboratory demonstration real time demonstration.

DESCRIPTION: This effort involves the use of three concepts:

a.Template generation. This method will take into account additional conditions in template creation process which are aimed at improving the performance of classification algorithms. The approach here aims at maximizing the metric value (using correlation, goodness of fit, etc.) of the target class while minimizing the metric value for the other classes.

b.Pretraining by target signature decomposition. Well documented limitations in NN is the long training time required to get an acceptable solution. In an approach developed using one dimensional signals, the signal is decomposed into a basic set of signals called the basis set. The NN is trained to recognize the signals in the basis set to produce the pretrained network. The pretrained network is than used as the starting point for final training to produce a classifier. The approach not only reduced training time, but also reduced the amount of training data to produce better performing networks.

c.Feature extraction by target signature compression. Some researchers claim that the output of the hidden layer in the NN contains the feature being used by the net to classify the signal. The study of what's hidden in the hidden layer has been difficult because of the complexity of the layer's output. One approach is to train the NN to reproduce the input signal at the output. If successful, the target features for the input are present in the output of the hidden layer since the information is used to reconstruct the input at the output. Compression is given by how much smaller the hidden layer is from the input layer.

PHASE I: a. Algorithm definition study. This study will include an analysis of the ILIR results, a literature search of template generation techniques, pretraining techniques for neural networks and neural network compression concepts. b. Development of algorithms, c. Survey of SAR and FLIR sensors, d. Simulation. Contractor will provide a laboratory demonstration simulating the SAR and FLIR sensors, using real SAR and FLIR data provided by the government. The target set will be limited to seven different classes. Demonstration will show how the three algorithms work in each sensor to identify targets. In addition, demonstration will include the use of a bayesian algorithm to integrate the ID declarations from the SAR and FLIR ATR.

PHASE II: a. Increase the robustness of the algorithms using the results from Phase I. b. Contractor to conduct a real time demonstration using SAR, FLIR sensors and the algorithms developed in Phase I.

POTENTIAL COMMERCIAL MARKET: Medical imaging techniques, commercial aviation industry, intruder detection and identification, manufacturing inspection and intelligent highway system devices are potential commercial applications.

A96-058TITLE:3D Visualization of RF Propagation in Terrain

CATEGORY: Exploratory Development

OBJECTIVE: The Army requires innovative techniques to represent, visualize, and reason with ground-based three dimensional models of radio frequency (RF) energy especially as it is attenuated due to terrain blockage, competitive RF, atmospheric absorption, and other sources of interference. The primary application for the visualized RF environment is airborne collection

management of very high frequency (VHF) radio energy, although other applications are plentiful. This effort is not concerned with planning the airborne collection management process, but rather in developing a virtual environment of 3D antenna patterns over terrain that will ultimately serve as the front end to a flight path mission planning problem (note: some of the antenna patterns will represent desirable places to fly, whereas others must be avoided, due to electronic interference or physical threat to an aircraft).

DESCRIPTION: Consider the problem of visualizing a system of three dimensional RF antenna patterns dispersed over the surface of the earth. The purpose of modeling and visualizing 3D antenna patterns is to produce a virtual digital environment in which flight path collection management of VHP energy may be explored by a battlefield mission planner (although the planning process is not the purpose of this work). The antenna patterns may be perceived to be models of RF energy propagated from ground-based locations. Some of the patterns are omnidirectional and may be represented with simple hemispheres, but more prevalent are directional antenna patterns with lobed behavior. An antenna's radiation pattern may be derived by analyzing station gain and path loss. Traditionally, antenna radiation has been characterized by appealing to two planar cross sections - the E plane representing a cutting plans of lines of electric force along the axis of the antenna, and the H plane, representing magnetic force perpendicular to the E plane. 3D Visualization requires the cross section concept be extended to depict antenna radiation as a translucent solid. Coordinates of the RF solid will be represented in the Autocad Drawing Exchange Format (DXF) to be compliant with popular modeling, rendering, and animation programs. "Nested" translucence will permit viewing of RF energy buried several levels below that represented by other sources of RF energy. Concepts supporting 3D visualization of RF energy and the flight path planning process are currently being developed at the IEWD as part of the Automated Map based Intelligence Support System (AMBISS), using Sun Sparcstations and a Silicon Graphics Indigo2 workstation.

PHASE I: During Phase I the contractor shall perform development to support 3D RF visualization, focused on the VHF directional antenna problem. Successful bidders will have experience with the Terrain Integrated Rough Earth Model (TIREM), a model designed and validated by the tri-services to represent path loss suffered by pairs of antennas respectively transmitting and receiving RF energy in the VHF portion (30-300 MHZ) of the electromagnetic spectrum. Also, the contractor shall be familiar with RF propagation using gridded databases such as Digital Terrain Elevation Data (DTED) or Digital Elevation Matrix (DEM). Received favorably will be those proposals indicating technical expertise with the emerging field of scientific visualization, including the topics of 3D modeling using DXF-formatted models, texture mapping with translucent, corrosive, bump-mapped and other surfaces, rendering modes including ray tracing, and experience with Silicon Graphics or OpenGL graphics programming. Competence with animation is also a desirable credential (RF energy may be perceived as pulsating when a signal fades or surges; also an RF radiation surface changes dramatically as a transmitter or receiver moves through rugged terrain). Deliverables shall include an interim report, a final report and a limited prototype demonstration of an environment containing a terrain populated by multiple texture-mapped 3D DXF models of directional, lobed VHF antenna radiation.

PHASE II: Phase II will be a full blown implementation of 3D RF visualization, extending the environment from VHF developed in Phase I to other forms of RF, including HF and radar. The contractor will perform the development using Digital Terrain Elevation Data (DTED), Arc Digitized Raster Graphic (ADRG) map products, and RF modeling software approved and validated by the tri-services. The implementation shall be compatible with UNIX- based platforms, with special emphasis on the Sun Sparcstation or Silicon Graphics workstations.

POTENTIAL COMMERCIAL MARKET: Commercial broadcasting networks and aerospace companies may be interested in the demographic impact of the technology as a means of visualizing the extent of propagation of VHF energy over a given geographical area or airspace. Law enforcement and security organizations could leverage the technology for surveillance applications. The earth resource exploitation and surveying industries may be interested in the technology as a means of visualizing communications when exploring new territories.

A96-059TITLE:Intelligence Preparation of the Information Battle Space

CATEGORY: Exploratory Development

OBJECTIVE: Understanding the information battle space is critical to providing support to both the C2-attack and C2-protect parts of C2W. Intelligence Preparation of the Information Battle Space (IPIBS) will serve as the fundamental building block for all C2W actions. The objective of this project is to develop the capability to overlay leadership decision making profiles onto the technical information processing capabilities of an adversary to determine the probable courses of action of that adversary, and how those courses of action can be influenced by C2 attack.

DESCRIPTION: The adversary decision making template is produced from AI assisted analysis of the leadership/personality profiles of key leaders and their related decision processes, matched against a set of problem types. similarly, a technology/culture based information infrastructure template is constructed from information technology and regional and country intelligence data bases. A C2W situation template is then created by superimposing the decision making process template on the information infrastructure template. Using AI assisted analytical tools, the C2W situation template is analyzed to determine strengths and vulnerabilities. The same process and analytical tools will be used by counter intelligence soldiers to conduct vulnerability assessments of the friendly information system and provide recommendations for improving Operational Security (OPSEC) and to protect the C2 system. The capability to thoroughly understand and graphically depict the information battle space is the fundamental basis for the successful execution of C2-attack operations. The IPIBS, and the analytical tools used to produce it, then become the wargaming, mission planning and mission rehearsal tools that are used to develop alternate C2W Courses of Action (COAs), predict effects, and conduct mission planning. Building on the intelligence mission of conducting electronic warfare, other sophisticated electronic attack operations will be planned and executed by intelligence units as part of the commander's C2W plan/strategy.

PHASE I: An analysis will be conducted which addresses the decision making processes of the various types of leadership profiles possible and how these decision making processes might be influenced by attacks on the information infrastructure. Phase I will culminate in a report that will describe the approach to implementing the IPIBS.

PHASE II: Phase II will involve development of a prototype system that implements the overlay of leadership profiles onto the information infrastructure and how attacks might be used to cause desirable outcomes. Several scenarios which represent typical war and operation other than war situations will be provided by the government and the system will be exercised against these scenarios. At the end of Phase II a report will be delivered that describes the results of the project. All software developed will be compatible with IBM PCs or equivalent.

POTENTIAL COMMERCIAL MARKET: The tools developed in this project would be useful for analysis of a firm's competitive position in a given market, and how that market might be influenced by actions taken by that firm to improve its position. These tools would also be useful for product marketing analysis and decision making.

A96-060TITLE:Wideband Fast Switched RF Synthesizer

CATEGORY: Exploratory Development

OBJECTIVE: Develop Fast Tuning Synthesizer(s) which can be used to rapidly tune over the 0.4 to 22 GHz range.

DESCRIPTION: Given the very short on-time of modern emitters at any given frequency, it is necessary for modern Signals Intelligence (SIGINT)/ Electronic Support Measures (ESM)/ Electronic Intelligence(ELINT)/Electronic Attack (EA) systems to rapidly tune to the proper frequency to intercept, identify and counter threat signals. The synthesizer should exhibit tuning speeds of <500 nanoseconds between band edges, the synthesizer must have sufficient frequency accuracy to permit the successful demodulation of narrow band signals to allow the generation of the appropriate countermeasure waveforms. The design will allow use as a coherent signal source, will strive to be inexpensive and lightweight and will use commercial and industrial system/subsystem components where appropriate.

PHASE I: This phase would define the design parameters and component limitations that would reflect the state-of-the-art in synthesizer technology available to meet the stated performance goals. The innovation would be in techniques/ technology which would enable the stated performance to be realized in minimal size, weight, power, and cost. The design and simulated performance of a prototype would be developed.

PHASE II: The proposed prototype would be built, tested, and integrated with the IEWD Electronic Support (ES)/EA Testbed to show its rapid tunability and frequency accuracy.

POTENTIAL COMMERCIAL MARKET: Home Satellite Systems, Commercial TV broadcast, elemental absorption line analysis, Radio astronomy.

A96-061TITLE:Integrated Low-Cost Ku Band Transmit/Receive Module

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a single chip, low power, Ku band Transmit/ Receive module

DESCRIPTION: Ground surveillance radars and on-the-move satellite communications antennas need phase arrays to form and point beams. Current work on high power modules does not satisfy the needs stated at a cost effective price. A major component of the coat is the large multi-chip packaging required. Both phase shifted and comparator source generator designs with single and dual paths will be considered with either gating or circulator isolation. Output power of 600 mw per path in desired after an 16-18 dB gain. The receiver side needs 18-20 dB of gain with a PHENT (paeudoheteromorphic high electronic mobility transistors) or other low noise preamp. All gains need set and dynamic gain control matching. Phase control should be at least five bits and separate for the XMT (transmit) and RCV (receive) paths. On-chip logic will be serial feed and have storage for beam patterns and gains at several frequencies. A $ 100 large quantity packagable design is sought.

PHASE I: Investigate and choose an appropriate target technology. Choose a circuit architecture. Design and develop a board containing all the digital control logic in an available technology. Determine whether a single chip design is feasible or not. Do a computer layout of the logic and RF in the target technology with RF path simulation.

PHASE II: Translate the Phase I design into a mask set for prototyping. Produce enough packaged chips for testing. Make any design adjustments and produce forty operational packages for prototype testing on a candidate phase array.

POTENTIAL COMMERCIAL MARKET: The main market would be for satellite and ground point to point communication antennas from moving platforms. Single chips would be suitable for small area motion detectors.

A96-062TITLE:Low Light Level Solid State Sensors

CATEGORY: Exploratory Development

OBJECTIVE: Develop shortwave detectors sensitive in the 1 to 2 micron waveband

DESCRIPTION: The focal plane arrays that are sensitive to reflected light in the 1 to 2 micron waveband. This focal plane should operate with minimal cooling (greater than 230K) to achieve image intensifier like performance. The array should also have pixel sizes close to image intensifiers (7.5 microns). A test array shall be built and tested to demonstrate low light level performance.

PHASE I: Develop material sensitive to reflected light in the 1-2 micron waveband. Make a small focal plane array and evaluate.

PHASE II: Develop high performance large format reflected light sensitive 1-2 micron focal plane arrays that has image intensifier like performance. Demonstrate sensor by building a small low light camera.

POTENTIAL COMMERCIAL MARKET: The commercial market would consist of small low light camcorders.

A96-063TITLE:High Power Tunable Output Filters for Electronic Attack (EA) Systems

CATEGORY: Exploratory Development

OBJECTIVE: Development of electronically tunable output filters for EA transmitters. These filters will replace the use of mechanically or PIN diode switched filter banks. Filters are used in EA to prevent the emission of unwanted frequencies, the increasing bandwidth requirements of modern EA systems call for increasing numbers of filter banks. The filter banks in order to survive the high power used in EA systems tend to be large and heavy. Considerable size and weight savings could be realized by using tunable output filters which would reduce the number of filters needed. Another benefit of tunable filters would be a much faster switching speed, PIN diode switches are currently the state-of-the-art in speed while the mechanical switches are significantly slower.

DESCRIPTION: The tunable filter concept is based in the variable capacitance of semiconductor junctions. It may be possible to develop a power varactor device capable of surviving in the output circuitry of a high power RF amplifier. Another possibility would be to investigate the use of current high power Field Effort Transistor (FETs) and Bi-Polar Junction Transistor (BJTs) as voltage or current controllable variable capacitances which could be used as part of the tunable filter. In both cases models of the devices can be used to develop circuits that can be used to estimate the bandwidth limitations of this approach. The goal of this effort is to design a filter system capable of operating over the HF and VHF frequencies, 1 to 300 MHZ, and handle a power output of 2 kW with as few filters as possible.

PHASE I: This phase will investigate the possible tunable filter topologies and the device parameters needed to achieve the goals. SPICE models shall be used to predict the performance of the filter structures. Semiconductor simulations, ouch as PISCES, shall be used to predict the performance of any specially design discrete devices. Testing of commercial FETs and BJTs to determine their suitability for this application is encouraged. The Final Report for Phase I will indicate the best solution to the high power tunable filter problem.

PHASE II: During this portion of the effort the contractor will be required to fabricate and test a representative filter circuit based on the results of Phase I. All methods and techniques used to fabricate the filter or any single device in this design must be based on standard industry technologies and practices. The contractor shall verify the operation of the filter by providing demonstrations of the final configuration.

POTENTIAL COMMERCIAL MARKET: Potential markets are commercial broadcasting, cellular base stations, broadband test amplifiers and high speed HF Automatic Link Establishment (ALE) systems.

A96-064TITLE:Non-destructive Real-Time In-Situ Analysis of Vacuum Grown and Processed Infrared Materials and Sensor Arrays

CATEGORY: Advanced Development

OBJECTIVE: Non-destructive real-time in-situ electronic and, chemical analysis of MBE (Molecular Beam Epitaxy) grown and vacuum processed infrared materials and arrays using x-ray and Auger electron spectroscopy.

DESCRIPTION: Develop and install high resolution XPS (X-ray Photoelectron Spectroscopy) and digital scanning Auger with computer controlled sample stage for the non-destructive analysis of three inch diameter wafers. This includes the custom sample exchange, vacuum. Vessel and sample stage which provides for tilt nondestructive chemical profiling, resolution, both energy and spatial, must be sufficient to address II-VI compounds and alloys, particularly HgCdTe, and the resulting sensor array elements. This must be accomplished with source energy densities- low enough not to damage the materials or devices under evaluation. AU analysis, data acquisition reduction, and storage must be fully automated computer operations. An example configuration which addresses time requirements would include an x-ray monochromatic source, significant multichannel detection (minimum of 15) high resolution electron energy analyzer of long focal length (to clear wafer during tilt) and high resolution and sensitivity scanning Auger with low beam currents. Example specification would include signal-to-noise for Auger greater than 800:I (1000:I preferred) greater than 500,000 counts per second above background at 1OkV at 10na, and for

XPS a source resolution of 0.5 eV or less and an analyzer resolution of 25mv with a resulting count rate near (within 10%) 500,000 counts per second at 0.6eV resolution,

PHASE I: Design and install vacuum vessel and automated 3 inch diameter wafer stage to demonstrate wafer transfer and manipulation with existing Auger single Plus Cylindrical Mirror Analyzer (CMA) analyzer. Design must include all necessary ports and configurations for the proper subsequent placement of energy analyzer, monochromatic x-ray source and Auger electron gun.

PHASE II: Install and integrate all required analysis subsystems and computer work-station operation. Perform those modifications required to incorporate each subsystem into the custom in-situ analysis system These subsystems include: the high resolution electron energy analyzer, the monochromatic x-ray source, the digital high resolution scanning Auger, sample rotation high resolution ion depth profile system, and all required supporting hardware and control electronics. The workstation corner control system required will include all hardware and put software for system set-up, control and data acquisition, data reduction and display, Auger image processing and display, computer utilities, and automatic analysis (to include species identification, atomic concentration chemical state identification, and learned sequence operation).

POTENTIAL COMMERCIAL MARKET: Provides in-situ-high resolution electron spectroscopy for the molecular beams epitaxy, MBE, semiconductor growth community. Currently, the existing options include inadequate add-on components or external small sample systems which expose samples to ambient conditions. This addresses the need for rapid high quality non-destructive in-situ analysis in large wafer production growth systems.

A96-065TITLE:Integrated Detection and Location of Buried Metallic and Non-Metallic Targets

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate the feasibility to detect and locate shallow buried landmines.

DESCRIPTION: The objective is to develop and demonstrate a detection technologies capable of detecting and locating shallow buried landmines. These mines are metallic and nonmetallic and they range in size from 3 to 15 inches in diameter. The technology platform can be handheld, vehicle mounted, or airborne. The technical challenge is to develop a system which distinguishes targets from natural clutter in hardware and/or software. The advanced developed technology shall undergo testing against buried targets in a real, outdoor environment. All phenomenology is acceptable; the following suggestions are suggestions only and are not desired to limit acceptable concepts.

Specifically, hardware research topics might include optimal antenna configuration studies; in-situ soil parameter technologies; broadband, small footprint antenna configuration; x-ray source design using laser technology; infrared sensor with thermal resolution of 0.001 delta T; etc. Software research topics might include 2-D or 3-D imaging technologies independent of type of sensor input; methods of sensor fusion such as neural networks or correlation function: automatic target recognition algorithms applied to sensors, etc. The objective is to also obtain an understanding of the complexity of the detection problem. Mine detection has a long and rich history of technologies which have been pursued and found conclusively to be non-responsive to the mine detection problem. A literature search in previous mine detection technologies previous to the writing of the proposal is desired.

PHASE I: This phase shall include thorough analyses that theoretically and/or experimentally demonstrate the scientific soundness of the phenomenology to detect and locate the objects of interest.

PHASE II: This phase emphasizes field experiments and demonstrations designed to clearly establish the feasibility of the system to detect buried objects in real environmental conditions. The proposal shall accommodate the participation of the system in government blind field testing.

PHASE III: This phase shall emphasize an integrated system with sensor and signal processing onto a mobile platform. This phase shall further emphasize field testing and demonstrations of the system against real targets in real operating scenarios.

POTENTIAL COMMERCIAL MARKET: Mine detection technologies have applicability to various other applications including road inspection, utility line and pipe detection, buried waste detection and non-destructive testing.

A96-066TITLE:Software Architecture, Tools, and Modules for Soldier Education and Training

CATEGORY: Advanced Development

OBJECTIVE: To develop an underlying architecture, tools, and modules that will enable the development of standardized Intelligent Tutoring Systems (ITS) that will dramatically improve education and training for soldiers, leaders, and public school students.

DESCRIPTION: Computer-based education and training systems, often called Intelligent Tutoring Systems (ITS), have proven their capability to provide these advances. While much work is being done in this area, most applications are stand-alone courseware systems. For the potential of this technology to be fully realized, an underlying software architecture will need to be developed and then adopted as a common standard. A variety of innovative tools and modules will also need to be developed. The architecture will need to be open, modular, evolutionary, hardware-independent, and adopted as a commercial (not just military) standard. Courseware will be developed by many vendors, but will all need to conform to the standard architecture. This will permit students to build a personal student model of their achievement, rate and style of learning, and other factors. It will also permit students to custom design and integrate a complete curriculum to meet their needs, interests, and learning style. Additionally, it will permit a standard approach for measuring the effectiveness of courseware and educational techniques, which will provide a common framework for educational research in this area. Some tools and modules may include: courseware authoring tools, student evaluation modules, courseware-effectiveness evaluation modules, data collection and analysis tools, student model-building tools, or curriculum integration or planning tools.

PHASE I: The contractor will join with others in this field to work toward the development and adoption of a standard architecture. One or more tools or modules will be identified and proposed for Phase II development.

PHASE II: The contractor will continue to work with others in this field to evolve and standardize on an architecture. One or more tools or modules will be developed as proposed. The contractor will work with an Army sponsor to conduct a substantial test of the developed system.

POTENTIAL COMMERCIAL MARKET: Public education is also in need of an underlying software architecture, tools, and modules. The contractor will specifically be working toward the creation of a commercial architecture that will serve both public education as well as military education and training. The tools and modules developed under this contract should have both commercial and military market potential. Additionally, given these things, the commercial market for courseware should flourish.

A96-067TITLE:High Performance Miniature Antennas for Hand-Held Personal Communication Systems (PCS)

CATEGORY: Advanced Development

OBJECTIVE: RF systems for the Electronic Battlefield will require optimized and equipment specific antennas. Ideally, antenna designs should be specifically tailored to each application and optimized to assure maximum efficiency and gain coupled with minimal physical size and cost. A technology shortfall currently exists in the area of miniature and covert antennas that will be required for battlefield RF terminals to be effectively deployed in support of personal communications services to the soldier. Miniaturized antennas of the future will be required to support a multitude of "Iridium/ Orbcomm-like" low earth orbit hand hold (and smaller) satellite terminals, as well as RF cellmobile soldier terminals operating at VHF and UHF frequencies and ultimately to migrate up to the 20-Ghz (IFF (Identify Friend or Foe)) frequency band.

DESCRIPTION: The intent of this topic is to solicit workable concepts that will result in dual use (commercial/military) high performance, covert, low cost, adaptable (in gain, coverage, and equipment applicability) antennas for hand held use. Such antennas will address the requirement for moderate RF bandwidths and will be optimized for covertness and small physical size coupled with high gain performance. Potential concepts should address the RF and physical operation of the antenna under difficult (environmentally) and widely varying conditions of terrain and environment. Ideally, the proposed miniature antenna concepts will possess the attributes of hemispherical coverage and novel mounting schemes (such as flush mounting, enclosure sharing, etc.), support of frequency agile systems, support of a variety of modulation schemes and introduce technologies at or beyond the state-of-the-art. Narrow beam coverage as an option for use in some specific systems would be a desirable (built-in) enhancement.

PHASE I: Identify advanced concepts and technologies which will offer the potential of covert, high performance antennas stressing: miniature physical size, covertness, high efficiency, low cost, wide beamwidth, reconfigurable for narrow(er) beamwidth, and physical and electrical adaptability to a wide range of existing and emerging RF hand held terminals. Identify several prime candidates for development in a Phase II program. Low technical risk and high potential for successful development and dual use application would be the (technology/concept) selection criteria.

PHASE II: Fabricate, test, and optimize several candidate antennas in to operate in conjunction with an assortment of hand held RF terminal and cell mobile phone handsets. Establish performance criteria and verify through simulation and or live tradeoff analysis to determine and benchmark the antenna that most closely matches the Army's Electronic Battlefield needs for hand hold antennas.

POTENTIAL COMMERCIAL MARKET: Pursue commercial marketing to adapt the antenna to commercial systems such as wireless PCS, Pagers, RF Tracking and tagging systems, Call Mobile telephony, and mobile SATCOM world wide communication systems.

A96-068TITLE:Intelligent Display of Laser Radar, FLIR and Visible TV Imagery

CATEGORY: Advanced Development

OBJECTIVE: Provide a means of augmenting the ability of tactical users to identify combat vehicle targets by the intelligent display of co-registered data from Second Generation FLIR sensors, Laser Radar target profiles and Visible spectrum TV imagery. Co-registered imagery should be displayed on a monochrome or color monitor such that the means of display augments the operator's ability to discern the internal features of the target beyond that which would be discernible by viewing imagery from a single source.

DESCRIPTION: FLIR imagery at tactical ranges typically presents target imagery to an observer with approximately 25 vertical by 50 horizontal image samples across the target. Laser radar (LIDAR) devices are capable of collecting approximately 10 vertical and 20 horizontal range samples across the target. In some cases, the LIDAR image samples can match the FLIR image samples in quantity one for one. LIDAR can provide range resolution of approximately 20 cm. Visible TV imagery can be constructed such that it provides a one for one map of TV samples in the same quantities as FLIR imagery. In each case while the FLIR, LIDAR and TV image targets are co-registered, i.e., the three target images can be made to coincide spatially, the individual samples may not coregister. That is to say that row n of FLIR samples may not be in the same place across the target as row n of the LIDAR samples. Several attempts have been made to fuse FLIR and TV imagery and several approaches have been attempted to present three dimensional LIDAR images on a two dimensional display, (notably assigning a color to each range bin). To date these have not provided observers with much assistance in identifying targets.

PHASE I: Simulation and modeling using two targets. The contractor shall be provides with synthetic FLIR imagery and TV imagery of two tactical targets, a Soviet T-72 and a US MIA1. In addition, the contractor shall be provided with sufficient dimensional data to construct a LIDAR range map of the two targets. Target data provided to the contractor will be of significantly higher resolution than required by the problem presented in the description, above. The contractor shall model the data using the contractors proposed technique for image display and present the fused data in video tape and digital video formats in 6 target aspects for each of the two targets. Sample to sample registration between FLIR, LIDAR and TV imagery

shall be selected randomly. The video imagery shall be presented for each target in each aspect in at least 20 different random sample registration sequences for a total of 240 images.

PHASE II: Demonstration hardware. The contractor shall design develop and deliver hardware and software to fuse the images generated by a Second Generation HTI FLIR, day TV video and a LIDAR profiler. Output of the LIDAR profiler shall be azimuth, elevation and range data for each LIDAR sample. The contractor shall provide the source code of the software, the fusing preprocessor for each band FLIR, TV and LIDAR, the fusing processor and the display. The hardware and software must operate at 30 Hz minimum.

POTENTIAL COMMERCIAL MARKET: This project has commercial applicability for remote sensing devices in Police, Fire and hazardous environment activities where human operators must remotely operate equipment guided by multispectral sensors.

A96-069TITLE:Double-Sided High Temperature Superconductor(HTSC), Coated Single Substrate (thin-film), for Electronic/ Microwave components & Devices

CATEGORY: Exploratory Development

OBJECTIVE: To deposit HTSC thin-film on both surfaces of a single substrate. Fabricate variety of devices on both sides of the dual-faced HTSC substrates.

DESCRIPTION: Crystalline substrates are used for fabrication of HTSC devices or components. Decreasing the packaging size, increasing the efficiency, and the complexity of devices need be improved to expand the HTSC applications. The goal of this SBIR topic is to explore HTSC thin-film crystal growth on both sides of a single substrate. Furthermore, the resulting films will be used in device fabrication, characterization, and analysis. HTSC devices have shown suitable characteristics in applications such as antennas, and microwave devices. The performance of HTSC components, and their miniaturized dimensions can be greatly improved by utilizing a dual-faced HTSC Targeted application area to demonstrate such improvements are (reduced size, performance & device complexity) In high frequency(HF) antennas, and weight reduction for electronic sensing system for UAV payload applications.

PHASE I: The HTSC material must possess a transition temperature of greater than 80 degrees Kelvin (e.g.,TlBa2Ca3Cu4Oll or YBa2Cu3O7). For successful completion of PHASE-I, three to five different user specified operating devices will be fabricated, tested, characterized, and forwarded to the Army for further evaluation/testing. The government will specify configurations, and dimensions (in the range of 100-200 microns line width) of the devices. In addition to the devices, a formal written report including data, necessary graphs, data analysis, and etc., shall be delivered as part of this contract effort. The formal report must include, but not be limited to, the following salient technical areas: a detailed description of dual-faced thin-film deposition technique/ process; a detailed description of in-situ(preferably), or post annealing process; informative data on dielectric properties of different suitable substrate materials, and the particular substrate chosen for this project; detailed description of patterning procedure; a detailed comparison between the proposed method and those already existing in commercial HTSC fabrication industries; a detailed DC & AC test data and characterization of the devices (RF maximum frequency of 2 Ghz); recommendations on future devices and applications.

PHASE II: Phase II is the further investigation of the previous phase, and fabrication of more complicated devices (multi-port configurations, sensors, and antennas). Twenty devices will be fabricated, tested, characterized, modified if necessary, and delivered. A formal report, similar in scope to the report submitted in Phase I, is required.

POTENTIAL COMMERCIAL MARKET: The above technological effort can be implemented in variety of commercial applications related to integrated & microelectronics, civilian space technology, microwave, satellite communications, and etc.

A96-070TITLE:Soldier Situation Awareness and Well-Being

CATEGORY: Exploratory Development

OBJECTIVE: This exploratory development will research several conceptual opportunities to restore the diminished audio cues to the soldier in the described hostile environment. The effort will result in the demonstration of a combination of innovative technologies that enhance soldier awareness in a "cacoon" situation and permit him to perform the mission functions despite the threat of directed subliminal acoustic emissions. These functions will include the normal Command, Control and Communications required for tactical: situation assessment (enemy and friendly), planning, execution, status reporting, location reporting, synchronized action, reconnaissance, and physical well- being.

DESCRIPTION: Soldier performance in a modern battlefield environment is becoming increasingly demanding on the human sensory facilities and more lethal due to threat of biological, chemical, and other agents. Adding to the threat are electro-optic, electromechanical, and explosive weapons design to inhibit human performance by blinding, deafening, and transmitting subliminal commands disrupting normal cues. The logical defense mechanism to these threats has been to encapsulate and try to isolate the soldier from the hostile environment. When the human head is enveloped in a protective sealed helmet or the soldier confined to a sealed vehicle; he becomes disoriented because of the denial or mismatch of ordinary sensor cues. Compounding this problem is the need for the soldier to maintain communications on one or more nets which require wearing an earphone(s). The resultant effect causes the soldier to lose the vital situational awareness and well-being needed to react to changing threats and to carry out his mission.

PHASE I: Conceptually define and design a special audio transducer array to accurately capture the dynamic sound pressure waves. Develop the optimum geometry and time delay architecture to differentiate and resolve the directionality of the source. Formulate fast analog to digital converter and digital sound processing designs suitable for the processing of transducer array data into time and frequency domain coefficients. Use the signal processing capability to regenerate the captured sound pattern and format the data for presentation to the human listener such that audio cues seem natural and permit sound source direction, identity, and tracking capability using an encapsulating helmet or in a confined space. Provide a technical report on the findings and demonstrate the feasibility of approach.

PHASE II: Conceptualize and demonstrate audio cue enhancements so as to "focus" on a selected and background noise diminishment. Using the combination of sensor array and digital signal processor pin-point sound sources and amplify the sound simulating more sensitivity than the normal human ear. Develop and demonstrate integrated audio appliance prototypes that can accommodate the soldier communication and sound actuated systems in a "hands busy" environment. Integrate the regenerated environmental and spatially referenced audio cues on the same audio appliances. Prepare a Phase II plan for the development and demonstration of a fieldable audio cue restoral system that would optimize the lower echelon command, control, and communications needed to enhance situation awareness and soldier well-being on a hostile and contaminated battlefield.

POTENTIAL COMMERCIAL MARKET: Immediate applications on surveillance, drug interdiction, hearing protection, human audio sensor enhancement from tactical battlefield to foreign mission assignments. Use of the acoustic control and audio cue restoral will be of benefit in high noise factory production situations and when workers must wear encapsulating clothing such as in asbestos removal, environmental clean-up, nuclear biological active areas, micro-chip production clean rooms, riot control, and fire fighting.

A96-071TITLE:Moving Target Indicator (MTI) Radar Target Tracking using Context Constraints Derived from High Resolution SAR Imagery

CATEGORY: Basic Research

OBJECTIVE: Use Synthetic Aperture Radar (SAR) imagery to support real time validation of MTI target track association algorithms.

DESCRIPTION: Algorithms for tracking individual ground-based targets in a high target density environment using airborne MTI data tends to be problematic and can benefit from consideration of relevant domain constraints such as vehicle type, terrain obstacles and road networks. Since there exists limited regions of the world where adequate terrain elevation and natural and cultural feature databases exists, the development of context-sensitive target tracking models for ground-based targets tends to be inherently problematic. By using modern SAR imagery, it may be possible to identify certain easily recognizable domain features that are relevant to the MTI tracking problem. Although the analysis of high resolution SAR imagery for the purpose of extracting relevant domain features pushes the state of the art in image processing, it should be relatively straightforward to develop target association algorithms that produce track extensions that appear to be consistent with these discernible features. Similarly, such algorithms should suppress track extensions that appear to violate discernible domain constraints. For instance, target tracks that correlate with extended lineal objects in SAR imagery may be identified as a road- following vehicle. On the other hand, tracks that correlate with regions of the SAR image that appear to violate mobility requirements for ground-based tracked or wheeled vehicles, such as crossing a lake or ravine, would be suppressed.

PHASE I: In Phase I, algorithms should be developed that demonstrate the effective use of SAR imagery to support target track assignment algorithms for a subset of easily recognizable natural and cultural features. In order for this effort to be successful, fully registered SAR and MTI datasets must be obtained. The use of data from the Joint STARS may be adequate; however, even higher resolution images than generated by JSTARS may be needed to provide adequate detail for the successful fusion of the output from these two sensors.

PHASE II: In Phase II, the number of SAR features used by the tracking algorithm should be extended. Problems uncovered during Phase I should be addressed and resolved. For example, since parts of the road networks may be shadowed in the SAR imagery, the road will appear to be discontinuous. The tracking algorithm should be extended to accommodate at least a few of the typical anomalies observed in SAR imagery. In addition, more comprehensive test and evaluation of the algorithms should be carried out, to include the use of additional SAR and MTI datasets.

POTENTIAL COMMERCIAL MARKET: While available Digital Terrain Elevation Data (DTED) and Data Feature Analysis Data (DFAD) datasets remain limited, many DoD and non-DoD applications exist that require "context-sensitive" evaluation of real time sensor data. Treaty validation and earth resource monitoring, for example, both require the evaluation of real time sensor information with respect to relatively stable domain knowledge.

A96-072TITLE:Cost Effective Micro-Cell Communications and Situational Awareness using Spread Spectrum and Global Positioning System (GPS)

CATEGORY: Advanced Development

OBJECTIVE: Achieve the functions of Personal Communications Systems (PCS) type communications, position location, and commander's situational awareness of position locations in a cost- effective way by not implementing a separate GPS receiver at every handset location. Added benefits are that each handset is a light as possible.

DESCRIPTION: Present theory of situational awareness calls for embedding GPS receivers in various communications devices and communicating the GPS position data received over a communications link to some data collection center. This topic proposes to develop a system that achieves the same objectives of small cell situational awareness and communications without the added cost, weight, and power (battery) requirements that separate GPS receivers at all user sites would entail. Code Division Multiple Access (CDMA) spread spectrum (developed originally for SATCOM applications) has the benefits of being a multiple-access, low noise, bandwidth efficient modulation technique, but it also has the feature that distance between a transmitter and receiver can be calculated very accurately by measuring the number of Pseudo Noise (PN) chips in the modulation code that have elapsed between transmit and receive time. It is feasible that this technique can be used to provide a relatively accurate position location of handsets within the cell and provide this information to a data collection site and/or back to each user. A potential architecture might be one where a single micro-cellular basedstation is connected to three separate antenna's that receive CDMA spread spectrum communications signals from many user handsets. Three separate antennas must

each be known in position and placed far enough apart to resolve the location of all of the transmitting user handsets. Using a differential GPS receiver for the three separate antennas would accomplish this and allow the whole system to be transported periodically to accommodate moving users. Each handset would broadcast their PN codes and be received at slightly different times by each of the separate basestation antennas. Triangulation of these received signals could then be used to determine location of the transmitting signal within the micro-cells coverage area. In this way, only a small number of GPS receivers potentially just one) are required rather than including one embedded with each cellular handset. The system could be used to transmit calculated position back to a user requesting this data if they need to locate themselves on a local map.

PHASE I: Architecture definition, location algorithm development, modeled and measured data to confirm feasibility, and prototype design.

PHASE II: Refined architecture, prototype demonstration, and field demonstration.

POTENTIAL COMMERCIAL MARKET: Related applications are numerous. For example, the systems could be used as a combined paging, locating, and communications micro-call within an office building. Systems like this could be deployed at ski slopes or similar environments where communications and position location are important provided it can be done in a small handset. For instance, users of the system on a ski-slope could then talk to each other (other family members, staff) and be easily found if trouble occurs. The system could be adapted for use on a golf course for determining accurate measurements of distance from the handset to each hole. As commercial applications for such a system expand, costs and availability for DoD uses will decrease.

A96-073TITLE:Automatic Target Recognition (ATR) for Infrared Hyperspectral Imaging Technology

CATEGORY: Engineering Development

OBJECTIVE: Specific objectives are to expand the applications of second generation thermal imaging technology (Horizontal Technical Integration) to imaging applications that require spectral information. Two principle applications are target identification and chemical vapor imaging. Target Identification - Identification of targets by unique spectral properties has become of increasing interest to reduce probability of false detection or detection of targets in high clutter conditions. This program seeks to develop the capability to image at selectable or tunable spectral bands to increase the imaging contrast available for target identification. Chemical Imaging - The nature of a chemical plume makes it nearly impossible to acquire or track confidently without an image of the (chemical plume) target. Program concept is to provide an enhanced thermal camera that will permit the targeting of chemical plumes and other trace gases from ground locations. This research will provide a novel multispectral narrow band camera that will provide a unique view of the chemicals on the battlefield.

DESCRIPTION: The basic concept is to design a camera that spectrally dithers a tunable filter to permit signal optimization and background rejection. Research objectives involve the application of B-12 um focal planes, tunable filter technology and system development. Principle detector candidates include staring or scanning HgCdTe IRFPAs.

PHASE I: Develop rapid and adaptable spectral modulation techniques between 7.5 and 11.5 um at 0.05 um resolution (5 cm-1 at 10 um) for enhanced suppression of background clutter, detector nonuniformities and other interferences, agent discrimination and detection of additional targets such as troop emissions, ground vehicles, ships, aircraft, projectiles and missiles. Model, design or build optical assembly for use in chemical vapor imaging studies. Identify technical issues (cold filter, detector specifications), redesign and incorporate performance optimization requirements. (3-5 micron chemical imaging systems will also be considered but given less priority).

PHASE II: The goal is to demonstrate a proof of principle brassboard that will permit the imaging of chemical effluents or use spectral identification methods for target detection.

Specific tasks include: sensor performance modeling, compare performance predictions w/performance goals, identify low risk approach, develop test strategy, fabricate and test brassboard generic hardware to integrate tunable filter, customize software for specific applications, laboratory tests, field test for scenarios and final report describing performance for different applications.

POTENTIAL COMMERCIAL MARKET: Societal impact includes improved public health and safety, a means for cost effective environmental hazards reduction and regulation compliance and the enhancement of national security.

A96-074TITLE:Battlefield Image and Text Distribution Using a Personal Communications System (PCS)

CATEGORY: Advanced Development

OBJECTIVE: There are several sources of video images which can be received by a Common Ground Station (CGS) type earth station. They can be from a satellite, UAV, Tomahawk missile, or a helicopter at the receiving CGS terminal. These images have overlays of coordinates, radar Bites, targets and enemy movements added. No equipment currently exists that is capable of wide area distribution of this information for use by the soldier. The data and image could potentially be distributed over the local area by an inexpensive personal communications type terminal. A relatively high speed PCS can display the local area with troop and vehicle movements. Updating movements and position of enemy troops and equipment can be a matter of minutes. This data can be distributed to field commanders over the battle area in a secure manner.

PHASE I: Survey and study existing PCS concepts which can be used for a local data, digital video distribution system. The system to be a rugged manportable terminal capable of 10 to 15 mile secure communications. For security, the PCS can be an encoded or spread spectrum type terminal. The terminal should be capable of image updating in 3 to 4 minutes. A flat panel display should be approximately 511x411 in size 50 CGS terminal changes can be viewed. The system to be capable of display/report over multiple interfaces. This terminal should be able to transmit and receive in a cellular mode for a global type communications.

PHASE II: Design or implement an advanced development system to demonstrate the capability of local distribution of secure CGS type battlefield transmission to hand-held data image terminals.

POTENTIAL COMMERCIAL MARKET: Pursue commercial marketing to make technology available to industries for monitoring rapidly changing events over a wireless system.

A96-075TITLE:Visual Software Development for Parallel Machines

CATEGORY: Exploratory Development

OBJECTIVE: Determine methods and appropriate automated support that will facilitate visual programming for software applications, in particular mission critical, that will be implemented using massively parallel machines.

DESCRIPTION: The SBIR will address the issues associated with providing visual design methods, and associated automated support, for software applications intended for massively parallel processors. Issues include: a process for dividing complex problems into pieces that can be worked in parallel; communications approaches; how to assure a reasonable processing to communications ratio; distributed vs. parallel implementation differences; and application language considerations. To be usable and effective, these methods must follow good software engineering principles, include visual design representation that is integral to the method and support high order software languages, such as Ada 95, and platform independence.

Software is an essential (often the essential) component of most military and commercial systems. These systems involve large volumes of data from a variety of input sources that must be quickly processed and provided to a large number of outputs. This significantly increases the processing capability needed to provide the performance required from these Systems. Distributed computing may provide the more cost effective today, but as the cost and size of the parallel machines decreases, their use becomes more attractive. Creating software that takes advantage of this processing capability requires a software development approach that can decompose the solution into a large number of pieces that can be efficiently performed in parallel. This is not a simple task, since the approach must assure a high processing to communications ratio for the overall application. While it may not be feasible to completely design an application that can run in parallel, distributed, and single processor environments, it

should be possible to minimize the effort needed to move from one environment to another. Implementation in High Order Languages, such as Ada 95, which provide support for parallel and distributed programs should help mitigate difficulties encountered, including platform portability. Visual design methods offer a means for improving communications among the design/management team, and assisting developers and maintainers in "seeing" the complexity of the software program.

PHASE I: Select or formulate a visual design method and associated techniques needed for the creation of software applications running on parallel machines, and define automated support required. Additional consideration will be given for proposals that use Ada 95 as the application implementation language and identify potential users, military and commercial, of the proposed product.

PHASE II: Develop a prototype implementation that incorporates and demonstrates the approach and support proposed in Phase I.

POTENTIAL COMMERCIAL MARKET: Commercial corporations in areas such as banking, communications, and oil and natural gas exploration/refinement use large complex software programs in their day-to-day operations. Others, such as retail sales and service organizations, are migrating toward similar situations. Well engineered, understandable, and reliable software running on parallel machines would significantly enhance their operations, and an automated, engineering based visual design method will make that software more available, supportable, and affordable.

A96-076TITLE:Statistical Overlay of Communications Systems

CATEGORY: Engineering Development

OBJECTIVE: In the Distributed Interactive Simulation (DIS) environment, there does not currently exist the ability to model communications equipment tied to battlefield entities or units, for DIS exercises. This type of representation on the electronic battlefield is required in the Intelligence and Electronic Warfare community to describe tactical situations accurately. There exists in the IEW community, systems that exploit information gained through the interception of communication traffic such as GUARDRAIL and Rivet Joint. Therefore, an accurate portrayal of potential target system is necessary in determining the performance of these collection systems under a variety of battlefield scenarios. The ability of such systems to perform missions in a DIS exercise environment is considered a highly desirable goal since the intercept collection systems are expensive high value assets to deploy.

DESCRIPTION: The proposed effort will develop and model the distribution of communications equipment associated with specified deployed battlefield entities and organizational units in a simulated environment. Further, the deployed Semi -Automated Forces (SAFOR) will produce simulated communications traffic for a variety of tactical battlefield situations. The resulting communications simulation and modeling products will be integrated into an existing, off-the-shelf, tactical battlefield simulation system with Distributed Interactive Simulation (DIS) compliant protocol. Preliminary investigation into target systems has identified synthetic tactical battlefield generators such as Modeled Semi- Automatic Forces (MODSAF) or Interactive Tactical Environmental Management System (ITEMS) as candidate systems that are available and possess the features required.

PHASE I: An initial investigation in determining the organizational makeup of forces that can be represented as Semi-Automated Forces (SAFOR), distributed on the battlefield and the communications devices deployed with these forces will be performed. From this initial analysis, a single communications system will be selected. An implementation approach will be defined that accurately describes the parameters of the selected system will be constructed. Typical parameters would include power, frequency, bandwidth, beam characteristics and other relevant characteristics. The approach will also describe the techniques that will be used to tethered or attached to an entity that has a representation or known model in the DIS environment. The first phase will provide a detailed approach to meet the end goals of this project.

PHASE II: The objective of Phase II is to implement the approach defined in the first phase. software models for communication Systems will be developed and will be tethered to entities on the battlefield. Initially it is envisioned that the definition and deployment of communications devices and associating these devices to entities would be a manual, operator interactive process. The model will be exercised through various DIS scenarios, data will be collected on the performance of a communication collection system. The performance of multiple scenarios will generate a range of data sets that can be used for system sensitivity analysis. Once the basic approach is modeled and is operationally sound an automated deployment system for larger forces in the many on many mods of tactical battlefield operation will be developed. On the simulated battlefield numerous forces must be deployed with a wide range of equipment associated with each entity in a short period of time. It is proposed that an Expert Systems and/or several AI techniques can be utilized in defining these deployment patterns, strategies and equipment distributions on the synthetic battlefield. Some of the areas where expert systems and AI techniques can be applied are listed below. Use of templates or expert systems software in defining the deployed entity or unit. Tactical situation deployment of forces based on preset rules. Varying deployment patterns based on tactical situations or opponent type. In determining the organizational makeup of the Semi- Automated Forces (SAFOR) distributed on the battlefield, several factors comprising the characteristics of specific entities or units on the battlefield with associated communication capabilities require investigation. Some of these factors are as follows: The size of the aggregate unit deployed in a given location. The location on the battlefield of the unit. The type of mission by the unit deployed. The type and experience of the unit deployed. Types of communication equipment available to the deployed unit. C3 methodologies employed by the unit and opponents. Finally, as part of the Phase II effort, development and integration in the following areas will be accomplished. Creation of a communications systems database for entities and units. Integration of a communications database subset (a small number) to a DIS compliant software generation system. The target generation system is TBD (possible candidate systems MODSAF or ITEMS).

POTENTIAL COMMERCIAL MARKET: The Statical Overlay of Communication Systems will be designed around the implementation of tactical communication structures into the DIS environment. The product could be ported into existing simulator designed to analysis link budgets as a method to create a realistic environment or noise to effect link performance. Depending on the AI method used the noise could be a learned from collected test data thus significantly reducing time to develop a scenario. Also depending on the AI method used, that algorithm could be ported to consumer products that require analysis of their environment to determine there operation (e.g. an air conditioner could learn the daily cooling pattern and in the future implement them independently).

A96-077TITLE:Remoteware for Split-Based Operations

CATEGORY: Exploratory Development

OBJECTIVE: To develop and perform experiments and demonstrations with a standard software mechanism for remotely working with and assisting warfighter(s) in the field. This is to be accomplished by exploring software operating systems and application programs that can be used by two or more people in different locations.

DESCRIPTION: Just as workers can be more productive when assisted by persons performing administrative or other offline tasks, warfighter's can benefit from assistance. The existence of internet services on the Army's telecommunications system can make this possible by providing the infrastructure for these services to be performed remotely, removing the assisting personnel from danger and without them incurring the enormous support costs of fielded soldiers. This task seeks to develop and experiment with facilities which will support this type of interaction between personnel remote from the warfighter location and the warfighter.

PHASE I: The Contractor shall develop a system concept which will provide the technical basis for remote assistance of warfighters and develop initial experience with a prototype applications of this technology.

PHASE II: The Contractor shall develop the technical basis into a standard mechanism to support cross platform remote warfighter assistance applications and develop a number of prototype systems/applications, providing validation of, and experience with, the concept of remote warfighter assistance.

POTENTIAL COMMERCIAL MARKET: This technology can provide the basis for a global market, providing access to personnel in remote, and presumably less costly areas, that can provide services in a more cost effective way than acquiring them locally.

A96-078TITLE:Large (Virtual) Screen Head Mounted Display for Battlefield Visualization

CATEGORY: Advanced Development

OBJECTIVE: To develop and perform experiments and demonstrations with a virtual, 360 degree, heads-up display mechanism.

DESCRIPTION: The existence of devices for tracking parts of the body, such as accelerometers and eye tracking devices makes possible virtual 360 degree, full color, 3-D display devices, which when combined with 3-D aural devices can provide a virtual experience of virtual and real world objects for training, simulation, manipulation, or computer applications requiring large virtual screens. The user would move his head or eyes to naturally move around the large virtual display. This effort shall design, construct and experiment with a prototype virtual visual/aural display environment, and provide a development environment for developing experimental applications.

PHASE I: The Contractor shall develop a system concept for the display environment and develop initial outline of some prototype applications of this technology.

PHASE II: The Contractor shall develop the system concept for the display environment into a virtual 360 degree, full color, 3-D display device, combined with a 3-D aural device providing a virtual experience of virtual and real world objects and develop a number of prototype Systems/applications.

POTENTIAL COMMERCIAL MARKET: This technology can provide the basis for developing a strong US industrial presence in the virtual reality industry which is currently in its infancy.

A96-079TITLE:Amplified Optical Splitters for Optically Controlled Phased Array Antennas

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to investigate the development of amplified optical splatters (lossless splatters) for use in optically controlled phased array antenna systems. This will require demonstration of monolithic optical splatters (preferably based upon multimode waveguides, not y-branches) with integral semiconductoroptical amplifiers (SOA). The devices are required to split and amplify orthogonal polarizations equally. Crosstalk between orthogonal polarizations shall be minimized. Techniques to minimize amplified spontaneous emission (ASE) will be addressed. The devices will be used to distribute orthogonal polarized optical signals to the beamforming photonic integrated circuits. The devices will operate at nominal wavelengths of 1319 nm and/or 1530 nm. The near term goal is to use optical hybrid integration to integrate these devices with optical beamformers. The ultimate goal is to monolithically integrate these optical elements in a single device. This would provide a lightweight, low cost, robust, technically superior optical system for the optical control of phased array antennas.

DESCRIPTION: CECOM, is developing technology leading to the demonstration of optically controlled phased array communications sub-systems for Army communications on-the-move (OTM). Carriers frequencies might vary from 6 to 60 Ghz with data rates of 2.4 Kb/s to 155 Mb/s or more. Adaptive multiple antenna beams and adaptive null capabilities will ultimately be required. Major emphasis is being placed on a high degree of photonic integration to develop modular, scaleable and "frequency independent" subsystems for multiple applications and to reduce size, weight and cost, thus leading to a practical realization for Army tactical systems. Near term emphasis is on optical phase control. The system supports the Army initiative to "digitize the battlefield".

PHASE I: In Phase I, modeling will be conducted to experimentally verify the feasibility of the objective. Initial discrete 1X4 splatters and SOA's will also be developed.

PHASE II: In Phase II, the model(s) will be refined and IX4 and lX16 monolithic amplified optical splatters will be developed.

POTENTIAL COMMERCIAL MARKET: This concept will have potential uses in long haul communications systems, satellite and cable television (CATV) applications. Applications include SATCOM OTM (on-the-move ground terminals) and terrestrial communications OTM.

A96-080TITLE:Information Display for Battle Damage Assessment (BDA)

CATEGORY: Exploratory Development

OBJECTIVE: Define/develop a user modifiable set of display symbology for Battle Damage Assessment (BDA). The goal is to determine a set of symbol representations which form the building blocks for the unit resource information to be displayed. In addition, an interface is to be developed so that the user can easily design display combinations based on personal preference, and for the declutter of map displays.

DESCRIPTION: Battle Damage Assessment (BDA) is the timely and accurate estimate of damage resulting from the application of military force, either lethal or non-lethal, against an objective or target. One method of keeping the commander Informed of the threat's dynamically changing military capabilities is by displaying the threat's resource information on a map. Display requirements include the capability to annotate the reported resources of a given battle unit and, once a conflict begins, their changing unit strength and effectiveness. Various methods of display are necessary to accommodate user preference and for the

declutter of map displays in a dense environment. Viewing the threat resource information allows the commander to make decisions based on the current estimate of the enemy's remaining military capabilities and potential.

PHASE I: Study the current methods of displaying unit resources for BDA. Develop a core set of symbol representations. Design various display methods for core symbol combinations. Design an interface for the utilization and/or modification of the displays and symbols according to user preference and for the declutter of BDA information.

PHASE II: Implement and demonstrate a prototype of the Phase I design. Integrate the Phase II prototype with IEWD designated systems.

POTENTIAL COMMERCIAL MARKET: This technology would be applicable to software display systems for which the information requirements could vary with different users or change dynamically. Areas such as these Include transportation, logistics and weather systems.

A96-081TITLE:3-D FPA Process, Operation and Performance Model

CATEGORY: Advanced Development

OBJECTIVE: Extend existing heterojunction device physics model to a 3-D FPA process and device simulation model with the ability to simulate operation of SWIR-VLWIR scanning and staring focal plane arrays. The model will find application at both ARL and NVESD in groups that evaluate IR detector material and analyze FPA operation and performance. The model should also find application in IR FPA manufacturing and future system simulators that include IRFPA sensors.

DESCRIPTION: The 3-D model shall encompass two areas. IR detector processing and IR sensor operation. The model shall include modules that simulate double layer heterojunction IR detector processes with the output being displays of detector formation, material characteristics and detector performance and modules that simulate scanning and staring SWIR-VLWIR Focal Plane Arrays with the output being FPA performance. FPA performance should be displayed in a 3-D graphics format. The model should also include the ability to flowdown detector performance and material quality from FPA performance input.

PHASE I: Phase I efforts will include identifying existing heterojunction detector models for extension, identifying critical heterojunction fabrication steps and processes, development of models to represent the processes, identifying additional models necessary to fully simulate the operation and performance of IR detectors and FPAs in the SWIR-VLWIR (1-20um) region.

PHASE II: During Phase II software shall be written, fully tested and documented to simulate heterojunction detector processing and simulate and display in a 3-D format IR detector operation and FPA operation and performance. 3-D displays for FPA's shall reveal FPA crosstalk and non-uniformity. The software shall output FPA performance based on material quality and processing parameters input by the user. The software should also be capable of working in the reverse mod so that an output of material and processing parameters can be generated form FPA performance parameters input by the user or passed to the module by the detector processing simulation module. The model shall be validated with data provided by NVESD, in IRIS proceedings and in IRFPA, IR Detector and IR material reports on file at DTIC (Defense Technical Information Center).

POTENTIAL COMMERCIAL MARKET: Commercial processing/manufacture of infrared detectors.

## U.S. Army Edgewood Research, Development, and Engineering Center

A96-082TITLE:Miniature MALDI-TOF Mass Spectrometer

CATEGORY: Exploratory Development

OBJECTIVE: To develop a rapid, sensitive, bioselective technique that provides both triggering (i.e., biosentinel) information and data as to the identity of a biological agent.

DESCRIPTION: Current triggering mechanisms for biological detectors rely on non-specific counting and sizing of airborne particles. Since these methods provide no information on the nature of these particles, false alarms are prevalent. Mass spectrometry is the most sensitive and selective of laboratory techniques for identification of biological and chemical species. Unfortunately, these instruments suffer from size, weight, power supply, fragility and operator requirements which limit their use in the field. Matrix-assisted laser desorption ionization (MALDI) is one of two next-generation mass spectrometric technologies capable of providing considerably enhanced detection and identification of the full range of biological agents (i.e., toxins, bacteria, viruses). MALDI utilizes a very rapid laser pulse of low intensity to vaporize and ionize high molecular weight biomolecules in a matrix of organic material. The process provides a means of mass analyzing fragile large biomolecules with minimal fragmentation as well as minimal multiple charging of the resultant ions. Due to the pulsed nature of the ionization process, MALDI is best suited for coupling with a time-of-flight (TOF) mass spectrometer. The advantages of a TOF mass spectrometer include very high ion transmission (hence sensitivity) and unlimited mass range. Conventional MALDI also requires human intervention to prepare samples for introduction to the mass spectrometer, since MALDI currently requires drying of a liquid sample solution on a substrate. Direct on-line coupling with liquid sample processing techniques as will be required for field analysis of biological agents is not currently facile.

PHASE I: This effort will provide enhancement of MALDI-MS technology through development of improved mass resolution in a compact device and through development of liquid sample introduction approaches permitting direct coupling with analyze chemical separation methodologies for bacterial and viral challenges. Resolution enhancement will be realized through space-velocity correlation focusing.

PHASE II: The full range of factors affecting MALDI=TOF-MS resolution will be defined and the space-velocity correlation focusing method further developed to provide optimum resolution over the widest possible mass range in the smallest possible TOF-MS configuration. The other major instrumental enhancement to be accomplished is to construct and incorporate within the ion source region of TOF-MS a new sample introduction methodology. This new approach utilizes ultra low volume flow of solvent containing analyze and matrix through a capillary terminating in the ion source region, thus permitting direct on-line coupling of liquid based analyze separation methods.

POTENTIAL COMMERCIAL MARKET: The MALDI mass spectrometric technique is one of two approaches currently very widely used in the biological analysis field (pharmaceuticals development, infectious and hereditary disease studies, etc). The proposed developments will diminish the overall size of the mass spectrometer by a factor of two to three and streamline laboratory applications, thus providing a huge competitive advantage over current approaches. Successful development of the approach will have an impact on the market measured in the tens of millions of dollars. In addition to commercial applications, law enforcement agencies have demonstrated considerable interest in techniques which could shorten the time for DNA analyses. The enhanced resolution and streamlined analysis by the proposed approach in the analysis of DNA fragments will provide an attractive complement in the analysis of such materials.

A96-083TITLE:<u>High Performance Aerosol Collectors</u>

CATEGORY: Basic Research

OBJECTIVE: To develop a low energy aerosol collector which collects in the sub-micron range while preserving the viability/integrity of the biological agents being collected.

DESCRIPTION: Biological warfare threat agents are inherently aerosols, small particles carried in the air along with the multitude of ambient aerosol particles. Downwind from a release, the concentration falls to very low numbers, and requirements documents specify detection at concentrations of a few particles per liter of air. By comparison, it is not unusual for ordinary air to be carrying a million ambient aerosol particles per liter. Current detection systems (e.g., NDI-BIDS and P3I-BIDS components) require samples on the order of 10,000 particles for analysis which, in order to make a detection quickly, requires a

high volume aerosol collector (1,000 liter/min) which concentrates the aerosol into a small volume of liquid. The BIDS system uses multi-stage virtual impactors to accomplish this. While they represent the state-of-the-art, they have several shortcomings: (1) They need a lower particle cutoff of about 1 micrometer in diameter. There is concern that currently required collection time is too long, (2) Virtual impactors are heavy, bulky,, and power consuming, (3) Modifying them to reduce the lower cutoff sizes requires much more power (e. g., cutting the size in half takes about a 4-fold power increase), and (4) Current impactors are such energetic devices, they damage biological particles, which interferes with subsequent analyses that depend on viability.
The most important aerosol-concentrating step in these aerosol collectors is the phase change to liquid. Current research offers alternatives to the virtual impactor, and improvements in collection medium which can enhance survivability of injured microorganisms. Furthermore, aerosol inlets do not have the same collection efficiency for all size particles, and these size effects depend on the wind speed and direction. There is a need to develop collectors for employment in much higher winds, but for which the directionality is far less variable. Examples include aircraft carriers operating into the wind for flight operations, aircraft, UAVs.

PHASE I: The focus will be on evaluating the potential for designing a concentrator with a 1 micron cut-off without increasing power utilization. Approaches to design a "bio friendly" collector which reduces physical stress on the biological materials, and collects them in a hospitable liquid for suspending hydrophobic particles and protecting viability, will be stressed. The device shall concentrate at least 350 l/min of air into a small volume of liquid (approximately 5 ml) with 30 percent collection efficiency for 1 micrometer diameter particles using not more than 40 watts.

PHASE II: A low energy, compact, energy efficient, wetted cyclone for UAV scale applications will be designed. Additional new concepts include passive (turbulent) collection to wetted walls in a tipped, sharp edged inlet; low resistance electrostatically charged filters; tortuous path wet walled flow-through tubes; and studies of highly superisokinetic and subisokinetic designs, including blunt inlets for wind direction insensitivity over reasonably forward directions.

POTENTIAL COMMERCIAL MARKET: Applications in the commercial sector include any situation in which air quality must be stringently monitored, such as the manufacture of integrated circuits, hospital surgical suites and isolation wards, or in civil defense applications. The indoor air quality community comprises a number of companies engaged in fulltime such work for industrial and health services clients. They desperately need such a device which could run unattended on battery power overnight. As an indication of the size of this customer base, there are over 15,000 certified Industrial Hygienists in the United States. A significant proportion of them would have a use for such aerosol collectors

## U.S. Army Missile Command

A96-084TITLE:Optoelectronic Packaging for Through-Substrate Communications

CATEGORY: Exploratory Development

OBJECTIVE: To develop materials, devices, and packaging techniques that allow high-speed communications vertically through the substrates of multichip modules (MCMs).

DESCRIPTION: Recent developments in integrated optics technology have led to the capability of hybridizing different material systems onto a silicon chip. This enables the placement of advanced optoelectronic devices onto the chip substrate. Since silicon is transparent to infrared energy, the possibility exists to optically communicate through a silicon substrate using 1.3um sources and detectors. If the chips are mounted to a rigid or flexible MCM substrate that is also transparent to IR, the modules can be stacked three-dimensionally to provide optical communication vertically and electrical communication horizontally and at the module edges. What is needed is a low cost method of packaging these optoelectronic multichip modules to allow for high speed processing within the modules and high speed communications between stacked modules.

PHASE I: Examine material combinations and processes for high density packaging of optoelectronic modules. Determine applicability of available substrate materials. Investigate applicability of off-the-shelf silicon CMOS processors. Perform trade studies on emitter and detector components (LEDs vs. vertical cavity surface emitting lasers, P-i-N vs. metal-semiconductor-metal detectors) and interface circuits. Address design issues relative to alignment of emitters and detectors. Develop basic packaging design for a simple two module, four chip stacked signal processor. Simulate performance and thermal-mechanical characteristics of the processor. Develop engineering estimates for volume manufacturing of the processor.

PHASE II: Design and fabricate a prototype 3D stacked, optically interconnected simple signal processor. Test processor performance and thermal characteristics. Examine cost drivers in fabrication process and recommend cost reduction enhancements. Design and execute a small fabrication run of a Fast Fourier Transform (FFT) processor in a multiple module package.

POTENTIAL COMMERCIAL MARKET: The equipment developed under this SBIR effort would be an enabling technology for the availability of high performance processors for military applications in automatic target recognition, C4I, and digital battlefield applications. Computation-intensive commercial applications include medical sensor data processing, high-end workstations, and supercomputer applications.

A96-085TITLE:Advanced Three-Phase Combustion Analysis

CATEGORY: Exploratory Development

OBJECTIVE: Develop methodology to simulate combustion of a three-phase fuel mixture in a combustion chamber and determine mixing and combustion efficiency.

DESCRIPTION: Advances in Computational Fluid Dynamics (CFD) for missile exhaust plumes has recently led to vastly improved models for analysis of the combustion of two-phase fuel mixtures in the U.S./Japan Ducted Rocket (DRE) Program. This methodology can be expanded to three-phase fuel mixtures with a reasonable risk.

Recent advances in CFD methodology combined with advances in parallel computing and flow visualization methods have led to the ability to use advanced computational methods to analyze mixing and chemically reacting two-phase flows in three dimensions. This technology advance has led to the design of more efficient inlets, diffusers, and combustors for ducted rocket powered missiles.

The advances have occurred in the use of a Lagrangian formulation for the solid particulates in the flow, an advanced turbulence model using large eddy simulations to determine sub-grid turbulence, and the use of computationally efficient variational techniques in the computational algorithms. These improvements have provided a detailed understanding of the nature of the mixing and combustion never before seen in the technology.

Similar advances can be made for three-phase flow systems by adding liquid thermodynamics to the existing two-phase mixing and reacting fluid dynamics. This element will be added to a time dependent Navier-Stokes algorithm that produces time accurate solutions to the coupled set of partial differential equations.

PHASE I: Technical approaches will be formulated for the addition of liquid phase thermodynamics to existing two-phase mixing and reacting fluid dynamics models to provide an advanced three phase reacting flow computational fluid dynamics model. The formulations will include sub-models to treat each of the flow phenomena such as particle breakup, particle coalescence, phase-change, and liquid/solid phase combustion. At least one innovative sub-model will be coded and implemented to assess the capability and potential for technical advancement. In addition, the enhanced computational fluid dynamics model will be exercised for one proof-of-concept test case to be provided by the Government, a simulation of the combustion of a solid fueled ducted rocket with two phase flow to include both gas and solid phase combustion. The results of this simulation, the predicted combustion efficiency for this engine, will be delivered to the Government for comparison with a measured efficiency. The intermediate results are expected to provide a time space map of the following: a. Gas density b. Gas temperature c. Gas velocity d. Gaseous species mole fractions e. Pressure f. Unburned fuel in the engine g. Temperature of each size of particulate h. Velocity of each size of particulate i. Species composition of each size of particulate j. Turbulent kinetic energy k. Turbulence scale length l. Vorticity

PHASE II: The three phase flow model enhancement formulated in Phase I will be finalized, documented, coded, and incorporated into an existing Government two phase reacting Navier-Stokes computational fluid dynamics model. Additional test cases will be provided by the Government for comparison with measured data to demonstrate the ability of the advanced three phase gas-liquid-solid particulate flow model to solve realistic problems.

POTENTIAL COMMERCIAL MARKET: This is clearly a dual use technology with application to turbine engines (aircraft, helicopters, aircraft auxiliary power units), internal combustion engines (gasoline, diesel) and solid fueled engines (ramjets, rockets, missiles). The commercial market is the aircraft and automotive industries.

A96-086TITLE:Optical Based Pressure Measurements for Aerodynamic Flows

CATEGORY: Exploratory Development

OBJECTIVE: Development and demonstration of a non-intrusive technique to measure surface pressures on a body immersed in an aerodynamic flowfield.

DESCRIPTION: The rapid advancement of Computational Fluid Dynamics (CFD) has led to a dramatic improvement in the capability to predict flow fields around a tactical missile, a UAV, or a helicopter. These rapid advances are providing the capability to design Army hardware faster and much more accurately than was possible in the past. This predictive tool is, however, limited by the understanding of the physical principles involved in these flow fields. These physical principles must be determined by using both CFD and making experimental measurements in order to understand the physics of the flows. This critical area has also seen improvements recently with the development of new measurement techniques for the flow field. Optical diagnostic techniques have been developed and have been implemented in ground test facilities for the measurement of various flow field variables of interest. Included among these is velocity using Laser-Doppler velocimetry, species density using Raman spectroscopy and Laser Induced Fluorescence (LIF) techniques, as well as temperature using Raman spectroscopy and other laser based spectroscopic techniques. Optically based pressure measurements concepts have been developed but have been applied only in limited situations primarily for research. The state- of-the-art in this technology field is the use of pressure sensitive paints to determine surface pressures on models used in ground test facilities. Only a minimum of technology development in this area is required to allow this technique to attain a wide usage in development projects rather than strictly

used in research projects. Optical pressure measurements would provide a complete description of the mean flow field without altering the very flow field that is being measured using conventional pressure transducers by adding pressure to the flow field variables that can already be measured optically and are mentioned above. These measurements would provide a great enhancement in the flow field description by providing blanket coverage of the surface pressure as opposed to pressures only at selected locations where a probe is placed. This allows a visualization of the "forest" without the necessity of extrapolating the forest by looking at a few of the "trees" in that forest.

PHASE I: Work in this phase would be concentrated on producing a feasibility study for the optical based pressure measurement system and the demonstration of a limited capability system. Work would be aimed at choosing specific chemical compounds that will fluoresce at the flow conditions of interest for the ground testing of tactical missiles, UAVs, and helicopters. This choice would involve the combination of high intensity signals for the range of pressures expected for the flow conditions mentioned, the temperature sensitivity of the active chemical compounds over the same range of interest, and the choice of the laser, the sensor array, the data recording and storage facility, and the software necessary to tie the facility together.

PHASE II: Work in this phase would include the development, design, and fabrication of the system and a demonstration of its capabilities in a ground test facility. Specific requirements include the calibration of the optical measurement system by determining the operating characteristics of the pressure sensitive paint used in the system. These also include a calibration of the pressure maps under various operating temperatures that the paint will be subject to in the ground test facility. Additionally, there is the requirement to provide the software to correct the data for skewed surfaces relative to the optical axis. It will be necessary to develop calibration techniques to provide for both static and dynamic signals from the surfaces of the model to produce calibrated pressures on the model. Methods of addressing the non-uniformity of the paint coating must be addressed. Contamination and degradation of the paint in the wind tunnel environment must also be addressed. This system must be capable of accurate measurement of pressures over a range of operating conditions consistent with the environment seen by Army tactical missiles, UAVs, and helicopters.

POTENTIAL COMMERCIAL MARKET: This is clearly a dual use technology with application to turbine engines (aircraft, helicopters, aircraft auxiliary power units), internal combustion engines (gasoline, diesel) and solid fueled engines (ramjets, rockets, missiles). The commercial market is the aircraft and automotive industries.

## U.S. Army Natick Research, Development, and Engineering Center

A96-087TITLE:Body Heating System

CATEGORY: Exploratory Development

OBJECTIVE: To research, design, and develop a personal heating system to provide auxiliary heat to the individual soldier.

DESCRIPTION: The US Army operates in all climate extremes, including the extreme cold. In extremely cold environments, soldiers wear bulky, insulative clothing. A method to eliminate some of the bulk in the clothing or to extend the mission is to provide auxiliary heating to the body. Currently no lightweight, easy-to-use heating system is available to the individual soldier. Such a system would augment current cold weather clothing ensembles by providing longer durations at colder temperatures or enhance freedom of movement by reducing insulative layers of clothing. The complete system, including power, shall weigh no more than 8 lbs, last a minimum of 4 hours before recharging/refueling/etc., recharging/ refueling shall be accomplished in the field by the individual soldier without tools, shall provide a maximum of 500 watts of heating, shall have automatic control, and shall have minimal signature.

PHASE I: Investigate the various technologies available to provide auxiliary personal heating and identify those that show high potential in meeting the stated objectives. A demonstration of feasibility is highly desirable.

PHASE II: Design and develop a working prototype of one or more of the technologies identified in Phase I. Also demonstrate the effectiveness of the system(s) against the performance criteria.

POTENTIAL COMMERCIAL MARKET: The potential commercial market for such a body heating system is very large. Virtually anyone outside in the cold for extended periods of time would benefit from the system. Such people include: construction workers and linesmen, cold storage workers, skiers, snowmobiles, ice fishermen, scientists, etc.

A96-088TITLE:Extruded, Shelf-Stable, Intermediate-Moisture Meat Jerky Analogs

CATEGORY: Basic Research

OBJECTIVE: To identify physical/chemical mechanisms responsible for textural changes in extruded meat jerky analog products during storage and to recommend processing/formulation technologies to minimize these deteriorative reactions.

DESCRIPTION: Extruded meat-in-carbohydrate-matrix, intermediate-moisture products are under development as eat-out-of-hand ration components. These products are designed to have flavor and texture comparable to commercially available meat-jerky items, but also to provide carbohydrates as an energy source. Current development has yielded ration prototypes containing approximately a 1:3 meat:starch ratio with a moisture content of approximately 20%. These products are highly acceptable shortly after extrusion, but toughen significantly after short periods of storage (i.e., a 10-fold increase in elastic modulus after 4 weeks accelerated [ 125 F] storage).

PHASE I: Produce extrudates having a range of formulations and using a range of process/shear parameters. Also, test different types and levels of plasticizers and humectants. Evaluate textural stability during storage using mechanical testing, and conduct thermal-analysis/nuclear magnetic resonance-evaluation to assess changes in component state (i.e., migration or mobility of water).

PHASE II: Determine mechanism of extrudate toughening. Recommend process/ formulation parameters to minimize textural deterioration.

POTENTIAL COMMERCIAL MARKET: Snack items, high energy (performance enhancing) foods, backpack/camping products.

A96-089TITLE:Air Release Valve for Airbags

CATEGORY: Exploratory Development

OBJECTIVE: To design, fabricate, and test an air release valve for airbags for soft landing of airdropped payloads.

DESCRIPTION: In an effort to achieve rapid deployment and quick mobility, the U.S. Army is currently investigating using pressurized airbags to absorb ground impact energy and to soft land airdropped payloads. The airbags are made of heavy-duty coated fabric attached to the underside of a platform. The payload is rigidly rigged to the top of the platform. For low G-force soft landing of the payload, the airbag is pressurized first before ground impact. Upon ground impact, the high-pressure air inside the airbag has to be released at a prescribed pressure level to achieve soft landing of the payload. The prescribed pressure level depends on the payload weight, its descent velocity, airbag size, and air release area. Typically, the release air pressure level is about 5 psig and the required air release area is 1 to 2 sq. ft. A simple, low-cost, reliable air release valve is needed for this application.

PHASE I: Currently, the U.S. Army is experimenting with a 8'X4'X2' (height) airbag supporting a 1000 lb. payload. An air release valve operating in the range of 3 to 7 psig with a 1 to 2 sq. ft. release area is needed for this airbag system. In Phase I, a design concept of the air release valve will first be formulated. A prototype of the valve will then be manufactured. The prototype will be tested for its reliability and performance in a controlled environment with air pressure ranging from 3 to 7 psig.

PHASE II: Upon successful performance demonstration in Phase I, the air release valve will be modified and redesigned to be installed on the platform of the airbag system. The entire system will be vertical-drop tested from a crane to

evaluate the dynamic performance of the air release valve. The valve design will be further improved based on the test results. At the end of Phase II, two air release valves based on the final design will be delivered to the government.

POTENTIAL COMMERCIAL MARKET: Conceptually the following are possible applications of airbag technology in the private sector. Airbags could be used to supplement or eliminate non-environmentally safe packaging material used in cargo shipping, i.e., polystyrene packaging peanuts, etc. Shipping containers could be developed. Transportation safety crash protection for easily rollable vehicles could be designed using the airbag technology, i.e., moped's, motor scooter/cycles, golf carts etc. Safer cargo handling equipment can be developed using airbag technology, i.e. airport baggage handling, warehousing tractor trailer shipping/receiving systems. Most recently, the Justice Department has an interest in using airbags to restrain captives from excessive movement inside a police vehicle.

## U.S. Army Strategic Training Command

A96-090TITLE:Distributed Interactive Simulation (DIS) Applications for the Combined Arms Tactical Trainer (CATT)

CATEGORY: Exploratory Development

OBJECTIVE: To develop new and innovative solutions specific to CATT problem/ issue areas.

DESCRIPTION: The CATT program is developing a family of interoperable simulators for training a combined arms force in a real-time synthetic environment where the focus is sustainment training for collective tasks and skills in command and control, communication, and maneuver. The Close Combat Tactical Trainer (CCTT) focuses on Armor Close Combat and is the first of the family. CCTT can be represented as five major system elements: 1) manned simulators and staff workstations, 2) semi-automated forces (SAF), 3) DIS compliant network and protocols, 4) after-action review system, and 5) terrain and weapon performance databases.

As the CCTT work progresses and the training requirements become more mature the need for additional technological work has been identified. These needs are outlined below. Potential offerors may submit proposals for any or all of these problem areas.

a. The need exists to incorporate a wide variety of real-world, command, control, communications, computers, and intelligence (C4I) equipment into the CATT synthetic environment. Currently, CCTT has integrated the SINCGARS Radio Model (SRM) developed by CECOM for transmitting and receiving digital voice and data. The initial SRM was computationally intensive and modifications had to be made in order to save computer cycles and allow the SRM to be hosted within the computational resources of individual CCTT simulators. In the future, other C4I systems will be required for integration into simulators, including many of those in the Army Battle Command System (ABCS) including, EPLRS, MCS, MSE, ASAS, etc. The purpose of this effort is to develop an innovative C4I modeling methodology for interfacing C4I systems with a DIS simulation. The Tactical Internet Model (TIM) will be used as a proof of concept in this topic for integration into CCTT. Complementary objectives would include: reducing the computational demand of the SRM, interfacing Applique via an SRM and DIS interface, reducing network bandwidth demand for C4I traffic, and using client server architectures for radio and digital messages.

b. SAF is a key component of the CCTT (and CATT) program. Much effort has been expended in developing and encoding Combat Instruction Sets (CIS) to form SAF behaviors which are verified, validated, and accredited (VV&Aed) and linked explicitly to approved Army doctrine. There is a clear need to capture, reuse, and potentially change the software code associated with a given behavior or set of behaviors. The focus of this effort is to examine this problem and propose methods of capturing and editing the behavior code. If successful, the next step will be to develop a behavior editing tool for creating new behaviors. The tool is envisioned to allow a user (not a software technician) to capture the algorithms and code that execute with respect to SAF behaviors. The tool should work in a run-time environment and work on previously verified, validated, and accredited behavior code. Since, the tool is envisioned for users, it is imperative that this task be abstracted through an easy, intuitive graphical user interface. Training on the tool should be minimized and the tool should not require special hardware to run.

c. The need exists to develop a low cost alternative to the CCTT Commander's Popped Hatch (CPH). The purpose of this effort would be to develop and demonstrate an innovative, low-cost alternative to the CPH. For example a helmet mounted display or virtual reality goggles could be suitable for this purpose.

d. CCTT is using a FDDI Local Area Network (LAN) for distributing DIS packets. The need exists to maximize the number of packets that can be distributed locally over the network. The purpose of this effort is to explore innovative methods for data transfer over a FDDI network. Advances in Asynchronous Transfer Mode (ATM), data compression, and multicasting may have an impact on this problem.

e. After Action Reviews (AARs) are a key component of any training exercise. A need exists for an expert system or intelligent media agent to aid the observer/controller or evaluator to quickly sort and select critical training issues, identify and

supply the supporting results and doctrinal reference data, and produce structured AAR media presentations. The purpose of this effort will be to develop a prototype expert system that can capture results data from CCTT PDUs as well as requirements from the Individual Training Support Package (TSP) used to plan and develop the exercise scenario.

f. The need exists to develop and integrate highly efficient algorithms into the CCTT Semi-Automated Forces (SAF). Much of the computational resources available to the SAF system are used in performing routine, repetitive, algorithmic calculations associated primarily with terrain reasoning tasks. The purpose of this effort is to develop innovative methods to improve SAF algorithm performance while minimizing computational load and resources. When improvements cannot be made or are otherwise not available, new methods may be proposed and developed. Algorithms of key interest fall into the following broad categories: terrain assessment, route planning, obstacle avoidance, collision avoidance, intervisibility, identification of cover and concealment, fast, adaptive search algorithms, etc.

g. Existing planning and monitoring techniques and tools available for the execution of research projects contain little or at most a limited capability for managing engineering information sharing between multiple complex projects with numerous contractors located at diverse locations. Projects which implement Concurrent Engineering development processes frequently require significant customer (Government) participation in the Systems Engineering Integration Team (SEIT) and Integrated Product Team (IPT) processes to insure project success at meeting major product milestones. Specifically, existing tools do not allow for centralized control over distributed systems engineering related functions. Additionally, improved methods of disseminating research goals, status and results to other on-going projects are desired. Other systems engineering related improvements are sought and encouraged, and could be the focus of proposed research. For all systems engineering applications, the capability to centrally participate in distributed systems engineering functions is needed, specifically, a process applicable to PM CATT projects and the in place management information system structure. The capabilities could include common databases linked via wide area networks, desktop based video tele-conferencing, improved communications capabilities, and advanced information sharing techniques.

PHASE I: Explore alternative concepts and develop feasible approach.

PHASE II: Implement a best approach from Phase I with the objective of demonstrating the feasibility and effectiveness of the concept.

POTENTIAL COMMERCIAL MARKET: Entertainment industry; commercial simulators such as flight trainers and drivers trainers, video arcade industry, robotics, and system engineering management.

A96-091TITLE:Advancements in Distributed Interactive Simulation (DIS) Technology

CATEGORY: Exploratory Development

OBJECTIVE: To develop new and innovative solutions to a set of specific problems/technical issues of interest to the Project Manager for DIS.

DESCRIPTION: DIS represents an umbrella concept for future simulations. It includes a synthetic environment within which humans interact through simulation at multiple networked sites using a compliant architecture, modeling, protocols, standards, and databases. PM DIS is actively pursuing the development of advanced technological applications of DIS and has identified several additional areas, described below, currently needing further research. Potential offerors may submit proposals for any or all the areas.

a. The need exists to develop and test prototype architectures to support the integration of Command, Control, Communications, Computers and Intelligence (C4I) operational weapon systems with virtual and constructive simulation. Specifically, integration of real or "live" C4I systems with virtual and constructive simulations in the context of the Defense Modeling and Simulation Office's so-called High Level Architecture (HLA) development is an important application area having at least 3 open technical issues requiring research:

1) representation of information to be exchanged between the "live" C4I systems and virtual/constructive simulations via the HLA Run-Time Infrastructure (RTI),
2) the development of an effective concept for representing and exchanging perceived data between "live" C4I systems and virtual/constructive simulations via HLA's RTI and determination of impacts on system bandwidth requirements, data logging, and after action reviews, and
3) determination of the effects of simulation based events, if any, on the "live" C4I system's performance. During Phase I, an offeror will be expected to review at least 3 candidate C4I system and nominate one to become the C4I "standard" system for the Phase I and II research

b. For large scale DIS applications the need exists for computationally efficient methods of simulating acoustical and electromagnetic (A&EM) propagation realistically in the atmosphere for battlefield scenarios. A technically similar problem, modeling of acoustic energy propagation in the ocean, has been studied extensively resulting in the development of very efficient and effective computational methods. An example is the development of the Parabolic approximation, Split Step Fourier (SSF) algorithm, to the Wave Equation (PE). The PE/SSF solution approach provides an efficient tool for ocean acoustic researchers to obtain solutions to the difficult problems of detection and localization in sonar system designs. It is conjectured that the PE/SSF methodology can be extended to the modeling and simulation of A&EM phenomena with application to large scale DIS exercises. In Phase I, an offeror will investigate the feasibility of extending the PE/SSF method to the propagation of A&EM energy in the atmosphere. Phase II will involve a practical implementation and demonstration for a selected Army application.

c. As the uses and missions of DIS applications mature, there is a need to develop efficient and effective methods for high throughput and low latency communication of encrypted/classified parameters for DIS experiments (to include multi-level security exercises) via the Defense Simulation Internet. In Phase I, offerors should investigate and develop innovative practical techniques or extend existing techniques such as multi-casting, bundling, compression, packet encryption, bulk encryption. Phase II will involve a practical implementation and demonstration for a selected Army application.

d. As the uses and missions of DIS applications mature there is a need to develop analytical tools and assessment system with the capability of analyzing weapon system operation and performance (e.g. missile flyout, and projectile trajectory) during a DIS experiment and after completion of the DIS experiment. In essence we are talking about developing "an after-action-review" capability but in the context of a weapon system development and testing environment. Such a system must apply and implement innovative visualization techniques to data it has collected (it must be capable of processing/interpretation of DIS PDUs at high data rates). In Phase I, offerors should investigate and develop innovative practical concepts. Phase II will involve a practical implementation and demonstration for a selected Army application.

e. There is a need to develop techniques and methods to support the scalability of joint and theater echelon-sized entities to be controlled as computer generated forces for future large scale DIS exercises. Viable techniques/methods must support the transmission of C3I data through varying levels of aggregation and reflects appropriate behaviors at varying levels of aggregation due to inputs of C3I such as situational awareness reports and FRAG orders. In Phase I, offerors should investigate and develop innovative practical techniques and methods. Phase II will involve the implementation and demonstration for a selected Army application.

f. Verification, Validation and Accreditation (VV&A) of synthetic environments may be viewed as the process which provides the scientific basis for the effective use of simulation for training and operational situations. Changes in a model within a simulation now require a complete repeat of the VV&A. This is a time consuming and costly process. What is needed are new and innovative concepts, techniques and methods that will directly address this problem and promote the re-use of existing VV&A models. In Phase I, offerors will develop practical concepts, techniques, and methods. Phase II will involve the implementation and demonstration for a selected Army application.

g. Many constructive simulations are available today that simulate logistics at the strategic level (mobilization, deployment, sustainment). These include entity level simulations of the strategic movement of Army forces and equipment from CONUS installations to the theater of operations. Most of these simulations are for planning and analysis purposes, and are not DIS

compliant. Currently there is no requirement for these simulations to be DIS compliant or interoperable. However, it is anticipated that strategic logistics will play an increasingly important role in future large scale DIS exercises. Therefore, the need exists to develop an automated and seamless interface between existing strategic level logistics simulations and DIS compliant systems operating on the DIS network. An interesting and possibly useful concept to consider may be that of an "logistics agent". Such an agent would act as an interface between the existing non-DIS compliant logistic constructive simulation and other entities participating in DIS exercises. It is also envisioned, this agent would act as " a facilitator" in the sense it would permit and support the use of both the training assets of DIS and the planning and estimation assets of constructive logistic simulations in an holistic manner. In Phase I, offerors will explore and develop a practical agent concept. Phase II will involve the implementation and demonstration the concept for a selected Army application.

h. Large scale DIS exercises are extremely complex dynamic domains that require a real time dynamic data base management system (DBMS) to support them. Standard hierarchical relational DBMSs and to some extent object oriented methodologies do not adequately support the problems created by complex data and complex problems all in a real time dynamic synthetic environment. The envisioned DBMS must be able to manage complex data (greater than 5 relationships per entity), within complex problem domains (100,000 or more geographically dispersed independent entities in a synthetic environment), in a dynamic real time synthetic environment. In phase I, an offeror will Explore, propose and demonstrate feasible new Data Base Management System concepts. Phase II will involve the Development and implementation algorithms and the integration of the same into a designated Army synthetic environment applications.

PHASE I: Develop practical concepts, methods, and techniques.

PHASE II: Implement and demonstrate the results from Phase I.

POTENTIAL COMMERCIAL MARKET: Commercial communication networks; commercial interactive network game/entertainment industry.

A96-092TITLE:Advancements in Interactive Immersive Dismounted Soldier Training Technology

CATEGORY: Basic Research

OBJECTIVE: To develop new and innovative technological solutions to support the development of cost effective immersive unencumber training for the dismounted soldier in the context of synthetic environments.

DESCRIPTION: Until recently the inclusion of the individual dismounted combatant as a "real" proactive participant in combined arms simulation based training exercises (e.g. SIMNET and DIS exercises) was considered impractical. Advancements in virtual reality (VR) technology appear to have reached a state of critical mass because there are now at least three on-going projects within the DoD that have as their goal the development of an VR based synthetic environment that could support dismounted soldier training. For any of these efforts to be really successful the illusion they seek to create must be sufficient to cause the trainee to suspend believe while in the environment to the extent the trainee believes his action or inactions could cause harm or serious injury to himself or to his comrades. This illusive phenomena is called "presence" and has a sensory component and a functional component. The sensory component has to do with providing the appropriate stimulus to the senses while the functional component has to do with the functionality of other objects in the synthetic environment that the trainee interacts with such as weapons, radios, stethoscopes or any other assortment of "tools" a dismounted soldier might need to his job while in combat. To achieve the desired level of " presence" in the envisioned VR based synthetic dismounted soldier training environments will probably take years of research and development. The goal of this topic is to move the technology in an incremental fashion toward an acceptable state of "presence" in synthetic training environments. Several areas have been identified. Potential offerors may submit proposals for any or all the areas.

a. Body awareness (the correlation between the body we see and feel, and its synthetic representation) in the VR environment is commonly considered to be an important contributor to "presence". Two areas of interest are: low latency unemcumbering

holistic full body tracking (head, hands, feet, and torso), and a minimum "foot-print" wireless interface and high bandwidth communication link for soldier worn instrumentation.

b. High resolution visual imagery over a wide field of view is commonly considered to be another significant contributor to "presence". It turns out that high resolution imagery is only necessary over a small region of the field of view. Two areas of particular interest are: a practical ergonomically sound eye tracker compatible with current head mounted displays, and a practical ergonomically sound direct retinal scanning system (note: an eye tracker may be a necessary component of a retinal scanner).

c. Spatial audio is common considered to be significant contributor to " presence". It is not the development earphones and loudspeakers that is needed but rather new and innovative practical approaches for the presentation of auditory information. Sounds must come from the location of the objectives in the synthetic environment. Moreover, it is critically important that this be accomplished in such a way as to provide interactive synthetic environments with real-time rendering of realistic sounds which emanate from complex boundary and environmental conditions.

d. Olfactory stimulus or smells clearly has a definite "presence" role in synthetic environment. An approach that delivers the correct odor at the right time and place with minimum " foot-print" compatible with the synthetic environment is needed.

e. A new and innovative wireless accurate minimum "foot-print" instrumentation concept is needed to track (position, orientation, & key equipment operational events) the dismounted soldiers "tools" in the synthetic environment.

f. Methodologies for rapidly (<48 hours) creating terrain and associated feature databases for dismounted soldier applications with resolutions under one meter (micro-terrain) are needed. Both off-line pre-processing and real-time/on- line methodologies are sought. In addition, the development of an effective methodology for transforming legacy databases into databases with required resolution for dismounted soldier applications.

PHASE I: Explore concepts, methodologies, design possibilities in the above subject areas; develop concepts for each of the relevant possibilities: and show the feasibility for concepts developed.

PHASE II: Taking the results of Phase I, take the most promising concept, design, or approach and develop and demonstrate.

POTENTIAL COMMERCIAL MARKET: The proposed developments would have application in many commercial the entertainment, communications, and instrumentation.

A96-093TITLE:<u>The Relationship of Physiological and Psychological Effects and Performance/technology within an Immersive Virtual Environment</u>

CATEGORY: Exploratory Development

OBJECTIVE: To investigate relationships between various physiological and psychological effects within the virtual environment with the intention of (1) identifying causal factors, (2) development of new identification tools and (3) minimizing these effects through design or technology.

DESCRIPTION: The virtual environment will attain a degree of sophistication as a result of growth in wide range of technologies, many of which are in early stages of development. Most of these technologies support the stimulations of the senses (seeing, hearing, and tactile feeling) with the goal of making the virtual environment illusion compelling to the point of total emersion. If this endeavor is to be successful system design can not ignore the aspects of human physiology which are relevant to the simulator environment.

PHASE I: Assess, analyze and summarize current research for the purpose of identifying causal factors that may have technological solutions, and identify and develop new tool concepts for analyzing physiological and psychological areas of concern within a research testbed environment.

PHASE II: Develop and validate research testbed.

POTENTIAL COMMERCIAL MARKET: Video arcade entertainment industry; commercial simulators such as individual weapons trainers and SWAT scenario rehearsals. Within the medical community, assists in dealing with phobias.

## U.S. Army Tank-Automotive and Armaments Research, Development, and Engineering

A96-094TITLE:Real-Time Position and Orientation Tracking of Multiple Operator's Line of Sight

CATEGORY: Exploratory Development

OBJECTIVE: Integrate and develop the necessary hardware and software to enable a cost effective wireless, high fidelity six degree-of-freedom tracking of 25 human operator's eye/sensor line of sight, each of which are confined in a small cubicle.

DESCRIPTION: Real-time tracking of the operator's head orientation or sensor line of sight is of critical importance in both the real and virtual environments. A tracking system of high resolution (+/- 0.5 degrees and +/- 1 inch) for the position and orientation of an operator is required for use in live and simulated tests that involve humans. Head tracking to provide the observers field of view provides an additional dimension to observer testing. Knowledge of the observer looking at a target is essential in validating target recognition. Proof of Principle test have demonstrated that head tracking is sufficient for this purpose and that expensive, elaborate, eye tracking systems are not necessary. Current methods, which use short range magnetic fields are not suitable for large numbers of operators in close proximity. The Army Materiel Systems Analysis Activity requires a minimum of 25 operators to provide statistically acceptable data. The operators are normally placed in close proximity to ensure line of sight consistency. A need exists for a tracking system or systems so that up to 25 operators can be tracked in close proximity to one another. The tracking system must have a wireless instrumentation device for the operator with a minimum operating radius of 2 meters. It must also be lightweight, accurate, insensitive to metallic interference and have a high sampling rate. This system must also operate in a variety of environments from use in simulation labs to covered shelters outdoors to inside vehicles or simulators.

PHASE I: Research and design a system that would meet the criteria stated above. The report should address unit cost along with technical performance specification and operational constraints.

PHASE II: Develop, test, demonstrate and integrate the tracking system for 25 operators.

POTENTIAL COMMERCIAL MARKET: The potential commercial market for the position and orientation tracking system for simultaneous users is applicable to all virtual environment simulation exercises to perception and visualization experiments. Demand for the type of data that this system can provide will increase as more emphasis is placed on the consideration of man-machine interfaces and interface with MANPRINT analysis and simulation.

A96-095TITLE:Advanced Ground Vehicle Propulsion Technology

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to examine and develop technologies to increase power density with respect to volume and/or weight, increase efficiency, reduce specific heat rejection, and provide reliability improvements for high output military diesel engines.

DESCRIPTION: Anticipated future high output diesel engine operating conditions include cylinder heat loading greater than 4 horsepower (HP) per square inch (piston surface area), 4 cycle break mean effective pressure exceeding 300 psia, and brake specific heat rejection to coolant of 12 BTU per HP-Min or lower. Technology areas addressing these targets as well as that of reducing engine weight include, but are not limited to: 1) high temperature tribology (i.e., tribological system approaches should address high temperature lubricant capability, and friction and wear minimization in areas of borderline lubrication); 2) insulative componentry (i.e., components to be considered shall include pistons, rings, liners, valves, valve guides and seats, head or head combustion face and intake and exhaust ports and novel monolithic and coating applications for these components will be considered); 3) fuel injection system/ combustion enhancement (i.e., technologies to be considered include ultra-high pressure injection or other combustion technologies enabling diesel combustion toward stoichiometric conditions without fuel economy degradation); 4) high efficiency, broad range, low inertia and high tolerance to high exhaust pressure, and concepts to use a turboalternator as a compounding unit are being considered for electric drive applications); and 5) engine lightweight structural concepts (i.e., requirement exists to provide dramatic weight reduction in diesel engine structure and componentry). Also concept designs presented shall be consistent with Army initiatives to reduce operating and support costs. Two generic cost drivers are directly applicable to this topic: 1) causes of electrical/mechanical replacement costs and 2) causes of fuel/fuel distribution costs. It should be noted that the contractor may select component technologies supporting the above overall objective of the advanced diesel engine area. It is not expected that the contractor should necessarily develop a technology system addressing all the areas discussed above.

PHASE I: The contractor shall research technologies and prove concepts from a feasibility standpoint. Concepts designs shall be presented and substantiated via analytical calculations, drawings or in the case of hardware initial bench type testing.

PHASE II: Concepts shall be demonstrated in Phase II using a single or multicylinder engine with operating conditions similar to those of a high output military engine. Steady state as well as transient testing for 100 hours or more may be required.

POTENTIAL COMMERCIAL MARKET: Although commercial and military engines are of different power ratings, the trend for commercial engines is also toward increasing high brake mean effective pressure and higher operating temperature. The engine area of interest presented are all generically applicable to future commercial diesel engines currently under consideration.

A96-096TITLE:Phase-Change Mechanical Actuators for Ground Vehicle Design Applications

CATEGORY: Exploratory Development

OBJECTIVE: Determine potential applications in military ground vehicles for a class of mechanical actuators which get their driving force from the expansion of solid materials as they melt.

DESCRIPTION: A new class of linear mechanical actuators exists, which combines aspects of solenoids and hydraulic cylinders. A solid polymer, such as polyethylene or a wax, is contained in a hydraulic cylinder. as a polymer is melted by an electric resistance heater, it expands, driving a piston. This principle permits relatively small actuators to provide large forces and controllable strokes. These devices offer mechanical designers alternatives to solenoid and hydraulic cylinder actuators. They may replace solenoids where cost and force are more important requirements than speed. They may also substitute for hydraulic cylinders in locations which are hard to reach with hydraulic lines, but still accessible to electrical wiring.

PHASE I: Study potential military and commercial ground-vehicle applications for current technology phase-change mechanical actuators. Compare phase-change actuators to electrical and hydraulic actuators, in several common ground vehicle applications, such as hydraulic system control and positioning/tensioning devices. Comparisons should account for size, weight, power consumption, actuation speed, positioning accuracy, cost, and installation characteristic. Identify new applications for phase-change actuators, or offer substantial design, cost, performance or durability/maintenance benefits.

PHASE II: Develop and test a phase-change actuator, or family of actuators to serve a military/civilian dual-use application identified in Phase I. the device(s) will be demonstrated in military and civilian vehicle applications.

POTENTIAL COMMERCIAL MARKET: Phase-change actuators will offer designers of all electrical vehicle control systems (such as fly-by-wire) important alternatives to solenoid actuators. They will be an inexpensive means for all electric control systems to generate large forces, if actuation speed is less critical. These actuators will be most important in automotive applications, where electric control systems are increasingly used, and cost is crucial.

A96-097TITLE:Vision Research and Human Perception for Target Detection

CATEGORY: Basic Research

OBJECTIVE: An investigation of early models of human vision for target detection applications.

DESCRIPTION: The research community has made remarkable progress in its understanding of the early human vision system during the last 20 years. Computational vision models (CVM) use an oriented Laplacian pyramid spatial frequency decomposition as a means to perform a multi-resolution analysis of 2-D imagery. The output from the signal to noise model then inputs to a statistical decision theory module to predict probabilities of detection and false alarm. A missing ingredient in the latter process is the encoding of cognitive information which the human observer uses for higher levels of target discrimination. A major goal of this topic is to investigate the means for incorporating this knowledge into a model of human performance.

PHASE I: Outline a novel approach to accurately predict human observer performance for higher levels of target discrimination with complex target/ background scenes.

PHASE II: Develop a predictive model of human target acquisition performance for low contrast targets which correctly correlates with perception experiments. Calibrate and validate the model for both low and high contrast targets.

POTENTIAL COMMERCIAL MARKET: This human perception modeling research work will support the development of classified signature reduction and the TARDEC/GM collision avoidance countermeasure programs.

A96-098TITLE:A Numerical Approach for Predicting the Structure Borne Noise of Ground Vehicles Using Statistical Energy Based Finite Elements Analysis (SEFEA) Technology

CATEGORY: Exploratory Development

OBJECTIVE: To develop a numerical approach that can model the behavior of complex structures, such as ground vehicles, by using energy based finite element methods to address the high model density of the structure under analysis.

DESCRIPTION: The finite element method is presently being utilized to compute the structural vibrational behavior of military vehicles. However, these numerical techniques can only perform in the lower frequency range, below 200 Hz. That means that structural information from 200 Hz to 5,000 Hz is not available using standard FEA techniques. Statistical Energy based finite element addresses the higher modal density content of complete military vehicles and extends the analysis frequency range to the higher frequencies.

PHASE I: Develop an energy based finite element formulation applied to a simple military vehicle structure. The method will compute the feasibility of applying this method to the higher frequencies. The method will be verified by comparison to test data for a wheeled vehicle (e.g. a HMMWV).

PHASE II: Extend the frequency limit and apply the method to a more complex structures like tracked combat vehicles.

POTENTIAL COMMERCIAL MARKET: The energy based finite element method would have great potential in the commercial world to more fully understand complex structures.

A96-099TITLE:Accelerated Corrosion Test Chamber

CATEGORY: Exploratory Development

OBJECTIVE: To develop the critical parameters related to accelerated corrosion chamber development for the early identification and monitorship of corrosion in automotive components.

DESCRIPTION: Automotive components used by TACOM's wheeled vehicle fleet undergo varying degrees of corrosion under harsh operating conditions. A chamber that can simulate the corrosion behavior of the component or the integral system is desired, so that predictability exists for the performance of a system or component prior to full production and deployment in the field. This simulation using the corrosion chamber is expected to save TACOM several million dollars due to early feedback on current and future off-the-shelf acquisition.

PHASE I: Demonstrate the capability to develop a corrosion test chamber that can simulate numerous types of environments on components and integral systems.

PHASE II: Develop a component-sized chamber that can be used for corrosion studies of test components that can be correlated with field observation for corrosion.

POTENTIAL COMMERCIAL MARKET: This chamber will have the potential to be adapted for simulating corrosion over a wide range of industries that include power generation, automotive, aerospace, machine tool and weapons systems.

A96-100TITLE:Advanced Military Radiator

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to design, fabricate and test an advanced radiator cooling system for the M109A6 that is more compact and efficient, lighter weight and lower cost.

DESCRIPTION: Anticipate future need for an advanced radiator that is more compact, efficient and lighter weight than the present radiator. The M109A6 cooling system uses a high percent of the engine power to drive the fan. It would be desirable to have an advanced radiator cooling system that is more effective than the current M109A6 cooling system while increasing the performance. To reduce weight of the radiator one approach might be to use lighter weight material such as aluminum. Also the concept design presented shall be consistent with army initiatives to reduce operating and support costs.

PHASE I: In Phase I, the contractor would develop a concept for the advanced radiator and perform testing of that concept in the laboratory. The concept and testing shall be documented in sufficient detail to allow the government to determine if it will satisfy the requirements for the M109A6 and provide the desired improvements.

PHASE II: In Phase II, the contractor shall fabricate and test a breadboard prototype of the advanced radiator. The following items shall be deliverable under this effort: design drawings, test report, final report and the vehicle worthy prototype.

POTENTIAL COMMERCIAL MARKET: Application can include such commercial vehicles as police cars, ambulances, fire trucks, or other vehicle exposed to rough field usage. This technology could lead to a reduced operating and support (O&S) cost for any vehicles exposed to rough field usage.

A96-101TITLE:Optimization of the Spatial Arrangement of Reflectance Points for a Global Reflectance Model

CATEGORY: Basic Research

OBJECTIVE: Develop the optimum arrangement of reflectance points on any given vehicle geometry for a Bi-directional Reflectance Distribution Function (BRDF) based reflectance model.

DESCRIPTION: A reflectance model can be broken into two parts, a local reflectance model and a global reflectance model. The local model is based on a Bi-directional Reflectance Distribution Function which quantifies the amount of specular and diffuse light reflected from a particular point. The global model incorporates many reflectance points together along with the environment to give the total luminance to an eyepoint. Too many reflectance points is not practical due to computation times, so the question arises how to best arrange these reflectance points on a modeled vehicle to minimize the error and run-time.

PHASE I: Determine the optimum arrangement of reflectance points where run-time and error in luminance for a given vehicle geometry are simultaneously minimized.

PHASE II: Model a vehicle with various reflectance point arrangements and resolutions and develop an automated approach in C++ at finding the optimum reflectance point arrangement for that vehicle. The optimization criteria must work for a general vehicle model with the effects of a camouflage pattern considered.

POTENTIAL COMMERCIAL MARKET: There is dual-use potential in the Architecture and Film communities where interior and exterior modeling of light is used to communicate ideas and proposals. Other opportunities lie in the surface optics community. Simple ray tracing approaches do not consider light in a physically reasonable way.

A96-102TITLE:Validation Analysis System for Crewstation Simulators

CATEGORY: Exploratory Development

OBJECTIVE: To develop a validation analysis tool to handle the widely varied requirements of crewstation simulators.

DESCRIPTION: The Army is currently investing in the development of new class of simulator, the crewstation simulator. They place soldiers in simulated combat vehicles, where they interact with their environment and other simulated entities (through the Distributed Interactive Simulation, DIS< network). The DoD has set ambitious goals for its crewstation simulators, they are to be of sufficient fidelity and correctness to allow important decisions (battlefield tactics, design, procurement) to be made. Due to the breadth of the simulation (almost all aspects of a vehicle are simulated) and the disparate nature of the elements to be simulated (a Soldier Machine Interface simulation is dramatically different from a vehicle dynamics simulation), determining correctness is very difficult. The objective is to develop a suite of analysis tools (developed, purchased, or public domain) that mirror the non homogenous nature of the simulator, but are integrated such that they work effectively together. The ultimate goal is to utilize this suite to validate the performance of constructed simulators. Crewstation simulators are constructed such that they can simply record a large set of their internal workings; continuous data (like an oscilloscope), event data (like a timeline), histograms, etc. This data is recorded in simple, generic ascii formats; and forms the basis for all analysis. The results of analyses should be stored in a system that allows ready access to them, and related results; a configuration management system. Examples of elements to be compared to reference data and analyzed are: 1) Vehicle/turret/gun motion; 2) Propulsion system performance; 3) Soldier Machine Interface (SMI) performance; 4) Weapon system performance (missiles, guns, ballistics, etc.); 5) DIS compliance. Because of the ever changing nature of the crewstation simulation, it is desirable that the analysis be readily adaptable to different situations.

PHASE I: The goal of Phase I is to fully develop the system concept, perform significant design, and possibly to prototype a portion of the system.

PHASE II: The goal of Phase II is to develop a system as describe above. In order to insure usefulness, it is expected that the user will be continually providing feedback during its implementation, possibly by testing intermediate version.

POTENTIAL COMMERCIAL MARKET: The test analysis system will of course be applicable to the development of commercial products such as flight and automotive simulators. However, the test analysis system is intended to be one piece of much larger set of tools, with a development process built around the tools. This development process is specifically designed to handle the construction of complex systems, systems that are readily found commercially. It is the intention of the Army to promote this development process (with tools), and to distribute it to institutions where it can be applied.

A96-103TITLE:Low-Cost Titanium Tow Bar

CATEGORY: Exploratory Development

OBJECTIVE: Develop, design and investigate low-cost manufacturing and processing using low-cost titanium alloys to make tow bar lighter and cost competitive with the new M1 steel tow bar.

DESCRIPTION: Titanium alloys have higher strength-to-weight ratio than steels. However, higher cost of titanium alloys has prevented its use in automotive and military ground mobility vehicles. Titanium companies have developed lower cost titanium alloys which offer the potential for reducing automotive and military component weights such as springs, torsion bars, tow bars, etc. at a cost that is competitive with steels.

PHASE I: The contractor will evaluate low-cost titanium alloys for M1 tow bar maintaining commonality of attachments to the vehicles. Evaluate manufacturing processes, joining processes, post processing, material properties, and cost. Conduct trade-off studies to formulate the most cost-effective solution. Conduct lab testing of the selected material and process for the design of the tow bar in Phase II. A final report will document the results and compare the cost-effectiveness to the new steel tow bar and directions to be taken to make it cost competitive to steel tow bar.

PHASE II: The contractor will design the low-cost titanium tow bar from the properties established in Phase I. Contractor will manufacture a number of tow bars for testing at proving grounds. Analysis data. Conduct failure analysis. Redesign and fabricate if necessary.

POTENTIAL COMMERCIAL MARKET: The evaluation of low-cost titanium from the standpoint of their use for automotive and military applications is of substantial interest to the commercial automotive industry. This effort would benefit both the automotive industry, as well as the military market.

A96-104TITLE:Advanced Armor Vehicle Design

CATEGORY: Advanced Development

OBJECTIVE: To combine a capability (develop under an earlier contract) to evolve an optimum armor design by employing Artificial Neural Networks (ANNs) and a genetic algorithm using these ANNs with a 3-D ray tracing program such as BRLCAD to achieve an advanced vehicle hull design that is optimized for armor within constrains for weight and cost.

DESCRIPTION: During the last several years, under a TACOM contract, several branches of artificial intelligence have been successfully combined to produce a computer program that designs optimal armor configurations given an ensemble of threat munitions and armor weight constraints. The program utilizes artificial neural networks (ANNs) trained to understand armor design by using field test data and a genetic algorithm that uses these AANs to evolve an optimum an optimum armor design. In this process many thousands of armor designs are generated, evaluated, and either rejected or their best features combined to produce ever better designs. To our knowledge this is a totally new development concept which appears to hold great promise in future design efforts. It is now desired to combine this with a DAD process to design a vehicle that carries forward the results into a vehicle design.

PHASE I: Phase I would consist of the following steps: 1. Identify the CE, KE, and EFP threat munitions to be used against the vehicle. 2. Identify the envelope of possible azimuth and elevation angles of attack with respect to the vehicle for

each munition. 3. Identify all the candidate armor that will be evaluated against the threats. These can include reactive, passive (including vehicle structure) and combination of these. The candidates could include off-the-shelf tested designs, designs optimized against specific threats as described in the TACOM effort above, proposed contractor designs, etc. 4. Use a 3-D ray tracing program such as BRLCAD to construct approximately 100-200 rays passing through the crew compartments and covering the envelop mentioned above. Probabilities can be assigned to each of these rays to distinguish likelihood of top attack vs. frontal attack, side vs. front glacis attack, etc. Possible munition types are assigned to each ray together with the probability of use of given munition. 5. A total weight budget can be assigned to the vehicle. Using a composite of all the ray data, a genetic algorithm is then used to evolve the optimum armor types and placements on the vehicle in order to achieve the maximum crew protection within the total weight budget allowed for the specified threat suite.

PHASE II: Phase II would consist of fabricating a hull or a mock-up of the resulting Phase I design and validating the optimized design by subjecting it to ballistic test.

POTENTIAL COMMERCIAL MARKET: Validating of the method would open the way to optimize other vehicle designs where there are many input variables with numerous constraints. Classical optimization technology is simply not able to deal with such a complicated problem with finite computer resources. Our experience in the last three years has been that genetic algorithms offer the only hope of achieving near optimum results when confronted with many variables, all of which must be considered in arriving at the solution.

A96-105TITLE:PRISM, SPIRITS and GTSIMS Compatibility

CATEGORY: Exploratory Development

OBJECTIVE: To allow SPIRITS to take advantage of the image based systems capabilities within PRISM, incorporate plume technology from SPIRITS into PRISM for ground combat target and helicopter use, and to allow both of them to be capable of fully utilizing GTSIMS (DISAMS, etc.).

DESCRIPTION: GTSIMS is a missile engagement model that incorporates signatures of targets and backgrounds into a simulation. PRISM and SPIRITS have long been accepted thermal signature models for ground targets and air targets respectively. By allowing PRISM and SPIRITS to interact with GTSIMS, the power of three respected models will be brought together. PRISM and SPIRITS would both be modified to allow direct feed into GTSIMS. In addition, the Image Based System (IBS), which is found exclusively in PRISM, has proven to be a powerful methodology for rapidly calculating radiation shape factors with high precision. In order for this method to be extended for use in air targets, the solution method requires expansion, so that large high resolution models (over 30,000 elements) can be used in signature prediction and then it must be modified for use in SPIRITS. SPIRITS would benefit greatly from this improved capability. And finally, although its signatures for vehicle surfaces (skin) and engine hot parts have been extensively validated in PRISM, any gas emissions from exhaust are not included in the signature prediction. One of it's weaknesses is the lack of a plume model. There are, however, accepted plume codes found within SPIRITS that could be adapted for ground vehicle and helicopter analysis. These changes would allow engineers to use SPIRITS for aircraft and PRISM for ground targets and helicopters in a more accurate and efficient manner.

PHASE I: Investigate the required interconnections between the models and set up the framework for the integration, adapt IBS for larger models and provide a stand-alone capability for use in SPIRITS, and investigate axial and non-axial plume models for the requirements to integrate a plume signature into a PRISM vehicle signature.

PHASE II: Finalize the integration of the models, fully integrate the IBS methodology into SPIRITS, and fully incorporate the plume code into PRISM while complying with the needs and goals of both the Multi-service Electro-optical Signature (MuSES) Code Consortium and the Electromagnetic Code Consortium (EMCC) thermal subgroup.

POTENTIAL COMMERCIAL MARKET: An easy-to-use thermal model with simulation, an emphasis on quick radiation, and the ability to utilize plumes has dual use potential in automotive applications as well as civil engineering applications. The simulation capability of GTSIMS coupled to thermal signature models could provide important collision avoidance studies for testing new onboard sensors on automobiles or other commercial vehicles (including aircraft). The temporal simulation of

thermal effects could also be used for roads and bridges to predict (and warn of) freezing conditions based on environmental inputs. An easy-to-use thermal model with engine exhaust plume capability has dual use potential in automotive applications where engine models and computational fluid dynamics (CFD) analysis are used for assessing performance and heat management concerns.

## U.S. Army Test and Evaluation Command

A96-106TITLE:Ultra High Resolution Digital Cameras

CATEGORY: Exploratory Development

OBJECTIVE: Using large format extremely high pixel density (e.g. greater than 25 million pixels) CCD sensors or equivalent devices, new or novel techniques are sought for ultra high resolution to digital cameras that will yield less than a one percent resolution degradation in comparison to standard film cameras.

DESCRIPTION: Images stored on film currently represent the highest resolution available for the collection of photographic data. Although standard video techniques are in widespread use, when high resolution images are required film is the technology of choice. Despite the excellent resolution presented by many films today, they possess several drawbacks which include relatively high cost, fragility of the film, processing delays, no real time display capability, no direct means of digitizing images for computer processing without resolution loss, cumbersome methods for acquisition and viewing, and others.

This task will extend current technologies or develop new technologies for the acquisition of visual imagery that will rival or exceed the resolution of conventional film. It is highly desirable that the developed technology provide for short exposure durations and relatively high framing rates (on the order 1ms and 400 frames per second) as part of the camera systems capabilities. Additionally, the developed technology shall be such that it will have the potential for the commercial market at competitive cost levels. The recording and display media shall be given equal consideration to that of the actual cameras.

PHASE I: Investigate new or novel techniques for ultra high resolution digital imagery. The end result of the investigation shall be the identification of the selected technology that will yield the desired image resolution. The investigation may entail the actual laboratory demonstrations of various technologies and techniques. Should an extension of existing technologies be considered unusable, the investigator shall develop a detailed design analysis for a new or divergent technology that will yield the desired results.

PHASE II: The investigator shall develop and deliver to the government a complete functional prototype system as defined and approved in Phase I. The contractor shall fully characterize the camera and conduct field tests at the government sponsors facility.

POTENTIAL COMMERCIAL MARKET: The commercial market is constantly striving to improve the quality of video products available to consumers. The dramatic improvement to the resolution of video systems that this SBIR may yield may be opened up to a tremendous commercial market that will range from average consumers to major corporations.

A96-107TITLE:Precision Target Ballistic Scoring System

CATEGORY: Engineering Development

OBJECTIVE: Produce a capability to measure yaw, tumble, angle of arrival and projectile velocity of subsonic and supersonic projectiles.

DESCRIPTION: Automatic computerized system capable of precisely scoring subsonic and supersonic projectiles or particles singly or in bursts. Projectile sizes will range from 0.22 caliber to 120 mm cannon shells. Shall be capable of calculating and

displaying a single projectile scoring within 30 seconds. Shall be capable of recording and scoring and displaying 100 round bursts within 2 minutes. Typical burst rates are 675 rounds/minute for 30mm and 1100 rounds/minute for 20mm projectiles. Shall be capable of accuracies to 0.050 inches and target size to 25 ft square. In priority order, it is desired that the system shall be capable of measuring yaw, tumble, angle of arrival, and projectile velocity at the target location during Post Processing. System should not be degraded by changes in humidity, temperature, barometric pressure, wind or ambient light. System must be capable of operation in severe desert environment. System setup and calibration requirements must require less than 1 hour and be maintained for 8 hours. System must be capable of remote operation with Control, Display and Data Storage Units up to 3-5km from target scoring area. Lightweight cable or FCC free RF communications desirable. System should be capable of generating standard ballistic statistics, XY, time, time at target, dispersion, high and low velocity and velocity dispersion.

PHASE I: Breadboard system and supporting analysis.

PHASE II: Single Station system demonstrating all intended measurement capabilities.

POTENTIAL COMMERCIAL MARKET: Measurement, processing and communications technologies produced by this effort would have wide application to civilian robotics, security systems and data processing systems.

A96-108TITLE:External Initiation System with Internal Crush Switch

CATEGORY: Advanced Development

OBJECTIVE: Develop and demonstrate a rail mounted system capable of initiating multiple warheads, on a moving missile system, while utilizing the missile's internal crush switch.

DESCRIPTION: Missile systems contain tandem warheads that are designed to defeat reactive and active armor targets. When dynamically launched on a rail, a missile must be modified to permit the initiation of the warheads. In the case of tandem warheads this requires installing high energy detonators and installation of an initiation system. The initiation system has historically been one of two types: 1) an internal system that rides inside the surrogate missile body and utilizes the missiles internal crush switch. The main advantage of this system is the use of the tactical crush switch. The disadvantage include poor reliability, high cost per circuit and lack of timing data (unless a high cost telemetry package is added) or 2) an external system that is located near the target and utilizes an external crush switch. The main advantages of this system are low cost, easy data retrieval, and high reliability. The main disadvantage is the mounting of an external crush switch which changes the tactical configuration of the missile system and biases the test results. The ideal system would have the benefits of the external system (low cost, high reliability, and easy data retrieval) and the benefits of the internal system (use of the tactical crush switch).

PHASE I: Investigate new and innovative ways to develop an external firing system and utilize a missile's internal crush switch.

PHASE II: Implement the design concepts by manufacturing hardware and testing it in a controlled explosive test conducted by the government.

POTENTIAL COMMERCIAL MARKET: This device may be used by the mining or construction industry where precise timing of explosives is required for demolition or construction.

A96-109TITLE:Damage Detection in Thick-Walled Composites Using Surface Mounted Piezoelectric Elements

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a piezoelectric element transducer system for composites damage detection.

DESCRIPTION: Thick-walled composite structures (one inch thickness or greater) have particular susceptibility to damage, such as delamination and matrix cracking, under the action of residual stress developed during fabrication. This damage can be

present before the structure is subjected to any external load whatsoever. Consequently, a reliable method is needed to check for damage prior to placing these structures in service. The method should be nondestructive and should be convenient enough to use on 100% of the items produced. The method proposed is based on removable surface-mounted piezoelectric elements. These highly sensitive elements should be able to detect delaminations by changes in response to vibratory excitations introduced by methods of controlled impact (free vibration) or surface excitation (forced vibration). Sensitivity, reproducibility and ease of operation are evaluation criteria for the proposed excitation approach.

PHASE I: Investigate new and innovative ways to apply surface mounted piezoelectric technology to damage detection problems. Ideal result is a sensitivity demonstration for flaw detection in thick composites.

PHASE II: Implement the design concepts by manufacturing a fully automated damage detection capability suitable for operation at the technician level. Successfully perform complete acceptance tests upon delivery at the government sponsor's facility.

POTENTIAL COMMERCIAL MARKET: This device may be used throughout the composites manufacturing industry.

A96-110TITLE:Passive Sample Technology Development

CATEGORY: Advanced Development

OBJECTIVE: Passive samplers have been used in industry for air safety monitoring of hazardous chemicals. The military has a passive sampler requirement for measuring chemical simulant vapor concentration (methyl salicylate) under nuclear- biological-chemical protective light-weight clothing. Commercially available samplers have been alveolate according to the following criteria; cost of sampler, protrusion height, theoretical diffusion characteristics, contamination potential, durability, precession and accuracy, and sensitivity. Methyl salicylate has been absorbed on Tenax TA sorbent material, concentrated on an automated thermal deception system, and analyzed by gas chromatography. In order to meet the customer test requirement, the precision and accuracy of passive sampling must be improved and the presence of interfering substances must be reduced. The current level of detection is 1-2 ng/sampler. Proposals are requested to improve passive sampler technology. Emphasis should be placed on passive sampling devices that can achieve real time vapor monitoring.

PHASE I: Investigate new or novel techniques for passive sampling of hazardous chemicals. Results of the investigation shall be the identification of the selected technology that will produce improvements over existing capabilities, especially with regard to vapor monitoring in real time.

PHASE II: A complete functional prototype sampling capability will be delivered to the government in accordance with the results of Phase I. The contractor shall fully characterize the sampler and conduct field tests at the government sponsor's facility, to include a real time monitoring demonstration.

POTENTIAL COMMERCIAL MARKET: Improvement will be made in passive sampling technology which may allow for real time vapor monitoring. There may be substantial safety advantages in having a commercial real time vapor monitor when workers go into a hazardous environment during a large spill clean scenario.

A96-111TITLE:Techniques for Assessing the Visual Quality of Digitized Imagery

CATEGORY: Engineering Development

OBJECTIVE: Develop a methodology and automated techniques for assessing the quality or fidelity of digitized imagery with respect to the human visual system.

DESCRIPTION: As the use of digitized imagery becomes more prevalent on the battlefield, a method for assessing the quality or fidelity of the imagery becomes increasingly important. Loss of image quality is particularly notable after an image has been compressed and reconstructed using one of the current compression methods such as JPEG, wavelet or fractal. In general, the

higher the compression ratio the more lossy the image is after reconstruction. In critical applications, such as in the medical field, the quality of imagery is extremely important, so a lossless compression method in needed. In less critical applications, a lossy compression system can be more easily tolerated, but only to a point. Thus, the amount of loss in image quality or fidelity that can be tolerated, in a given application, is an important measure. Developing an automated method for assessing image quality is the primary goal of this effort. Once developed the method can be applied to assessing images collected from remote sensors, electronic camera systems, and other digitized imaging systems.

PHASE I: Develop the baseline methods, algorithms, and criteria for assessing image quality.

PHASE II: Implement these methods in hardware or software and demonstrate the systems using various digitized images selected by the government. After instructing government personnel on the operation and use of the system, the system will be turned over to the government.

POTENTIAL COMMERCIAL MARKET: The methods for assessing digitized imagery quality can be used in any of the following commercial applications: digital laser discs, electronic camera systems, video teleconferencing, and interactive video on personal computers.

A96-112TITLE:Small Arms Scoring System

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a small arms scoring system capable of recording the impact coordinates of all types of small arms ammunition at multiple firing rates ranges.

DESCRIPTION: The Small Arms Branch of ATC is currently charged with conducting dispersion testing on various small arms weapons and ammunition requiring various target ranges and rates of fire. The current system used is the Oehler 82 Acoustic Scouring System. This system uses the projectile shock wave for determining impact coordinates. The system is thereby limited by the strength of the shock which in turn relates to target range. In addition, this system is extremely sensitive to temperature and humidity changes which can adversely affect accuracy of the data. Increases in current ammunition technology are resulting in increases in ammunition effectiveness. This has pushed the range at which dispersion testing is conducted beyond the current capabilities of the existing system. In addition, future developments in small arms ammunition will not be able to be accommodated by the current system. New developments in low velocity bursting munitions technology are to be tested at ATC in 1997 and will not be compatible with the current system. A new means of scoring small arms ammunition is needed. The system must be capable of handling both low and high velocity munitions from.22 caliber to 40-mm. One technology that may be explored would be a system using eye-safe LASER's similar to current scanners. Minimum performance specifications are the following: +/- 1 mm scoring accuracy, target size: 10' x 10' portable and 30' x 30' stationary, and projectile velocities ranging from 200 m/sec (75 m/sec desired) to 1550 m/sec.

PHASE I: Investigate new and innovative ways to record the impact coordinates, process and produce detailed output for small arms ammunition and weapon testing. The design must consider that the system will be used outdoors, under various temperature and humidity condition. The system must be able to score rounds using multiple targets and ranges, and should accommodate different ammunition dispersion characteristics.

PHASE II: Implement the design concepts by manufacturing hardware and testing it in a controlled test conducted by the government. Multiple calibers of ammunition varying in velocity and size would be tested.

POTENTIAL COMMERCIAL MARKET: It is plausible to expect that this effort may produce a more cost effective, as well as more accurate means of scoring small arms impacts. In that event, a significant commercial indoor and outdoor firing range market would likely take advantage of the new technology.

## U.S. Army Corps of Engineers Research Laboratory

A96-113TITLE:Affordable Sensing Technologies for Infrastructure Condition Assessment

CATEGORY: Engineering Development

OBJECTIVE: To develop and demonstrate affordable integrated sensor configurations which will automatically collect data on the condition/health of a target infrastructure system or component, such as building, roof, foundation, bridges, pavements, navigation locks and dams, and underground utility systems. Sensor configuration proposed should be affordable and reliable to operate, and provide complete automated inspection capabilities for specific types of structures or components.

DESCRIPTION: Recent advances in microelectronics and sensing technologies permit sensing various types of failures/distresses in infrastructure systems and their components. Off-the-shelf sensing systems, however, are of a single purpose, measurement specific type, like temperature, moisture, position/displacement sensing, etc. Sensing the condition of infrastructures, on the other hand, typically requires data from a multitude of specific purpose sensors to provide meaningful condition information. Such integrated sensor packages are not available for infrastructure inspection areas, and often are cost prohibitive.

PHASE I: Develop the design concepts necessary to provide complete condition inspection data for targeted infrastructure system or component. Target structure may consider buildings, roofs, building foundation, pavements, airfields, bridges, navigation locks and dams, and underground utility distribution systems (water, sewer, gas steam lines). Design criteria should include the sensing challenges of the target infrastructure/component, critical measurement types required, sensor fusion requirements, and operation costs.

PHASE II: Develop prototype sensor packages. Field test sensor packages at an Army installation.

POTENTIAL COMMERCIAL MARKET: A very high commercial potential. A very large market exists for proven sensor packages for automated infrastructure inspection. This includes private building/plant owners, and state and local governments.

A96-114TITLE:Rule-based Agents for Knowledge Worker System

CATEGORY: Exploratory Development

OBJECTIVE: Develop an innovative software application that is fully integrated with the Knowledge Worker System (KWS) that allows KWS users to define and use rule-based agents that perform a variety of personal and work flow functions in response to KWS system events such as receiving messages and task assignments, marking tasks as past due, etc.

DESCRIPTION: In 1987, it was estimated that 50 million white-collar knowledge workers in the U.S. were paid more than $1 trillion in salaries with these numbers increasing each year since, indicating a great incentive to improve knowledge worker productivity. The U.S. Army Corps of Engineers Construction Engineering Research Laboratories (USACERL) has developed KWS to help knowledge workers organize, learn priorities, and execute their work in the most efficient way possible. KWS provides an integrated, computer-based environment that enhances employee productivity by delivering task-specific information as needed. KWS can be compared to an electronic desktop that organizes all the tools the worker needs for each task. Its master calendar links knowledge workers whose tasks are interconnected. This calendar can update milestones, status information, and priorities to assist work groups in task prioritization and coordination. A software application is needed that integrates completely with KWS, running under Microsoft Windows 3.1, that allows users to define rule-based agents using a set of predefined agent functions that can be selected from a list and entered into rule-editor dialog boxes. A capability must be provided to group these rule-based agents into agent sets and the knowledge worker should be able to easily activate or deactivate agent sets using an agent manager. The agent manager should show all defined agent sets, the agents within each set, and the status (activated or deactivated) of each agent set.

PHASE I: Develop a set of actions and functions corresponding to KWS system events that can be used to define rule-based agents, demonstrate that the agents developed execute accordingly based upon system events that occur during a KWS session, and show that sets of agents can be activated or deactivated at will using an agent manager interface.

PHASE II: Develop a prototype rule-based agent application that is fully integrated with KWS, including a comprehensive set of network-based, Windows-based, and KWS system event actions and functions that can be used to design rules, and provides all of the application features described in Phase I.

POTENTIAL COMMERCIAL MARKET: Should a rule-based agent application be developed for KWS with technology such that its basic concepts and code could be used and integrated with other software applications, every software development firm with interests in integrating intelligent agents into their applications would be a potential buyer of this product or technology. Therefore, there is a high potential for commercialization.

## U.S. Army Cold Regions Research and Engineering Laboratory

A96-115TITLE:A Coherent FM-CW Radar for Continuous Geophysical Profiling Deployed on a Remotely Piloted Aircraft

CATEGORY: Engineering Development

OBJECTIVE: To develop a high resolution, coherent FM-CW continuous profiling radar system mounted on a small, inexpensive, easy-to-operate airborne remote controlled platform.

DESCRIPTION: Geophysical radar technology and remotely piloted vehicle (RPV) technology have made significant advances in recent years. The combined utilization of these two technologies has much potential for commercial and military applications. Currently ground- and airframe-mounted FM-CW radars are commonly used for many commercial and military related geophysical surveys, surveillance, and research efforts. However, these manned vehicle applications require significant capital investment, are expensive to operate and maintain, may require special certification or license, and are unsuitable for operation in at-risk environments. To overcome these limitations, a lightweight coherent FM-CW radar mounted on a small, inexpensive RPV is required. Initial applications pertain to measurements of ice and snowcover characteristics. However, future applications to subsurface sounding, bathymetry, soil constituency, vegetation, and infrastructure are inevitable and may require a variety of modified/new radar sensor arrangements. Therefore, a modular implementation of the RPV/sensor system would be advantageous. Desirable radar system characteristics include: lightweight, compact, centimeter resolution, 100 meter maximum range, greater than 25 scans per second repetition rate, less than 5 degree beamwidth, and coherent detection and processing. Desirable remotely piloted aircraft capabilities include: capability to hover, airspeed up to 50 mph, a usable altitude of 2 to 100 meters AGL (above ground level), greater than 1 hour flight duration, line-of-sight control, additional sensor payload capability, low operator training curve, short wingspan/rotor span, low cost, and simple maintenance, launch and recovery procedures. The RPV should be of a compact, transportable design. Desirable down-link telemetered data include: real-time radar data, GPS positioning information, down-looking video.

PHASE I: Demonstrate feasibility of coherent FM-CW continuous profiling geophysical radar with air-to-ground telemetered data and on-ground real-time processing and display. Demonstrate feasibility of a small, remotely controlled aircraft capable of carrying a radar system payload.

PHASE II: Develop, test, and modify (if necessary) a practical prototype system.

POTENTIAL COMMERCIAL MARKET: This radar system could be used to enable safe river and lake ice thickness measurements, to enable navigation season extension in ice-affected rivers, to determine location of liquid water in Arctic regions, to determine snowcover thickness and stratigraphy for hydrological and watershed assessments, to conduct trafficability studies over natural terrain, and to conduct hazardous/toxic/denied environment surveys.

A96-116TITLE:In-flight Aircraft Icing Prediction Detection System

CATEGORY: Engineering Development

OBJECTIVE: Develop a remote sensing prediction detection system with real-time cockpit display that maps airframe icing potential (magnitude and location of supercooled liquid water and drop size range) in three-dimensional space up to ten nautical miles ahead of an in-flight aircraft. With the information provided, a pilot could avoid areas of high airframe icing potential and be advised how to escape icing after penetration.

DESCRIPTION: Large areas forecasted for aircraft icing do not usually produce continuous airframe icing. Instead, icing occurs discontinuously with areas of little or no icing, punctuated by areas of moderate to severe icing. Forecasters do not have the skill or tools to provide spatially detailed aircraft icing forecasts. As a result, pilots usually do not know they are in serious icing conditions until aircraft airworthiness deteriorates. One solution to this problem is to place a remote sensor system on aircraft to locate areas of supercooled liquid water in the flight path. The system could create and display in real-time a map of airframe icing potential ahead of the aircraft. This would enable the pilot to change course to avoid or escape icing. The system would provide information to pilots in a manner conceptually similar to that provided by current airborne instruments that locate thunderstorm cells and wind shear ahead of aircraft. The system should warn of in-cloud icing potential and specifically identify freezing rain or drizzle (large droplets) in the flight path. The system must scan the amount and location of liquid water and its temperature up to ten nautical miles ahead of the aircraft from within clear air or clouds. In its final configuration the instrument should have an onboard processor to map real-time icing potential in a volume of air ahead of the aircraft and display it in a manner consistent with efficient cockpit management. Two technologies with prediction detection system potential are differential attenuation radar and multiple field of view (MFOV) lidar. Radar's advantage is its ability to penetrate clouds. An advantage of MFOV lidar is its ability to detect cloud droplet spectra. Disadvantages of lidar are its potential threat to eye safety, and its inability to cope with clouds of high optical depth. Both have weight, size and power disadvantages. Preferably, implementations of these technologies, alternative technologies, or fusions of several technologies will be integrated with existing and developing airborne weather and wind shear detection systems, creating one multiple use system.

PHASE I: Demonstrate feasibility, preferably with laboratory or field experiments, of remotely locating and quantifying cloud and precipitation phase, temperature, liquid water content, and drizzle and rain drop size spectra. Demonstrate feasibility of extending range to ten nautical miles, and for measuring from clear air to within clouds, and from within clouds to adjacent clouds. Capabilities should be verified with independent measurements.

PHASE II: Develop prototype system to demonstrate ability in wide range of in-cloud and precipitation icing conditions. Verify in-flight ability to remotely locate and quantify cloud and precipitation phase, temperature, liquid water content, and drizzle and rain drop size spectra in real-time to ten nautical miles, and demonstrate cockpit display. The system must pass applicable FAA and military certification requirements.

POTENTIAL COMMERCIAL MARKET: General aviation aircraft, helicopters, commuter aircraft and commercial jets need such a system. The system would extend operating conditions for all-weather helicopters and fixed-wing attack aircraft and improve safety and military readiness. The system could assist self-navigating smart weapons, and could be located at airports and on ships that launch and retrieve aircraft.

## U.S. Army Topographic Engineering Center

A96-117TITLE:Rapid Database Transformation for Modeling & Simulation

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this project is to design a system to rapidly construct databases for use in a variety of modeling and simulation systems. Models & simulations are increasingly being used to support contingencies/force projection (hot spots). Information must be current and database production and transformation methods must support rapid turn around. Near term goal is one week. Objective goal is forty-eight hours. Outputs must be compatible with existing mission planning (TEM/DTSS/SPARTAN) and with emerging wargaming or constructive simulation models like WARSIM 2000 in terms of database format, resolution, accuracy, content etc. This will promote correlation and interoperability between operational planning systems and the training or mission rehearsal system.

DESCRIPTION: The primary shortfall/bottleneck is rapid construction of high quality, current databases. The starting point should be standard Defense Mapping Agency (DMA) Digital Topographic Data (DTD). Specifically, high quality Interim Terrain Data (ITD), and 30 meter Digital Terrain Elevation Data (DTED) Level II from DMA, are used as the basic foundation. Enhance and value add with imagery, maps, all source material, to fill in the level of detail needed for the specific mission. The other critical shortfall is rapid transformation of the data. Image generators and high end workstations require data in specific formats for realtime simulation and fly through. The data is usually in a polygonal format. Textures are added which can be generic, photo source, and can be geo-specific. Highly detailed 3-D models of other natural and man made features like trees buildings, bridges, and roads are typically included. There is also a current shortfall in simulations in representing realistic physics based environment and terrain models. What has been done to date is primarily an artistic representation of the world. What needs to be done is to realistically reflect the world using physics or physically based models. Another problem is maintaining an accurate and consistent geodetic reference. Especially for mission planning applications the true geographic coordinates and representations in the simulation are critical to successful mission rehearsal and execution.

PHASE I: Develop a detailed system design needed to implement and demonstrate a system which uses the following basic guidelines, but is optimized to meet the 48 hour turn around requirement. Guidelines: Use standard digital topographic data (DTD) to the fullest. When not available, use a state-of-the-art photogrammetric exploitation system to generated DTD. In both cases use available systems to enhance/value add from controlled imagery and collateral sources. Standard and custom data must then be transformed into a format acceptable by the image generator for simulation. Use a commercially available geographic information system (GIS) as a transformation tool to tailor the data. Tailoring includes seaming, thinning, generalization, value adding additional features, conversion to the desired polygonal format, and preserving the feature attributes necessary for the simulation. This data is then exported to the image generator front end for additional enhancement. Loral (BBN SIMNET) and Evans & Sutherland (CCTT) use their own custom database modeling packages to make the textures/models and populate the database (S1000 & EaSIEST). Within these packages textures/models are added along with other specialized information needed for the simulation. Because building 3-D models is labor intensive, using a standard model library can avoid duplication of effort, promote re-use, and limit future model production to those custom models/features for the specific mission.

PHASE II: Implement and demonstrate the detailed design developed in Phase I.

POTENTIAL COMMERCIAL MARKET: Phase II potential should be very high Commercial applications of a system with capabilities described above could include disaster relief, environmental monitoring and restoration, training for hazardous waste removal, city, highway and construction planning. This system could be used to model and analyze any type of setting or environment with the advantage of being safe, low cost and with no environmental impacts.

A96-118TITLE:Climate Spreading Methodologies

CATEGORY: Exploratory Development

OBJECTIVE: Research current methodologies for the spreading (interpolation/ extrapolation) of terrain and climatic information. Develop empirical methods (geostatistical, inferential, rule-based) that allow the spreading of various terrain and climatic parameters over a spatial surface and methods to assess the goodness-of-fit of the spreading algorithms. Develop algorithms that integrate kriging, co-kriging, and multi-variate kriging into a commercial Unix-based GIS system (i.e., Arc/Info) to facilitate terrain-based mapping.

DESCRIPTION: There exists a need to have the capability to spread terrain and climate information over a map background. This capability would assist the military planner in a) providing more detailed, accurate terrain information about a battlefield and b) examination of levels of climate that would impact fielded materiel, personnel and selected operations at intended deployment locations. Various types of topographic and climatic data suffer from a rather low density of measurement sites and the random nature of the sites themselves. Recent literature has shown that certain surface-based variables are capable of being spread spatially to some degree of exactitude. Such techniques as kriging, cokriging, multivariate kriging, and inferential

statistics have been shown to hold promise in being able to generate climate element surfaces with varying degrees of accuracy. The models must be driven by commonly available terrain and climate data - or data derived from this information. Models may be created or borrowed from professional quality geostatistical software (i.e., GeoLib). Integration of geostatistical software with a GIS for the purpose of georeferenced map output is the critical step to be developed.

PHASE I: Examine the current state-of-the-art in spreading techniques. Select a fairly homogeneous geographic/climatic area and evaluate the performance of existing models. Develop empirical preliminary models that focus on the spreading of data (i.e., temperature, precipitation, soils, vegetation, etc.). Assess the impacts of other variables on model performance (elevation, locational and other environmental). Evaluate the performance of these models as compared to the existing techniques.

PHASE II: Extend the lessons learned in Phase I to fine tune the developed models. Extend the case studies to include more diverse environmental regions (e.g., mountainous areas). Assess model performance with respect to military as well as civilian applications and make recommendations for further research efforts. Integrate the geostatistical model results into a format that is importable and mappable within a commercial GIS such as Arc/Info. Design and develop any necessary graphical user interface (GUI) to facilitate the transition of geostatistical kriging results into the mapping environment and to facilitate the ease of use of the pertinent geostatistical software modules.

POTENTIAL COMMERCIAL MARKET: The ability to spread terrain and climatic information has potential civilian usages. Geostatistically based interpolation modules to be add-ons for commercial vendors of GIS and image processing software would be of high value. There are no multi-variable geo-based interpolation routines of any quality on the market. In regards to temperature, the heating and air conditioning community, building design and construction trades and agriculture all have a keen interest. Precipitation surfaces would aid in the determination of suitable sites/regions for agricultural utilization.

## U.S. Army Waterways Experiment Station

A96-119TITLE:Small-Scale Shock Sensors

CATEGORY: Exploratory Development

OBJECTIVE: To develop small-scale precision airblast and ground shock/motion gages

DESCRIPTION: Small-scale laboratory weapons effects and structural response tests provide critical information to military planners. To properly conduct such experiments very small scale precision pressure and ground shock and motion sensors are needed. To meet the desired objective at the proposed test scale, the instruments are required to be approximately 1 mm in the sensing direction and no more that 5-6 mm wide normal to the sensing direction. The instruments must have a frequency response on the order of 1 MKz, and be able to withstand the shock environments of well over 100,000 g's and peak pressure/stress from 0. 7 MPa (100 psi) to 340 MPa (50,000 psi). Innovative methods will be needed in order to construct rugged sensors of this size and capability.

PHASE I: Design, predict the performance of, construct, and test prototype gages for use in the precision weapons effects tests described above.

PHASE II: Improve design to optimize sensor performance and constructability, and test improved sensors over a broad range of shock environments.

POTENTIAL COMMERCIAL MARKET: Rugged, small-scale blast gages have an extensive market throughout the R&D community that studies shock physics. The market includes DoD and contractor laboratories, academic institutions, and other organizations that conduct R&D in military, aerospace, civil engineering, and other fields.

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A96-120TITLE:Static Laser Profilometer and Holographic Visualization Tool

CATEGORY: Advanced Development

OBJECTIVE: To develop a system to digitally measure and visualize the topography of surfaces of structures before and after damages. The digital topography of the damaged surface will be in a format for direct comparison with numerical predictions for validations.

DESCRIPTION: Advanced development of an existing technology is needed to provide the capability to digitally map surfaces from distances as short as a meter to as far as a hundred meters. This technology uses a scanning laser device modified to measure static displacements. The resolution required would depend on the scale of the maximum changes in the topography. This capability is not currently available. Development requires a unique system integration of laser measuring technology, data acquisition and computer technology, and holographic projection.

PHASE I: Develop the static displacement measuring capability for an existing scanning laser vibrometer system.

PHASE II: Develop the integration of a three-dimensional holographic projection for displaying digital images of numerical predictions and experimental results of structural damages from blast effects (or any other loading effects).

POTENTIAL COMMERCIAL MARKET: A system capable of measuring topography and roughness of any surface and also providing 3-D visualization will have extensive industrial and commercial applications. For example, such a system could be used for quality control in manufacturing operations. The technology could also be applied to evaluate the condition of concrete structures, roadways, and airfield runways.

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## U.S. Army Research Institute

A96-121TITLE:Dialogue-Based Language Training

CATEGORY: Exploratory Development

OBJECTIVE: To simplify computerized language tutoring through the development of advanced software techniques and to transfer concepts learned in language tutor development to the development of an authorable, dialogue-based military information and procedural tutor.

DESCRIPTION: Current and future, joint and international activities demand improved access to foreign languages, that can be provided on demand by intelligent software in either standalone or distributed, internetted environments. This research will make the existing dialogue capabilities in the Military Language Tutor fully authorable by language instructors by developing an artificial intelligence (AI) knowledge base that can be programmed by individuals with no computer programming expertise. The contractor will improve the language-independent dialogue capability of the Military Language Tutor so that it is capable of dealing with more complex constructions, such as anaphora, and has a larger language generation capability, in additional foreign languages. The contractor will add the ability of instructors to add new nouns to the lexicon and semantics components of the Military Language Tutor. Such additions will not require that the instructors be either computer programmers or computational linguists. This will be done for all proposed foreign languages. The contractor will develop an English language dialogue system capable of supporting military informational and procedural lessons. This will include a full sized, militarily

oriented, English computational lexicon plus natural language processing and semantics engines. This military information and procedures dialogue tutor will integrate all the advanced features described above, and be both stand alone and distributed, internetworked in its delivery. The development of a military dialogue-based lesson will provide a demonstration of the authoring capability and an intrinsically useful product for the Army.

PHASE I: In Phase I, the contractor will develop the conceptual approach and the detailed system design of the system which incorporates the elements described above. This will include the interface screen designs for the authorable AI knowledge base and the components of the lexicon and semantics engine that allow the addition of new nouns. The new AI knowledge-based scenario will be defined in detail. The military dialogue-based lesson and its internetted delivery will be defined and outlined.

PHASE II: In Phase II, the contractor will develop the software described above and integrate it within the Military Language Tutor. The contractor will alpha and beta test the resulting software and make required fixes. The contractor will develop and integrate a new knowledge-based scenario and demonstrate its language independence by applying it to all language versions of the Tutor. The contractor will develop a military information and procedures dialogue lesson and demonstrate it.

POTENTIAL COMMERCIAL MARKET: The potential commercial market for a language tutor that can engage students in realistic dialogue such that the dialogue can be altered by instructors, is significant. It is this dialogue capability that defines the real task of language use. As such, being able to practice it is central to learning language. To the extent that such an authorable dialogue component can be added to existing Army language tutors it will greatly enhance their training value and their cost-effectiveness. The ability to simulate an instructor in one-on-one dialogue has always been the primary goal of computer-based learning. It is this type of teaching that has always been the most effective, but also the most costly. Current advances in natural language processing now make simulating dialogue possible. The potential commercial market for a tutor that can teach through dialogue is very large. When the dialogue of such a tutor is authorable, and the delivery internetworked, the market expands to an even greater extent. The conversion of the military knowledge and procedures tutor to a general or industrial tutor would be relatively easy and of great value.

A96-122TITLE:Network-Based Training and Feedback to Improve Staff Performance

CATEGORY: Exploratory Development

OBJECTIVE: To provide a network-based training tool, using existing hardware and software technology, which will apply situational awareness and group decision making principles to a digital, distributed work environment. This tool should provide generic staff training to support specific applications for Force XXI.

DESCRIPTION: In the information age, an organization's ability to perform effectively will depend on the ability of the staff to operate in a digital environment. However, few organizations can sustain frequent off-site training to develop such skills. The training tool proposed here should provide on-site staff training for operating in a digital environment. This staff training tool must assume a fully digital, Internet work environment, where most information sources, human or electronic, provide information, including graphics, digitally. The network-based training tool must teach staff members decision rules to avoid information overload by excluding extraneous information, and by filtering and routing necessary information only to appropriate staff members. The infrastructure should be based on recent theory and research in shared mental models (e.g. commander's intent) situational assessment/awareness ("seeing" the situation, anticipating future actions), and group decision making principles. It must incorporate the latest research on cooperative workspaces and techniques in intelligent training to eliminate the need for instructors. The tool should incorporate intelligent, on-demand training within the electronic workspace for information sharing and decision making for staff functions. The product should provide a foundation for building staff skills to operate effectively in a digital environment.

PHASE I: This phase involves the conceptual development of the network-based training tool for distributed digital workspaces. Products include specifying necessary hardware and software and the specific training approaches. Training strategies should teach decision rules for information processing to avoid information overload, techniques to develop shared

mental models, situational assessment skills, and group decision making and decision implementation skills. The product should also specify the feedback and intelligent training architecture that will be provided in these areas.

PHASE II: This phase consists of implementing the plans developed in Phase I. It involves obtaining or developing the hardware and software, and specific training packages. The contractor will demonstrate the effectiveness of the training using an appropriate staff.

PHASE III: This phase entails executing and validating the utility of the intelligent training and feedback system for distributed workspaces in a military or civilian setting.

POTENTIAL COMMERCIAL MARKET: Today, rapid staff turnover in both the military and private sectors compounds the need for staff training. A wide range of staff organizations, ranging from emergency medical personnel using voice and graphic data in "telemedicine" to global corporations, use network conferencing for executive decision making and to handle voluminous amounts of digital information. Funding for formal, off-site training has been reduced. Staffs need a readily available way to practice, receive feedback on, and improve staff performance. This potential product fulfills these commercial training needs.

A96-123TITLE:Effects of Networked, Automated Surveys

CATEGORY: Exploratory Development

OBJECTIVE: To determine the effects on responses and implement improvements for using networked, automated, confidential surveys.

DESCRIPTION: Increasing availability of computers, local area networks and access to the internet have created more opportunities and reduced the costs of survey data collection, and raised new questions about the effectiveness of confidential, automated surveys. However, very little information is available on what effects automation, confidentiality, and digital software conventions have on the responses of survey respondents. There are many aspects of questionnaire format, confidentiality, and modes of responses which need to be investigated to improve automated survey construction. For example: What are the variables that could be expected to increase or decrease respondents' willingness to respond or their truthfulness, versus paper and pencil surveys? What is the effect of presenting the response scale in various types of format, such as the traditional location under the questions, or in a separate window? What is the effect of not being able to see a full page of the questionnaire or the overall length of the questionnaire? What is the effect of not being able to quickly review the responses to previous questions? In addition, how can analysis, front-end and interface components be embedded in the surveys to provide flexible and individualized interaction? Almost every aspect of survey questionnaire design and actions necessary for completion and analysis needs to be studied in order to assess the kinds and extent of effects that digital automation has on individuals' responses and response patterns.

PHASE I: Identify the aspects of survey questionnaire design, confidentiality, or format development and analysis which need to be (and can be) studied in order to respond to the study objective and improve survey software.

PHASE II: Develop the design and implement it, comparing the responses of digital automation with those obtained with traditional paper-pencil modes of data collection. Recommend procedures which develop confidentiality options and minimize response bias and error for automated surveys. Automate those procedures and embed them in the survey software.

PHASE III: Implement and market the findings and any software products to civilian firms which provide software for preparing survey questionnaires.

POTENTIAL COMMERCIAL MARKET: Knowledge of the effects of digital software architectures on survey responses is important for all military and non-military users of PC automated survey data. Response modes also have potential impacts for other information collection activities, especially for sensitive data.

## U.S. Army Space and Strategic Defense Command

A96-124TITLE:Reduction of Coincidental and Intentional Electromagnetic Interference

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop, and demonstrate low cost techniques to isolate electronic systems from external radio frequency (RF) interference.

DESCRIPTION: The expanded use of commercial-off-the shelf (COTS) equipment in military systems leads to increased probability that electronics will be operated in RF environments that are more severe than those for which the equipment was designed. We desire to extensively use COTS and still have confidence that it can quickly, cheaply, and easily be modified to meet operability requirements on the battlefield. Proposed RF countermeasures must work in real time and ensure system operability in the presence off friendly and hostile RF emissions. It is desired to be able to mitigate the effects of external wide band noise, nuclear electromagnetic pulse (EMP), non-nuclear EMP which might have a higher frequency content than nuclear EMP pulses and continuous emissions from both friendly systems and hostile jammers/weapons countermeasures should be able to defeat multiple pulses from high power sources. We desire generic solutions for mitigation of RF effects from pulsed and CW sources. Classes of systems for which mitigation techniques are sought include computers, communication equipment, radars, and missile electronics. The RF effects mitigation techniques may be based upon hardware or software techniques or a combination of both.

PHASE I: Analyze, design, and conduct proof of principle demonstrations of the effectiveness of techniques to ensure operability of electronics in the presence of external RF emissions.

PHASE II: Develop operable prototypes and conduct tests to evaluate performance of the protected equipment in the presence of disturbing RF environments. Evaluate the effectiveness and confidence of proposed RF effects mitigation techniques and prepare detailed plans for implementation in a appropriate military and commercial application.

POTENTIAL COMMERCIAL MARKET: There is a very large market within commercial electronics industries to ensure that important electronic systems remain operable in the presence of increasingly severe peacetime RF environments. In addition, protected commercial equipment should not be excessively susceptible to deliberate (terrorist) threats.

A96-125TITLE:Innovative Decision Aid

CATEGORY: Basic Research

OBJECTIVE: Develop an innovative process that will take data from a wide range of disparate sources as input and recommend a decision to a human.

DESCRIPTION: This is not a new problem. However, the information age and digitization of the battlefield have intensified the need for a solution. Artificial intelligence, neural networks, data fusion, fuzzy logic, and others are players in these area. Using one or more of these is not prohibited, but a new, innovative architecture is sought. The process should prioritize, compress, and fuse the data. Then the process should make a recommended decision based on the inputs and previous experience. The process should be robust. That is, it should be able to make the correct recommendation most of the time even with insufficient or incorrect data. The process need not run on a digital computer for maximum performance. The process should be based on science, but mathematical proof is not required if it works.

PHASE I: Show the feasibility of the process by simulation or other means. While innovative technologies sometimes do not have an available market, another task of Phase I will be able to identify a specific market and/or customer. A specific application (problem and solution) and customer needs should be analyzed.

PHASE II: Implement the process studied in Phase I. Develop the hardware/software package necessary to demonstrate the process. At the end of Phase II, a product capable of being demonstrated (preferably on a PC) to potential customers should be available.

POTENTIAL COMMERCIAL MARKET: Any human faced with making a decision in a limited time based on a large amount of data may be helped by the decision aid. Pilots, power station operators, air defense tactical operations center commanders, military commanders, manufacturing plant managers, and others may be candidates for this product.

A96-126TITLE:Virtual Parabolic Dish Antenna

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the physics and engineering aspects to consider in designing C, X, and Ku band SATCOM antenna that is "virtual" rather than a parabolic dish.

DESCRIPTION: The design would rely upon mass producible reflective elements that would be located parabolically in a skeletal framework and oriented toward any of three interchangeable feedhorns depending upon the band of interest. Alternatively, the design would rely upon mass producible collecting elements that would be located parabolically in a skeletal framework and need an integrating segment to mix together arriving radio frequency energy in the C, X and Ku bands for recombination into the original transmitted signal. In both cases, the framework would be designed so as not to be susceptible to disturbance from high winds, and to allow precise tracking of the satellite transponder.

PHASE I: Show the feasibility of developing and designing a "virtual" antenna for C, X, and Ku bands.

PHASE II: Design, develop, build and demonstrate one or more prototype "virtual" antennas for C, X, and Ku bands.

POTENTIAL COMMERCIAL MARKET: The satellite communications market is growing rapidly. The "virtual" antenna should have applications in the satellite communications market.

A96-127TITLE:High Resolution Tracking of Distributed Targets

CATEGORY: Exploratory Development

OBJECTIVE: Identify and explore methods for improving the ability of high resolution radars to maintain track on targets whose scattering centers are distributed over multiple resolution cells.

DESCRIPTION: Typical tracking radars have modes: bandwidths for which multiple scattering points across a target cannot be distinguished. To these radars, targets appear to be point sources which may fluctuate in amplitude. However, high resolution radars frequently have sufficient bandwidth to resolve multiple scattering points of a target. As the multiple scattering points fluctuate during track, the radar track point may jump between the scattering points. This jumping/wandering of the track point from look-to-look can induce a change in the apparent velocity of the target. Track filters which attempt to follow such false changes in target velocity may be driven off the target and lose track.

PHASE I: Show the feasibility of developing enhanced tracking methods applicable to targets which have range extent exceeding the range resolution of the radar.

PHASE II: Prepare specifications for implementing the new track method(s) in selected high resolution radars. Develop the necessary software/hardware to implement the new approach.

POTENTIAL COMMERCIAL MARKET: The cataloging of satellites and their orbital parameters is an ongoing process of interest to both government agencies and private companies. Many of the satellites are large compared to a radar resolution cell, so the new tracking methods developed will be directly applicable and transferable to these radars.

TOPIC: A96-128TITLE:High Temperature Materials Testing and Development Using High Energy Lasers

CATEGORY: Basic Research

OBJECTIVE: To create advanced methods for commercial high temperature materials testing using existing DoD high energy laser technologies, thereby reducing the development costs for advanced high temperature materials.

DESCRIPTION: We, at the High Energy Laser Systems Test Facility, propose the creation of a commercial high temperature materials testing industry utilizing existing mature continuous wave HF/DF chemical High Energy Laser (HELs) as well as pulsed C02 HEL technologies. High temperature materials include all materials intended to operate in high temperature environments. Rocket nozzle materials, fusion reactor wall and "diverter " materials, and high angle of attack reentry vehicle materials are three candidate areas of application. Military R&D lasers, available at HELSTF for commercial testing, are large enough Megawatt Class to envision component level failure tests simulating severe thermal environments at substantially reduced testing cost for product developers.

PHASE I: Early efforts should include a study (or review) of existing commercial high temperature materials and how they are tested. An effort to further analyze and identify critical needs of High Energy Laser Systems Test Facility HELSTF) potential high temperature materials research customers will also be required. Finally, a small scale demonstration of laser methodologies for known high temperature materials will be required.

PHASE II: Second Phase efforts will attempt large scale component level demonstrations leading to potentially patentable testing processes.

POTENTIAL COMMERCIAL MARKET: The market for such high temperature materials commercial testing processes while in the early stages of development, appears substantial and durable due to the large variations in potential and products and end product requirements.

A96-129TITLE:Reentry-Tracking Improvements for the TRADEX Radar

CATEGORY: Exploratory Development

OBJECTIVE: Explore methods of improving the TRADEX track filter to maintain track on reentry objects whose drag profile is either unknown or deviates from priority predictions.

DESCRIPTION: Certain classes of reentry objects observed by the TRADEX radar have drag profiles which deviate significantly from permission estimates. Although TRADEX radar (a coherent signature and metric radar) is capable of tracking well behaved targets during reentry, it can have difficulty maintaining track on targets whose drag profiles are uncertain.

PHASE I: Show the feasibility of developing track algorithms for implementation at the TRADEX radar to allow improved tracking of reentry vehicles which have uncertain drag characteristics. Validate the trackfilter algorithms via simulation.

PHASE II: Prepare specifications of the track algorithms to be implemented in the TRADEX real-time program. Assist TRADEX personnel with the installation of the trackfilter and planning site tests of the installed filter.

POTENTIAL COMMERCIAL MARKET: The improved trackfilter will be readily transferable to radars at other military test ranges preventing loss of track and allowing test data to be collected without expending resources to repeat test. In addition, the filter can be extended to other government and commercial tracking facilities allowing them to maintain track on targets which otherwise might have been lost.

A96-130TITLE:Data Compression for Post Mission Data Reduction at ALTAIR

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to design and build a software post mission data compression system for the ALTAIR radar.

DESCRIPTION: The design of the Nyquist Recording System (NRS) at ALTAIR includes a minimum data storage capacity of 4 GBytes. On some high interest missions, this quantity of data is required to be transferred from the ALTAIR field site to CONUS as quickly as possible over the High Speed Data Link (HSDL). The HSDL is a digital SatCom link operating at 1.5 MBps. Transmission of 4 GBytes of data would take over 500 hours at this rate. Compression of the radar data prior to transmission would allow faster data transmission, speedier post mission analysis, and reduced storage requirements.

PHASE I: Investigate the performance of data compression algorithms against test radar data from Near Earth targets. Determine best compression algorithm for radar data.

PHASE II: Design and code post mission software to compress/uncompress data recorded in NRS format. Test with mission data at site.

POTENTIAL COMMERCIAL MARKET: Phase II proposals should also include an assessment of the commercial applications and markets for use of the data compression system with the FAA air traffic control system and harbor and ship traffic radar control systems.

## U.S. Army Medical Research and Materiel Command

A96-131TITLE:Information Systems in Drug Discovery and Development

CATEGORY: Exploratory Development

DESCRIPTION: The Walter Reed Army Institute of Research maintains one of the world's largest chemical inventory and biology databases in support of the USAMRMC's research and development missions. The Division of Experimental Therapeutics is in the process of designing and implementing systems for the storage and retrieval of information developed from 500,000 chemical samples tested in USAMRMC programs. The goal of this topic is to develop an integrated report

generator (IRG) which will combine data from the inventory, biology and chemical structure databases and make it available to all of the Command using client/server computing. This will eliminate duplication of effort with its duplication of costs. It will facilitate molecular modeling efforts and lead to the discovery of structure activity relationships in the development of prophylactics and therapeutics.

PHASE I: Create and develop client/server computing for high-speed access to the information systems.

PHASE II: Design, develop and implement systems for the simultaneous retrieval of chemical structures with their associated inventory and biological testing results These systems will be used to develop printed reports or for the direct on-line comparison of chemical structures in two and three dimensions as a function of biological activity.

A96-132TITLE:Non-Invasive Intracranial Pressure Sensor

CATEGORY: Exploratory Development

OBJECTIVE: To develop a non-invasive sensor capable of reliably (R-second power for correlation with accepted methods must exceed 0.9) determining intracranial pressure directly or indirectly. Such a sensor can be envisioned, eventually, as either a body-worn sensor, or as part of a hand-held, palm-sized sensor suite holding a variety of sensors. Output from the sensor will be in a standard form, suitable for input to standard PC-type computers, or to other, military hardware currently in development, such as the Trauma Control Module or small, hand-held personal computers such as the Soldier Individual Computer (adapted for medical applications).

DESCRIPTION: This non-invasive intracranial pressure sensor must provide output in 15 seconds or less, and output should be "nominally" in standard units of pressure, such as Torr or mmHg. Together with such other instrumentation as the medical decision algorithm within the Soldier Individual Computer, this sensor should be capable of up-dating itself on a minute-by-minute basis.

PHASE I: Develop realistic proof-of-principle and demonstration, based on state-of-the-art design concepts, scientific literature values, previous models and validated assumptions including descriptions above.

PHASE II: Validate proof-of-principle with experimental data; refine design concepts as necessary. Phase II prototype (suitable for further testing at government laboratories) must be capable of updating data from previous readings, in order to determine whether intervening treatment was effective, or whether spontaneous course of casualty is changing.

POTENTIAL COMMERCIAL MARKET: Because head injury is a leading cause of death and disability in civilian as well as military trauma, and because determination of intracranial pressure is an effective diagnostic tool for assessing head injury, the commercial market is significant. Potentially, this device could be used on every vehicle responding to emergencies and by every paramedic, as well as for triage by qualified medical personnel.

A96-133TITLE:Field Portable Digital Ophthalmoscope/Fundus Camera

CATEGORY: Exploratory Development

OBJECTIVE: To develop a non-mydriatic ophthalmoscope/fundus camera suitable for user under field conditions that will permit acquisition and storage of digital images and rapid assessment of basic visual function.

DESCRIPTION: Eye injuries constitute approximately 10% of combat casualties. Definitive ophthalmological care is not routinely available far forward in the field medical system. Telemedicine offers the potential to extend the availability of definitive specialty ophthalmic care to lower echelons and thereby reduce morbidity in eye-injured soldiers and civilians. Diagnosis and treatment of ocular injuries depends on careful inspection of the fundus by trained specialists and accurate assessment of visual function. Current fundus cameras are not compact and rugged enough for field use. The development of a smaller, more rugged camera would allow providers at forward medical treatment facilities to image the fundus of injured

soldiers or civilians. Acquisition of image in digital form would permit transmission of the fundus image to distant sites where access to specialized care would be available. This would allow the provider on the scene to receive diagnostic and treatment recommendations from experts with detailed, immediate knowledge of the case. Integrating the capability to perform basic visual function tests, such as acuity and Amsler grid measurements, will further improve the diagnostic utility of the system.

PHASE I: Survey existing fundus camera/digital video technology. Conduct feasibility/design trade-off study to specify desired performance characteristics of proposed system.

PHASE II: Produce prototype system; demonstrate the ability of the system to acquire and store images of acceptable quality for diagnostic interpretation.

POTENTIAL COMMERCIAL MARKET: This system will also enhance the ability of civilian providers to diagnose and treat ocular trauma and disease processes such as hypertensive and diabetic retinopathy.

A96-134TITLE:Expression and Purification of Recombinant Proteins

CATEGORY: Exploratory Development

OBJECTIVE: To improve methods of recombinant protein expression and subsequent purification using "in vitro" or "in vivo" expression systems applied to pathogens of military significance.

DESCRIPTION: Currently, several expression systems are used to express recombinant proteins including viruses, bacteria, fungi, and transgenic plants or large animals. We require improvements in the current expression vector systems or host strains used for recombinant expression of military significant antigens or unit vaccine components. It is important to evaluate the efficiency of subsequent cleavage of fusion peptides/proteins often designed to assist affinity purification of recombinant proteins. Also important are improved methods of endotoxin removal during the purification process. Recent development in PCR amplification and cloning of immunoglobulin VH regions have identified methods for rapid isolation of complimentarity determining regions (CDRs) encoding high affinity antigen binding sites. In addition, directed mutagenesis can convert low affinity binding sites to high affinity. By incorporating this technology with production of transgenic plants or large animals for expression of these CDRs on conserved framework structures of human immunoglobulins, it should be possible to produce large amounts of functional protective antibodies.

PHASE I: For production of recombinant vaccine components, initial studies can compare amounts of proteins made by different expression systems. Strong consideration should be given to the subsequent ease of purification of endotoxin-free recombinant proteins. For recombinant human antibodies, research should demonstrate the capability of rapid selection of high affinity CDRs that bind and neutralize a pathogen, construct IgA or IgG isotypes using the selected CDR, determine the affinity of the antibody constructs, and select candidates for expression in either transgenic plant crops or transgenic large animals. Specific pathogens of interest include plague, anthrax, botulinum toxin, Staphylococcal enterotoxin B, Venezuelan equine encephalitis virus, dengue virus, and other militarily significant agents.

PHASE II: After selection of an optimal expression systems, increase efforts to achieve purification of recombinant proteins as vaccine candidates or functional protective antibodies. Perform preclinical efficacy trials to support submission of the product to the Food and Drug Administration as an Investigational New Drug.

POTENTIAL COMMERCIAL MARKET: There are universal applications for improved expression systems and purification techniques for recombinant proteins. Sub-unit recombinant vaccines and protective antibodies produced by these methods could be quickly prepared against domestic and tropical diseases endemic worldwide.

A96-135TITLE:"In Vitro" Exogenous Metabolic Activation System for Use in the Frog Embryo Teratogenesis Assay - Xenopus (FETAX)

CATEGORY: Basic Research

OBJECTIVE: Develop and validate a mammalian-derived "in vitro" exogenous metabolic activation system for use in the Frog Embryo Teratogenesis Assay - Xenopus (FETAX).

DESCRIPTION: There is a need to assess the potential human developmental toxicity of individual chemicals and complex chemical mixtures found in the environment. This information on human health hazard could be used in the risk assessment process. FETAX has been validated as an assay system for the detection of developmental toxicants. In order for the FETAX to be useful in the detection of all potential human developmental toxicants, a mammalian-derived exogenous metabolic activation system must be incorporated into the assay. This system will simulate the metabolic activation which occurs in mammals which results in the activation of xenobiotic chemicals into their more toxic forms.

PHASE I: Develop a mammalian-derived metabolic activation system for incorporation into the FETAX assay system.

PHASE II: Complete development and perform validation of the metabolic activation system.

A96-136TITLE:Innovative Design and Synthesis of Antiparasitic Agents

CATEGORY: Basic Research

DESCRIPTION: Malaria was a significant casualty producer in both World Wars, the wars in Korea and Vietnam, and recently, the deployment to Somalia. The global emergence of drug resistant strains of faliciparum malaria threatens the effectiveness of standard antimalarial drugs available to the military. Thus, a requirement exists for the discovery of new structural classes of drugs effective against multidrug resistant malaria. In the past, the acridine, quinoline, and phenanthrene ring systems have provided platforms for the synthesis of many effective antimalarials, however, cross resistance between these structural types is increasingly common. New approaches to the design of antimalarial agents are required in order to overcome the phenomenon of resistance. Two approaches are possible: rational design, or protein structure-based drug design. Rational design includes the discovery of novel chemical entities structurally unrelated to previously employed antimalarial agents, or the discovery of agents capable of modulating parasite resistance mechanisms. Consideration of the comparative biochemistry of the host and parasite should provide the rational molecular targets for a synthesis program which will culminate in the discovery of safe and effective antimalarial agents. Protein structure-based drug design includes the discovery of new compounds through consideration of the information derived from the 3-D molecular structure of target proteins obtained through x-ray crystallography. This project envisions the identification, cloning and "in vitro" expression of target proteins followed by isolation of milligram quantities of expressed proteins, purification to homogeneity and production of crystals suitable for x-ray diffraction studies. Determination of 3-dimensional x-ray structure of crystallized protein, design of new drugs and lead compounds based on crystal structure and initiation of "in vitro" assays to evaluate efficacy of those compounds. Rational approaches to the design of resistance modulating substances capable of overcoming parasite multidrug resistance using the above technologies would also be appropriate.

PHASE I: Rational Drug Design: Synthesis and submission of an adequate number of new chemical entities to the Army antimalarial drug evaluation program. This will allow the development of an understanding of the relationship between structure and antimalarial activity for a new class of antimalarial agents or malaria drug resistance modulators. Protein Structure-Based Drug Design: Clone, express, isolate, and purify key target proteins of "Plasmodium falciparum" or other parasites of military import. Obtain crystals suitable for x-ray diffraction studies. Provide crystals or genes to the Army program, if requested.

PHASE II: Rational Drug Design: Scrutiny of the biological activity of candidates submitted for testing will guide the design and synthesis of a second generation of agents with enhanced antimalarial activity. Protein Structure- Based Drug Design: Determine the three dimensional locations of the atoms in the target protein through x-ray crystallography. Use the molecular structure derived from these studies to design molecules complementary to the target protein's active site which will serve as specific inhibitors of the target protein. Provide electronic files of the three dimensional atomic coordinates of the target biological molecule to the Army program, when requested.

A96-137TITLE:Retinal Drug Delivery System

CATEGORY: Exploratory Development

OBJECTIVE: To develop a system which will permit infusion of sufficient concentrations of therapeutic drugs to the retina for effective treatment of inner eye injuries and diseases

DESCRIPTION: Delivery of drugs to the retina in sufficient quantity to achieve therapeutic results is impossible in most cases. Drugs given as eye drops do not reach the retina in appreciable quantities. The blood retinal barrier prevents penetration of many systemic drugs (given orally or by injection) into the retina. Drugs which do cross this barrier often have to be given in high concentration when administered systemically, which makes their retinal use risky due to increased risk of unacceptable side effects. A system which will ensure drug delivery to the eye will permit treatment of retinal lesions (such as laser induced injuries) more effectively using valuable drugs such as anti-inflammatories and neuoprotectives. Such a system would have wide application in both civilian and military medicine.

PHASE I: Review relevant literature; evaluate design alternatives; design the system; evaluate the relevant pharmacokinetics and pharmacodynamics of relevant drugs.

PHASE II: Construct a prototype system; demonstrate the system in an animal model.

A96-138TITLE:Development of Pharmacologic Antagonists for Botulinum Toxin

CATEGORY: Exploratory Development

OBJECTIVE: Synthesize effective metalloprotease inhibitors that can interact with and inhibit the active site of three botulinum neurotoxins (BoNTs) serotypes (A, B, and E).

DESCRIPTION: Exposure to BoNTs, the most lethal substances known, leads to flaccid paralysis, respiratory collapse and death. At present, there is no specific therapy for BoNT intoxication; only symptomatic and palliative treatments are available. Recent progress in our understanding of the mechanisms of action of BoNTs offers hope for development of specific BoNT antagonists. A key discovery was the finding that each of the seven BoNTs possesses zinc metalloprotease activity. The BoNTs selectively cleave proteins, termed synaptobrevin (VAMP), syntaxin, and SNAP-25, involved in the docking and fusion of synaptic vesicles.

PHASE I: Initial stages of drug discovery will involve molecular modeling to deduce the three-dimensional conformation of the BoNT serotypes A, B, and E and their protein targets identified above. This should be followed by the synthesis of small peptide-based inhibitors that have functional groups to bind the catalytically-important zinc. The initial compounds will be evaluated by the U.S. Army Medical Research Institute of Chemical Defense investigators in their validated cell-free systems.

PHASE II: The product developed in Phase I will be tested to prove safety, efficacy, and toxicity. The quantitative structure-activity profile from the Phase I study will be used to obtain a more refined estimate of the active site conformation of the BoNTs and allow for optimal ligand-active site interactions. This information will enable the synthesis of more active metalloprotease inhibitors and provide further refinements of the active site geometry. When peptide-based inhibitors with nanomolar affinities for BoNT are produced, the structural information will be used to design and synthesize non-peptide organic molecules that can be transitioned to therapeutic agents; these would be expected to have better bioavailability and membrane permeability than the initial peptides. Suitable drugs should have a high affinity for the BoNT active site and have low systemic toxicity.

POTENTIAL COMMERCIAL MARKET: The absence of an effective pharmacologic treatment for botulism assures a ready market for a metalloprotease inhibitor to treat this debilitating and potentially fatal intoxication. It will benefit military personnel who face BoNT exposure in the battlefield, civilian populations intoxicated by contaminated food products, and patients who may become intoxicated while receiving BoNT treatment for muscle disorders.

A96-139TITLE:Development of an Sensitive and Specific Antigen-detection System for "Strongyloides Stercoralis" and Hookworm Infections

CATEGORY: Basic Research

OBJECTIVE: To develop and evaluate a simple, fieldable, inexpensive, sensitive, and specific antigen detection system to identify persons infected with " Strongyloides stercoralis" and hookworm infections.

DESCRIPTION: Soldiers who train and conduct operations in certain parts of the US and in large areas of the tropical world are at risk for infection with soil-transmitted helminths including "Strongyloides stercoralis" and hookworms. Infections have been documented in association with World War II, Vietnam, and more recent tropical deployments. "S. stercoralis" can become a chronic infection with minimal or no symptoms which may pose a problem with hyperinfection and dissemination decades down the line if an infected person becomes immunocompromised as with certain malignancies or therapies. Outside of soldiers it is likely that hundred of thousands (possibly several million) of persons living in the US are chronically infected with "S. stercoralis". Traditional diagnostic technologies such as stool exams, duodenal aspirates, and serologic tests have limitations with respect of efficient mass post-deployment screening or screening prior to the administration of immunocompromising drugs due to cost, practicality, and issues of sensitivity, specificity in general and specificity in the setting of cross-reacting agents such as hookworms. A simple diagnostic method that was sensitive in early infection specific, and logistically acceptable would be a valuable tool for military clinicians and opidemiologists and may have an important civilian application for screening in infectious disease, transplant, and oncologic settings.

PHASE I: Development of the antigen detection assay.

PHASE II: Fielding the assay with a rigorous assessment of sensitivity, specificity, and logistic acceptability.

A96-140TITLE:Development of a Light Weight Portable System for the Determination of Infection Susceptible Patients and Early Detection of Infection

CATEGORY: Exploratory Development

OBJECTIVE: To measure factors present in injured individuals that predict likelihood of systemic infection or detect its presence early in its course.

DESCRIPTION: There is a critical need to detect and prevent infection in battle casualties as soon as possible after injury. A monitoring system that could be used to predict infection susceptibility after injury and detect it at early stages in battlefield medical facilities would allow detailed observation and facilitate early interdiction of infection in wounded soldiers. Such a system should be portable, field deployable and reliably monitor predictive factors in small quantities of body fluids, providing a timely readout of results to clinicians.

PHASE I: Determine and describe factors which will predict infection susceptibility and allow early detection. Describe necessary analytical tools to measure factors and evaluate results in field medical units.

PHASE II: Build prototype instruments and demonstrate field utility of system in simulated battlefield conditions.

POTENTIAL COMMERCIAL MARKET: The development of a monitoring system that could detect early stages of infection would benefit medical treatment facilities.

A96-141TITLE:Rapid Confirmation Assays Against Specific Toxins and Infectious Disease Pathogens

CATEGORY: Exploratory Development

OBJECTIVE: Design and test rapid and simple confirmatory diagnostic assays against selected toxins and infectious disease pathogens.

DESCRIPTION: Most diagnostic assays used to confirm the identity of pathogens require expensive and time consuming methods. Even with the advent of polymerase chain reaction, methods may require extensive molecular biology support. Proposed devices or methodologies should reduce the time it takes to make a confirmatory diagnosis to two hours or less. Methods should reduce the need for extensive laboratory support. Proposed assays should reach a level of specificity and sensitivity equal to or exceeding 95%. Assays may be directed against agent-specific antigens, polypeptides, nucleic acids or other biomolecules. Specific pathogens of interest include plague, anthrax, botulinum toxin, Staphylococcal enterotoxin B, Venezuelan equine encephalitis virus, dengue virus, and other military significant agents.

PHASE I: Demonstrate feasibility of device or methodology with pathogens of military significance. Demonstrate minimum levels of sensitivity and specificity (95%) using laboratory-derived specimens or equivalent.

PHASE II: Complete field evaluation of device or assay. Provide sufficient data to support transitioning to advanced development.

POTENTIAL COMMERCIAL MARKET: The developed assay can be adapted and commercialized for identification of any disease agent.

A96-142TITLE:Rapid Detection of Arthropod-borne Pathogens in Mosquitoes

CATEGORY: Exploratory Development

OBJECTIVE: Adapt the new "wicking dip-stick" detection technology to develop a one-step, "field-usable" assay capable of detecting arthropod-borne pathogens in mosquitoes.

DESCRIPTION: Identification of arthropod-borne pathogens in mosquitoes is normally accomplished by ELISA, a multi-component (4-6 hr) assay requiring specialized equipment, refrigeration/freezing of reagents, and highly trained personnel. However, arthropod-borne diseases typically threaten U.S. troops deployed to developing countries where access to such facilities and equipment is unavailable. Adapting the new generation of rapid (<15 min), stable (ambient storage), one step wicking dip stick technology to the detection of arthropod- borne pathogens in mosquitoes will permit it's use by far forward personnel in any environment. Timely identification of the arthropod-borne disease threat will insure increased compliance with personnel protective recommendations and/or will insure increased compliance with personnel protective recommendations and/or selective vector control efforts. These assays would be of immense benefit to both the Department of Defense (DoD) and to various civilian health agencies throughout the world. Malaria and dengue affect the health of hundreds of millions of civilians throughout the developing world. These diseases also pose a significant threat to U.S. forces deployed overseas, a fact borne out by our recent experiences in Somalia and Haiti. Development of assays for the detection of the pathogens causing these diseases are therefore an extremely high priority for the DoD.

PHASE I: Adapt rapid (<15 min), one step, stable (ambient storage) dip-stick wicking technology to the identification of malaria and dengue-infected mosquitoes. Given a panel of dengue- and malaria-specific polyclonal/monoclonal antibodies and a supply of positive control, i) select the most appropriate antibodies for incorporation into a malaria assay and a dengue assay that meet the criteria listed above, ii) develop a prototype dengue assay capable of detecting 104 plaque-forming units of dengue virus in a pool of 25 mosquitoes, iii) develop a prototype malaria assay capable of detecting 100 sporozoites in a pool of 25 mosquitoes, and iv) produce 1000 dengue assays and 1000 malaria assays to allow for initial laboratory/field validation of assay.

PHASE II: Production and testing of a consistent product (10,000 units of each assay). A direct comparison with "gold-standard" assays will be made to ensure sensitivity of the assay, as well as extensive tests for cross-reactivity and interferents. If the assays meet all requirements, adapt this method to develop (i) a single assay capable of detecting 5 species/polymorphs of human malaria sporozoites in a single assay, and (ii) a single assay capable of detecting flaviviruses,

alphaviruses, and phleboviruses. Again, the Army would supply the species-specific monoclonal/polyclonal antibodies required for assay development.

POTENTIAL COMMERCIAL MARKET: The results of this work would have application wherever rapid, inexpensive assessment of mosquitoes for arthropod-borne pathogens was required. This includes extensive application in the military, civilian government, and private health sectors. Use includes locations throughout most of the developing world. Various local (i.e., mosquito-control districts), national (i.e., Ministries of Health, the Centers for Disease Control and Prevention), and international (i.e., the Pan American Health Organization or the World Health Organization) health-care organizations have expressed interest in such field-usable assays.

A96-143TITLE:Development of Reactive Topical Skin Protectants Against Sulfur Mustard and Nerve Agents

CATEGORY: Exploratory Development

OBJECTIVE: The identification, synthesis, and application of reactive materials capable of neutralizing sulfur mustard and nerve agents (GA, BG, BD, and VX).

DESCRIPTION: Materials must be developed to neutralize sulfur mustard or nerve agents (GA, BG, BD, and VX) that contact the skin. The neutralizing materials should be incorporated into a base cream, containing a mixture of perfluorinated polyether oil and teflon particulates as thickener, for application to the skin as a protectant from cutaneous exposure to these agents. The incorporated materials must enhance the barrier effect by chemically neutralizing or catalyzing the noxious agents, so that in case of barrier breakdown the agents are no longer toxic. The material should have reasonable cost, be safe and nonirritating, chemically stable, and demonstrate rapid kinetics.

PHASE I: Conceptualization and synthesis of prototype reactive topical skin protectant materials capable of neutralizing sulfur mustard or nerve agents (GA, BG, BD, and VX). Incorporating the neutralizing material(s) in a base cream. Reactivity, stability, cost, and skin toxicity must be considered. Efficacy testing will be conducted by the U.S. Army Medical Research Institute of Chemical Defense.

PHASE II: Improve and refine the prototype reactive topical skin protectant into a final product.

POTENTIAL COMMERCIAL MARKET: This research would benefit industries where employees are exposed to toxic materials (e.g., chemical plants, pesticides, and herbicides). Police would benefit from protection against tear gas and other riot control agents. The general public would benefit from protection against environmental irritants such as poison ivy.

A96-144TITLE:Test System to Detect Enterically-Transmitted RNA Virus Pathogens

CATEGORY: Exploratory Development

OBJECTIVE: Detect the following virus pathogens at concentrations down to 10- third power particles per mL of body fluid (e.g. serum) to 10-fourth power per mL of environmental water: hepatitis E virus, human caliciviruses including Norwalk virus and Snow Mountain virus, hepatitis A virus, poliovirus types 1-3, other enteroviruses, human rotaviruses.

DESCRIPTION: Technology is emerging to rapidly detect rare RNA molecules by hybridization; promising approaches that combine rapidity with sensitivity are those that use solid state electronics to detect hybridization events. Because oligonucleotide probes can be designed to specifically detect the above enterically-transmitted virus pathogens, a field assay system comprised of a sample-concentrating unit (for environmental water samples) and a detector unit could be designed. Such a system could be used for rapid detection of virus pathogens in clinical specimens.

PHASE I: Develop a prototype detector unit capable of detecting one or more types of RNA virus genomes to a practically useful level of sensitivity. Poliovirus and hepatitis A virus RNAs are the suggested initial target molecules

PHASE II: Expand the detector's capability to an array of hybridization probes; lower the detection threshold; establish a sample concentrating procedure; construct a prototype instrument for field testing; use the instrument in field tests validated with more conventional virus detection assays.

POTENTIAL COMMERCIAL MARKET: The system could also be used to detect viruses in environmental water to supplement conventional testing for bacterial pathogens; the rationale for virus testing would be to identify sources of virus contamination, to monitor for failure of purification procedures, to indicate environmental risk, to quality-assess food or beverages produced at scale, etc. This technology is very likely to have multiple commercial applications.

## Topics Addressing U.S. Army Operating and Support Cost Reduction (OSCR) Initiatives

A96-145TITLE:Liquid Molded Composite Armor Smart Structures Using Embedded Sensors

CATEGORY: Exploratory Development

OBJECTIVE: Develop an in-situ sensor system for in-process and in-service process, health and dynamic response monitoring of monocoque or hybrid liquid molded composite armor structural parts.

DESCRIPTION: Composites offer lightweight alternatives for armor. The most effective means of manufacturing composite armor is by using liquid molding processes; however, processing and maintenance of thick-section composites requires unique sensor systems. Smart composite structures often contain embedded current-carrying leads or optic fibers used as sensors to determine in-process and/or in-service processing parameters and/or loading responses such as deflections, local strains, vibrations, etc. Many of these structures are manufactured using liquid molding techniques such as resin transfer molding (RTM) and Seeman's composites resin infusion molding process (SCRIMP). In-situ sensing systems may be used to intelligently control the process making production more economical and enabling the production of more complicated parts by a traditionally economical process. These same or other sensors could be used throughout the service of the manufactured part as smart structure material sensors in a state or dynamic mode for in-service damage detection or for active control of, for example, vibrational responses.

PHASE I: Demonstrate for a liquid molding composite armor manufacturing process a sensor or complementary multi-sensor system technology for in-process and in- service process, health, or dynamic response monitoring. Develop and demonstrate compatible sensor acquisition hardware capable of sensing critical or useful in-process and in-service process, health or dynamic response phenomena of a liquid molded part.

PHASE II: Demonstrate the use of in-situ smart sensors or a complementary multi- sensor system through the controlled liquid molding of a composite armor demonstration part. The processing would be intelligently controlled using the sensor-obtained flow/ cure information. Demonstrate subsequent in-service damage detection or control of an appropriate mechanical response of the same part using the in-situ process sensors as smart material sensors and develop/ utilize/ demonstrate an appropriate in-service control system to monitor and correct detrimental mechanical response phenomena.

POTENTIAL COMMERCIAL MARKET: A complementary sensor system providing both in- situ process monitoring and in-service health and response monitoring would have excellent market potential.

OPERATING AND SUPPORT COST REDUCTION: A complementary sensor system providing both in-situ process monitoring and in-service health and response monitoring would offer the government and the commercial marketplace a high potential for vast cost savings. This concept not only offers a real-time quality check on the part/component as it is being manufactured, thereby eliminating the cost of low quality inferior output, but also provides a means to monitor the part/component throughout its lifecycle. Its this lifecycle information that can provide valuable information to the user as to the need or lack of need to replace a particular unit. Early replacement meaning spending dollars unnecessarily to replace a unit that

is still in fine working order, or even worse would be the potential cost to NOT replace a unit that has started to fatigue and fails. The embedded sensors will allow us to have the data to make the best, most cost effective and appropriate decisions.

A96-146TITLE:High Energy Batteries for the Individual Soldier

CATEGORY: Exploratory Development

OBJECTIVE: To provide new/improved primary and rechargeable battery chemistries to power Army portable electronic and electrical equipment.

DESCRIPTION: The Army must up date its battery technology to keep pace with the increasing power demands of emerging portable electronic and electrical equipment. For most applications, the "dual use"/ low cost requirement shares a high priority with the performance requirement. For special applications, highest performance (without sacrifice of user safety) is given the highest priority. The Army's present baseline primary battery is Li/SO2, which provides approximately 160 Wh/kg and 40 W/kg of energy and power density, respectively using present packaging techniques. While the latter chemistry has much merit (good low temperature operation and excellent storability) it is not "dual use ", still presents some concerns over user safety, and does not posses the higher power and energy densities which are now desired. Conventionally-packaged Li/ MnO2 (liquid organic electrolyte, steel cell cases) batteries are being considered as possible successors to Li/SO2. Such batteries would be "dual use", and provide approximately the same room temperature performance as their predecessors, but (as presently formulated) would have restrictions on low temperature operation. Finally, Li/MnO2 packaged in soft plastic cases could provide superior room temperature performance, but presents potential safety concerns. It is anticipated that the Army's baseline rechargeable communications battery will soon comprise a liquid electrolyte "Li-Ion" chemistry. Such batteries will be "dual use" and provide upwards of 110 Wh/kg and 40 W/kg of energy and power density respectively. Low temperature performance limitations, and user safety are still areas of concern. Even higher performance levels are now being sought. Solutions which may be offered to the problem mentioned above may include, but need not be limited to: 1) Improved anodes - Li host alloys (including improved carbons) for primary and rechargeable batteries which will impart greater safety with little loss energy density, power density. 2) Improved cathodes - Li-insertion compounds with greater Li capacity, higher Li diffusivity, better cyclability, lower cost than presently available materials for Li-Ion cells. Other higher energy positive plate materials for primary or rechargeable Li batteries. 3) New/ Improved liquid or gel electrolytes - To enhance low temperature performance, storageability, power density and safety (e.g., through low flammability) of Li batteries. Liquid or gel electrolytes with very low vapor pressures and acceptable conductivity could enable safe packaging in soft lightweight cell cases. 4) Other novel cell components - improved battery separators and additives to enhance performance and/or safety.

PHASE I: Phase I should result in the identification/ synthesis of one or more materials for improved Li or Li-Ion batteries. Materials shall be sufficiently characterized (including prototype laboratory cells if feasible) to demonstrate potential usefulness in improved batteries.

PHASE II: Development and characterization of materials and components are to be completed. Prototype cells are to be developed and demonstrated.

POTENTIAL COMMERCIAL MARKET: Improved high energy batteries are being avidly sought for lap top computers, cellular phones, camcorders and many other electronic and electric equipment. Rechargeable battery chemistries may be useful for commercial transportation vehicles.

OPERATING AND SUPPORT COST REDUCTION: The Army must up-date its battery technology to keep pace with the increasing power demands of emerging portable electronic and electrical equipment. Only through projects such as this one can the Army, DoD and the private sector attack the problem of ever increasing power needs via technology that will produce lighter, smaller, longer lasting, safer, cheaper battery technologies. This type of work in tandem with other ARL projects, such as the power remaining indicator, will lead to better and less expensive fuel cells and reduce the logistics nightmare of always having enough "spares" on hand. This technology could also help lead the U.S. in the practical realization of the national goal of the "Electric Car".

A96-147TITLE:Advanced Turbomachinery and Mechanical Components for Small Gas Turbine Engines for Air and Ground Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: Develop advanced turbomachinery and mechanical components which lessen the performance penalties inherent in small gas turbine engines.

DESCRIPTION: Gas turbine engines of interest to the Army fall into the small size class, generally having less than 10 lb mass air flow per second through the engine. The small physical size of the turbomachinery and mechanical components forces certain restrictions on these engines in terms of allowable configurations, operating parameters, efficiency, operability, size and weight. As an example, most small gas turbine engines use centrifugal compressors instead of all axial stages to overcome the efficiency penalties associated with very small axial blading. Bearings and dampers become disproportionately large and heavy as engine size is reduced. Innovative turbomachinery and mechanical component configurations are sought which will lessen the performance penalties associated with geometric constraints inherent in small gas turbine engines. Of particular interest are: 1) compact and efficient diffusers for centrifugal compressors, 2) compressor configurations with wide flow range capability, 3) the application of MEMS (Micro Electrical Mechanical Systems) technology to turbomachinery components, 4) lubeless bearings, 5) compact seals (both air-air and bearing compartment, and 6) compact dampers.

PHASE I: Develop understanding of the physical phenomena underlying the proposed concept and show concept viability by performing preliminary analytical and/or experimental investigations. Estimate the potential benefits to be gained from the application of the concept and plan a Phase II demonstration.

PHASE II: Develop and demonstrate the viability of the proposed concept via a " bread board" demonstration. The demonstration test conditions do not have to duplicate actual engine operating parameters, but must be sufficient to incorporate all relevant physical phenomena.

POTENTIAL COMMERCIAL MARKET: Any concept which can significantly improve the performance of small turbomachinery or mechanical components has a virtually unlimited potential commercial market, such as: main propulsion engines, APUs (Auxiliary Power Units), turbochargers, and natural gas compressors.

OPERATING AND SUPPORT COST REDUCTION: The Army has a considerable number of air and ground vehicles, that use gas turbine equipment. This topic calls for technology that can provide advances in turbomachinery and mechanical components that will make these gas turbines more efficient and more reliable. The cost savings over the lifetime of the engines is readily measurable in both their use and maintenance support; an improved engine provides for better and more reliable use while requiring less logistics support, spare parts, down time and service.

A96-148TITLE:Point Sensor for Airborne Biological Particles

CATEGORY: Exploratory Development

OBJECTIVE: Design, construct and demonstrate a prototype instrument for real-time detection (based on intrinsic fluorescence) and rapid identification of airborne biological particles.

DESCRIPTION: Rapid methods for detecting and identifying airborne biological particles would be useful for a variety of applications, for example, in detecting and controlling the spread of disease of humans, animals, and plants. Real-time detection, as is attainable with light-scattering and fluorescence methods, should prove useful as an indicator of the presence of biowarfare agents. Unlike many non-biological atmospheric aerosols, biological cells contain fluorescent molecules (e.g., amino acids, nicotinamide adenine nucleotides, and flavins). The fluorescence from these molecules is useful in the development of laser based methods for detecting airborne biological particles and for distinguishing them from non-biological particles. Rapid identification of bioaerosols requires reaction of the suspect particles with probes (e.g., antibodies) specific for biomolecules of interest. The development of a prototype particle counter and identifier that uses the intrinsic fluorescence of biological materials for real-time detection and specific probes for rapid identification is the goal of this task.

PHASE I: Perform a systematic study of the issues that affect the feasibility of detection, and possible discrimination, of weakly-fluorescent bioparticles using laser-exited intrinsic fluorescence, and/or absorption spectra. Design a fieldable prototype fluorescence particle counter that measures the fluorescence and elastic scattering of individual airborne particles as they are drawn through the instrument. Determine laser sources and detectors that provide optimum discrimination between biological and non-biological aerosols.

PHASE II: Based on the findings in Phase I, construct a man-portable, lightweight, battery-powered real-time biodetector and rapid identifier that can be deployed for remote, stand alone, monitoring of biological aerosols.

POTENTIAL COMMERCIAL MARKET: Airborne biological particles are important causes of disease of humans (e.g., tuberculosis, influenza), animals, agricultural crops, and forest trees (e.g., white pine blister rust). Bacteria are being disseminated in the air for the control of insect pests in large areas. Allergies caused by airborne bacterial particles are of major importance. Methods to rapidly detect and identify airborne biological particles could have major applications in medicine, occupational safety, and environmental protection, in addition to their applications to national defense.

OPERATING AND SUPPORT COST REDUCTION: Methods to rapidly detect and accurately identify airborne biological particles could have major applications in medicine, occupational safety, and environmental protection, in addition to their applications to national defense. The advancement of this type of technology has the potential to go much farther than only saving a few dollars, this technology has the potential to prevent personnel injury and save lives. The dual use applications are obvious, with equally strong arguments on both the Defense and commercial sides. From the threat of biological elements on the battlefield to the identification of a particular allergy causing particle in humans and/or animals to a disease strain attacking plants or crops the cost reduction potential is enormous.

A96-149TITLE:Detector/ Amplifier/ Mixer Array for a Low Cost Imaging Ladar

CATEGORY: Exploratory Development

OBJECTIVE: This program investigates the feasibility of developing 1 x N detector/amplifier/mixer arrays for a low cost high resolution imaging laser radar.

DESCRIPTION: The Army Research Laboratory (ARL) Sensors Directorate is researching low cost, high range resolution laser radar for battlefield applications such as submunition target acquisition, robotics, fuzing, armor protection systems and low cost remote sensors for smart mines. The motivation is to exploit the very high angular and range resolution of laser radar to obtain 3-D images of targets that can be capably processed by automatic target recognizers expected in these new weapons. To form imagery with laser radar without some mechanical scanning device will require the development of detector/amplifier/mixer arrays. This program begins the process of developing such arrays.

PHASE I: The ARL Sensors Directorate is currently investigating, with excellent success, a unique high range resolution laser radar architecture based on FM radar ranging principles. This ladar architecture is discussed in SPIE (Vol. 2472, Pages 118-129) and requires a detector/amplifier/mixer chain as part of the processing to form range-gates. For current laser radar system applications, the detector/amplifier/mixer chain requires a bandwidth extending from 100 MHz to 1500 MHz, a detector gain of 70, and a low noise amplifier with a gain of 40 dB. The laser operates at 850 nm; however designs that operate in the eye-safe bands can also be considered. For Phase I of this program, the contractor shall perform a study to determine the feasibility of building 1 x N (N=20-30) arrays of detector/amplifier/mixer chains. This study will address a variety of issues including obtainable amplifier gain, noise, detector cross coupling, reliability, size and cost.

PHASE II: Phase II of this program will lead to the construction of a 1 x N detector/amplifier/mixer array, based on the recommendations of the Phase I work. Sample arrays will be constructed by the contractor and then inserted into ARL imaging ladar breadboard for an evaluation of performance.

POTENTIAL COMMERCIAL MARKET: The detector/amplifier/mixer array can be used in any commercial application of laser radar where high resolution 3-D imaging is desirable. Such applications include first-rate collision avoidance systems for

automobiles and other vehicles, smart highway applications such as vehicle classification for autonomously determining tools or highway use, mapping, and surveying.

OPERATING AND SUPPORT COST REDUCTION: The early stage development of these LADAR (Laser Radar) components will lead to huge operating and support cost reductions. Once developed and incorporated into next generation "smart weapons", this technology will provide the DoD with a highly accurate and lethal arsenal. Study after study and all advance theory has said that due to the effectiveness of this advanced arsenal, DoD will no longer need vast storehouses of rounds and the logistical nightmare of keeping the forward troops supplied with munitions; the one-target-one-smart weapon capability will supersede this necessity. We will no longer need to fill the belly of hundreds of B-52s and drop mission after mission of bombs, as in WWII Japan or Viet Nam; we will instead be able to use considerably less sorties with highly accurate very powerful weaponry to accomplish the same tasks. It is estimated that LADAR type smart weapons could and will shrink the DoD arsenal by 100 to 1.

A96-150TITLE:High-Mobility Scout Ground Vehicle

CATEGORY: Exploratory Development

OBJECTIVE: The primary objective is to foster the development of a ground vehicle having independently-controlled active suspension and independent electrically or hydraulically driven wheels. Application of this technology includes both military and civilian vehicles where high mobility is imperative. This class of vehicle would be ideal for reconnaissance and where high speed cross country operation is desired.

DESCRIPTION: It is envisioned that a test bed vehicle could be developed around a combined common roadarm suspension and a motor drive (electric or hydraulic) assembly. Directional control of the vehicle would be via differential power to each wheel. Ground clearance could be varied by independently controlling the vertical position of each roadarm. A conventional disk braking system could be integrated into each electric motor. Power will be provided by either a conventional generator or a hybrid generator and a battery system for an electrically powered vehicle. A conventional hydraulic pump system will provide power to vehicles having hydraulic motors. A conventional hydraulic pump and accumulator or a regenerative system will provide hydraulic fluid to each road arm suspension unit. Vehicle speed, direction and suspension response will be controlled by a fuzzy logic controller. A joy stick like device will be used to input speed and direction control.

PHASE I: Develop an integrated hydraulic suspension roadarm and motor unit suitable for use on a 3000 pound scout vehicle that will produce: a smooth ride at 50 MPH over rough terrain, 30 MPH speed up a 25 degree incline and achieve in excess of 80 MPH across level hard surface roads. The vehicle shall have a side slope in excess of 60 degrees. Deliver unit to the Government for their evaluation using fuzzy logic controller.

PHASE II: Develop a ground vehicle test bed using four hydraulic suspension and motor units developed in Phase I. Commercially available engine, generator and hydraulic pumps would be integrated into the test bed. Integrate the Government developed fuzzy logic controller into the test bed. Test bed vehicle will be delivered to the Government, for their evaluation/enhancement.

POTENTIAL COMMERCIAL MARKET: The Army envisions the future need for a high mobility scout vehicle. The technology developed through this test bed will be instrumental in the development of this future vehicle. This class of vehicle will also have a significant potential as a civilian off-road vehicle.

OPERATING AND SUPPORT COST REDUCTION: OSCR initiatives are exactly why topics like this one are submitted. The proposed SBIR project calls for the development of a "test bed" scout vehicle. This vehicle is not suppose to challenge Detroit or Japan for production vehicles, but what it will do is challenge the standard mind-set on the technologies available and currently in use versus new thinking and possible breakthroughs. Each aspect of this proposed vehicle offers the potential for a better/less expensive vehicle/component. As a 6.1 project this scout vehicle work will attack standard thinking about vehicle propulsion and suspension systems and introduce fuzzy logic control technologies, any or all of which has the potential to provide huge future cost savings while at the same time creating new state-of-the-art vehicle components and concepts.

A96-151TITLE:Advanced Technology Concepts and Components for Rotorcraft Drive Systems

CATEGORY: Exploratory Development

OBJECTIVE: Develop advanced drive system concepts and components which lessen weight and source noise, and extend reliability beyond current rotorcraft drives.

DESCRIPTION: Power transmission devices are necessary in current Army rotorcraft to transmit the power produced by turboshaft engines to the main and tail rotors. These transmissions are usually comprised of several stages, or modules consisting of: clutches, shafting, gearing, bearings, and other mechanical components. The weight of the transmission system is a significant portion of the vehicle empty weight. In addition, transmission source noise is propagated through the vehicle

structure and can reach the pilot with significant magnitude to produce hearing loss over time. Mechanical drives also are responsible for a sizeable portion of the unscheduled maintenance actions required by Army rotorcraft. Novel, light weight, low noise, reliable drive system concepts are sought which will reduce the weight and noise penalties inherent in rotorcraft drive systems and increase their reliability, hence increasing mission capability. Of particular interest are unique arrangements of mechanical components, hybrid or non-metallic components, and non-traditional power transfer methods such as light weight, high power electric generator and motor combinations.

PHASE I: Show concept viability through analytical understanding of the underlying physical phenomena. Perform preliminary performance and sizing studies. As appropriate, conduct proof-of-principle experimental investigations. Plan a Phase II demonstration.

PHASE II: Develop and experimentally demonstrate the proposed concept through a range of operating parameters sufficient to incorporate all relevant physical phenomena.

POTENTIAL COMMERCIAL MARKET: Light weight, quiet and reliable transmissions have great potential commercial application. Reduce weight translates into increased payload and therefore increased revenue. Reduced noise gives greater passenger and pilot comfort, along with community acceptance, or it lessons the need for noise absorption material, which again translates into increased payload and revenue. Increased reliability results in lower operating and support costs.

OPERATING AND SUPPORT COST REDUCTION: Light weight, quiet and reliable transmissions have great potential commercial application. Reduced weight translates into increased payload and therefore increased revenue. Reduced noise gives greater passenger and pilot comfort, along with community acceptance, or it lessens the need for noise absorption material, which again translates into increased payload. Increased reliability results in lower operating and support costs.

A96-152TITLE:Low Cost Photonic/Electronic Device Integration and Packaging

CATEGORY: Exploratory Development

OBJECTIVE: Develop versatile, low cost, packaging for next generation millimeter -wave (mmw), digital, analog, and opto-electronic integrated components.

DESCRIPTION: Next generation high frequency electronic circuits will include multi-function chips packaged to increase functionality of the module and to decrease overall system bulk and cost. However, low cost producible packaging is not yet available to integrate digital, photonic, microwave, and millimeter wave components together in the same hermetic package. What is required is a reconfigurable, low cost package and packaging scheme that can be used for digital, Optical Electronic Integrated Circuits (OEIC), and Microwave-Millimeter Wave Integrated Circuits (MMIC) components. A standard package would thus be used for all frequencies and technologies, enabling lower cost.

PHASE I: Investigate new and innovative materials, packaging technologies, and package designs for digital, MMIC, and OEIC components to operate to MMW frequencies, and to include optical and MMW interconnects. Packages must be hermetic, low cost, and have the capabilities for optical interfaces from optical fibers into either dielectric or semiconductor optical waveguides. Packages must also have low loss MMW interconnections to antenna and transmission lines and have low loss transmission lines inside the package. Shielding of components must also be considered to eliminate cross talk. Materials to enhance thermal conductivity, control Coefficient of Thermal Expansion (CTE) mismatches, and innovative solutions to electrical interconnects to chips are also sought.

PHASE II: Phase II of the program will consist of the fabrication of the novel configurable package. The configurable package will have to demonstrate its versatility and configurabily by utilizing digital, OEIC and MMW technologies and functions, producability at low cost, and hermeticity. A final demonstration will be made by packaging a DoD system module and undertaking system and mil spec testing. Perform a technology transfer to industry and the Physical Sciences Directorate of the Army Research Laboratory.

POTENTIAL COMMERCIAL MARKET: The development of a low loss, low cost, high production configurable package with the capabilities for both optical interconnects and high frequency electrical interconnects for transmission lines and antennas has an enormous commercial impact in the areas of communications such as cellular telephone, satellite, and optical communications, high definition television (HDTV), microwave cable TV, collision avoidance systems for next generation automobiles, and in high speed computers and data links.

OPERATING AND SUPPORT COST REDUCTION: Lower cost and higher quality are a goal of this SBIR project. Next generation high frequency electronic circuits will include multi-function chips packaged to increase functionality of the module and to decrease overall system bulk and cost. However, low cost producible packaging is not yet available to integrate digital, photonic, microwave, and millimeter wave components together in the same hermetic package. What is required is a reconfigurable, low cost package and packaging scheme that can be used for digital, Optical Electronic Integrated Circuits (OEIC), and Microwave/Millimeter Wave Integrated Circuits (MMIC) components. A standard package would thus be used for all frequencies and technologies, enabling lower costs.

A96-153TITLE:Phytoremediation: Use of Plants in Removal of Heavy Metal Contamination from the Environment

CATEGORY: Basic Research

OBJECTIVE: To develop suitable plant lines that hyperaccumulate and possibly metabolize heavy metals for use in bioremediation.

DESCRIPTION: Heavy metal soil contamination is a significant problem at many military and civilian sites, where lead, cadmium, chromium, copper, and mercury levels present serious environmental and health hazards. The most widely used method of dealing with tainted soils is excavation and reburial - a high cost procedure that is practical only for very small areas. Phytoremediation, or the use of plants to clean up soil, has technical and economic advantages over current methods for removing heavy metals, with, in some cases, the added benefit of being able to concentrate and harvest metals for reuse. Burying contaminated plants is both easier and cheaper than removing contaminated soil because they have far less mass. In cases of contamination with more valuable metals, like copper and nickel, plants can even be burned, leaving behind a residue from which metals can be recovered. Finally, plants can be engineered to convert some heavy metals to inert forms. Research is needed to identify and characterize novel genes and biochemical pathways involved in and/or transforming of suitable plants to hyperaccumulate heavy metals is also required. It is expected that this technology will generate a cost-effective means of removing heavy metals for both DoD and civilian applications.

PHASE I: Identification and characterization of useful genes or biochemical pathways in plants or other organisms that can be used in the phytoremediation of heavy metals; engineering and/or transforming suitable plant species to exhibit the ability to take up and/or detoxify heavy metals.

PHASE II: Development and optimization of transgenic or engineered plant lines that hyperaccumulate heavy metals and transfer, if necessary, of these abilities to crops that are non-edible, easily grown, and easily harvested.

POTENTIAL COMMERCIAL MARKET: This technology can be directly applied to the large and growing number of military and civilian sites in need of heavy metal removal as an economically and environmentally sound alternative to conventional cleanup strategies.

OPERATING AND SUPPORT COST REDUCTION: The topic directly supports the OSCR goal of remediating the environment.

A96-154TITLE:Remediation of Metal-Contaminated Soil Using Advanced Polymeric Methods

CATEGORY: Basic Research

OBJECTIVE: Develop a polymer and methodology that can remove and recover heavy metals from soil.

DESCRIPTION: The U.S. Army is vigorously working to develop new and more efficient means for environmental remediation. One of the areas of current exploration is the removal of heavy metals such as cadmium, chromium, and lead from soil. Soil contamination is a result of a number of Army-specific processes which include propellant manufacturing, plating, rinse water run-off from contaminated materiel, and the use and testing of munitions.

This solicitation seeks the development and demonstration of a water-soluble polymer that can interact with heavy metals thus removing them from soil. This could be accomplished by a number of means including encapsulation, adsorption, and chemical reaction. The polymer or process must designed such that separation from soil is easily accomplished. It is expected that the metals could be recovered from the polymer and that the polymer could be re-used or easily re- activated. The polymer and associated processing should be environmentally friendly.

PHASE I: Demonstrate proof of concept for a water-soluble polymer that can interact with heavy metals and remove them from soil and subsequently release the metals for recovery.

PHASE II: Demonstrate that the polymer and process can be scaled up for commercial applications.

POTENTIAL COMMERCIAL MARKET: Environmental restoration is not only a key concern of the Army but also the private sector. A new more efficient means for removing and recovering metals from soil is highly relevant to a host of manufacturing processes and remediation efforts in the private sector.

OPERATING AND SUPPORT COST REDUCTION: The topic directly supports the OSCR goal of remediating the environment.

A96-155TITLE:Honeycomb Structural Sealant

CATEGORY: Exploratory Development

OBJECTIVE: The principle objective of this effort is to develop and demonstrate a sealant for honeycomb composite structures, such as rotor blades, floor panels, and fuselage skins, that both excludes water and prevents water entrapment. The impact to component life cycles shall be investigated to estimate savings to maintenance costs and time.

DESCRIPTION: Water leakage and entrapment into helicopter honeycomb composite structures is a common problem. For rotor blades, the water leakage and entrapment results in corrosion and decreased rotor blade life for a multitude of rotary wing aircraft. A build-up of water in the rotor blades prevents adequate aircraft rotor track and balance, resulting in increased maintenance from vibration problems. Water entrapment in floor panels and fuselage skins adds weight to the aircraft decreasing mission capability and increasing maintenance due to water damage. It is desired to investigate new or improved technologies in polymer coatings that will prevent water leakage and entrapment. The coating must be durable yet flexible enough to withstand the flexure of components such as rotor blades in flight.

PHASE I: Identify and evaluate new coating and application technologies for reducing water leakage and entrapment. The coating must be technologically feasible and prove economical. Test effectiveness of the coating on coupons made from scrap honeycomb components.

PHASE II: Test and evaluation of full scale honeycomb components with the coatings. Testing will be conducted using appropriate test stand or rig capable of loading the components and simulating adverse weather conditions. Estimate cost effectiveness of the coating on rotor blade life cycle.

PHASE III: Flight/Field test selected honeycomb structures, such as rotor blades and floor panels, to demonstrate and validate the coating. Evaluate the cost effectiveness of the coating and finalize a coating specification.

POTENTIAL COMMERCIAL MARKET: Technology developed from this program will have equal military and commercial application since water leakage and entrapment is a common problem.

OPERATING AND SUPPORT COST REDUCTION: Water leakage and entrapment results in core damage to honeycomb structures, requiring expensive repairs to the core. For example, rotor blades have a typical phase maintenance interval of 500 hours, but more blades only make 300 to 400 hours before requiring maintenance. Water damage of the honeycomb core is a common problem. The use of a sealant to prevent the water damage will help honeycomb components reach their design life, reduce maintenance actions, and result in O&S cost savings.

A96-156TITLE:Active Harmonic Suppression Motor Controllers

CATEGORY: Exploratory Development

OBJECTIVE: Develop advanced variable speed motor controllers with active control of input line current harmonics.

DESCRIPTION: The Army has a need for advanced motor controllers that incorporate active harmonic control. These controllers will be used in Environmental Control Units (ECUs) on tactical electronics shelters. The controllers allow operation of the ECUs on multiple types of input power. The controllers also allow "soft start" of compressors and fan motors in the order to prevent voltage deviations in mission equipment, but control of line current harmonics is also critical for this mission equipment. The Army has already developed Pulse Width Modulated-type (PWM) motor controllers that meet most of the desired requirements; however, passive filtering of the harmonics currently imposes a weight and volume penalty. Active control offers an opportunity to decrease the size and weight of the ECUs. Active harmonic suppression also increases the efficiency of the motor controller. These controllers must be rugged and reliable in order to operate in extreme climatic conditions; current commercial hardware is not suitable for tactical use.

PHASE I: Prepare design/circuit analysis of motor controller to incorporate active harmonic suppression, variable voltage/variable frequency output, and multiple power inputs. Design analysis should also address potential EMI concerns. heat rejection, and least-cost considerations.

PHASE II: Fabricate prototypes and test to ensure requirements have been met. Prepare detailed purchase description to allow purchase of desired capability. It is anticipated that initial government production would give contractor expertise and tooling required to begin commercial production. Majority of contractors capable/active in this area already have commercial markets established.

POTENTIAL COMMERCIAL MARKET: Successful development of this technology has a large, immediate, commercial market potential. As variable speed drive technology has proliferated across industry, problems have surfaced with harmonic current interaction with other facility equipment. Variable speed ECUs in input Army that drives are currently used in various manufacturing industries, the chemical industry, and in the textile industry. In addition, many heating, ventilation, and air conditioning systems (HVAC) in commercial buildings use variable speed drives. Active harmonic control offers the promise of increasing potential applications for variable speed drives, as well as decreasing the operating costs for current applications. We therefore believe that this effort will have very good technology transfer potential.

OPERATING AND SUPPORT COST REDUCTION: The Army has a need for advanced motor controllers that incorporate active harmonic control. The controllers allow operation of tactical Environmental Control Units (ECUs) on multiple types of input power, and allow "soft start" of compressors and fan motors in the ECU's in order to prevent voltage deviations in electronic shelter mission equipment. Control of input line current harmonics is also critical for this mission equipment. The Army has already developed Pulse Width Modulated-Type (PWM) motor controllers that meet most of the desired requirements; however, passive filtering of the harmonics currently imposes a weight and volume penalty. Active control offers an opportunity to decrease or eliminate this penalty, which would result in a lighter shelter or increased shelter payload. Active harmonic suppression also increases the efficiency of the motor controller and the ECU, resulting in less total energy consumption over the life of the system. Active control of harmonics allows less harmonics in the electrical supply of the tactical shelter; this should provide higher reliability and longer service life for every piece of electrical equipment, from generators to

radios. Early elimination and control of harmonics will have many long-term benefits, especially considering the proliferation of electronic equipment in the digitized battlefield.

A96-157TITLE:Heavy-Duty Lightweight JP-8 and DF-2 Fuelled Engine(s) With Power Range 6-200 HP for Mobile Power Generation Equipment

CATEGORY: Exploratory Development

OBJECTIVE: Develop heavy-duty lightweight JP-8 and DF-fuelled engine(s) for Mobile Power Generation Equipment such as vehicle mounted or dismounted Auxiliary Power Units and Tactical Generators.

DESCRIPTION: The engines to be developed should be already in prototype stage. Their durability should be reflected by a predicted 3000 hours Mean Time Between Overhauls and their reliability should be revealed by a calculated Mean Time Between Failures of at least 1000 hours. The weight/power ratio should not exceed 2:1. The break specific fuel consumption (BSFC) should not exceed.45 lb/HP x hr for engines up to 20HP and.35 lb/HP x hr for the larger engines. The engines shall start and operate in temperatures between -250 F and 1250F.

PHASE I: Describe in detail the engine concept and thermodynamic cycle. Include preliminary test results of the prototypes that you already fabricated. Depict the development steps necessary for achieving the desired performance and physical characteristics.

PHASE II: Describe the commercial market potential competitiveness of this new engine. Describe in detail the development work. Describe in detail the engine testing. Provide 5 (five) prototypes for evaluation.

POTENTIAL COMMERCIAL MARKET: The lightweight diesel fueled engines have practically unlimited potential commercial market in all the industrial equipment applications (i.e., generators, compressors, pumps, etc.), farming equipment, recreational vehicles, ultralight airplanes and maybe even the automotive industry.

OPERATING AND SUPPORT COST REDUCTION: If successful the new type of engine(s) resulting from this effort will have a longer life than the engines presently used in the electric power generation, therefore, providing spare parts savings. In addition, they will be more fuel efficient and environmentally friendly. Other fuel savings will result from the transportation of lighter weight equipment.

A96-158TITLE:Migration of the Joint Task Force Communications Planning and Management System (JCPMS) to Current Commercial Technologies (NDI/COTS) and Standards

CATEGORY: Exploratory Development

OBJECTIVE: Develop a network management model to convey the current commercial technologies (NDI/COTS) and standards to the JCPMS modular concept and architecture.

DESCRIPTION: The ISYSCON program has been chosen as a baseline to provide the JCPMS capabilities. The JCPMS modular concept will be employed, and different modules within the joint system will perform unique functions. Each Commanders-in-Chief (CINCs) or Service can add any unique functionality to JCPMS to create it's own unique module. Maximize the use of NDI (Non Development I tems) and COTS (Commercial Off-the-Shelf) items will save the Government cost and time

PHASE I: Feasibility studied, research, evaluate and demonstrate the current commercial technologies by creating a network management model for JCPMS program

PHASE II: Implementation of the Phase I JCPMS model to the current commercial technologies (NDI/COTS) and standards and conduct testing with the users (Commanders-in-Chiefs (CINCs) or Services) for the verification of product.

POTENTIAL COMMERCIAL MARKET: NDI/COTS for JCPMS network management software and hardware are potentially available in the commercial market.

OPERATING AND SUPPORT COST REDUCTION: The implementation of the JCPMS model to the current commercial technologies and standards to satisfy Army materiel requirements will result in the streamlining of the JCPMS acquisition process. It will also eliminate and reduce the cost of extra research and development efforts, reduce the amount of training development costs associated with normal operations, reduce the logistic support, the setup cost for depot operation, reduce testing by using previous test and performance data provided by the manufacturer, and reduce the procurement cycle of spares and subsystem support for the support of operations involving Army equipment as well as minimize life cycle acquisition lead times.

A96-159TITLE:Modeling and Simulation Techniques for Large-Scale Communications Modeling

CATEGORY: Advanced Development

OBJECTIVE: Streamline the Modeling and Simulation process showing optimum run times applying state-of-the-art techniques.

DESCRIPTION: Modeling and simulation (M&S) is needed to assess the effectiveness of technology insertion and the impact of doctrinal and operational changes, in support of the US Army's Force XXI Concept. Such large scale simulations, utilizing today's technology and methods, are computer resource and time intensive, in some cases requiring several days of computer run time. The purpose of this contract effort is to streamline the M&S process by developing and applying techniques to simplify large-scale communications modeling while maintaining fidelity. This will include techniques to aggregate results from brigade-level simulations to provide Division and Corps-level experiments. Techniques will also be developed for designing experiments to provide the most efficient application of resources for the issues being addressed. Data analysis and reduction tools will be developed to support post experiment analysis and documentation efforts.

PHASE I: Assess the effectiveness of technology insertion and impact of doctrinal and operational changes in support of US Army's Force XXI concept. Conduct analysis of current models for their optimum run times. Force XXI, the Army of the 21st Century, will evolve through the continuous transformation of units, tactics and equipment. A key to this transformation is the Army's increasing emphasis on the power of information. CECOM supports the evolution towards Force XXI by developing digital information systems designed to promote rapid and accurate decision making. Modeling and Simulation (M&S) is used by CECOM as an effective and cost-efficient means of supporting the development, integration, and testing of information systems required for Force XXI while mitigating risks associated with their fields.

PHASE II: Build and demonstrate the capability of optimizing run times.

POTENTIAL COMMERCIAL MARKET: Stream line the software for commercial uses in Industry, businesses, and medical applications.

OPERATING AND SUPPORT COST REDUCTION: Modeling and simulation (M&S) is a cost- effective expedient for specifying, designing, and developing the C3I systems and architectures required for the 21st century force (Force XXI). M&S allows the materiel developer to perform trade-off and "what if" analysis prior to expensive field testing with hardware. While current M&S techniques realize cost savings over traditional development methods, further advancements in OSCR must be made to realize the full potential M&S. M&S of large-scale networks can be resource-intensive, requiring considerable computing power and personnel resources to set up, run, and analyze the results of simulations. As the Army moves beyond Task Force XXI and begins analyzing division- and corps-level networks of increasing complexity, the cost of current simulation techniques will rise correspondingly. This SBIR will support OSCR initiatives by reducing the costs of large-scale simulations through minimizing the computer and human resources required to develop models and perform simulations. This will be accomplished by examining methods for automating traffic input fields, aggregating simulation results, optimizing model code,

applying statistical techniques to experiment design, and examining automated data-reduction/analysis techniques. Products produced under this SBIR will realize cost savings in the development, execution, and maintenance of M&S.

A96-160TITLE:Combinatorial Biology and Genetic Super Libraries

CATEGORY: Exploratory Development

OBJECTIVE: Design and construction of genetic super libraries which mimic the complete human immune response in their ability to encode billions of antibody combinations. In vitro selection of antibodies to select pathogens, and production using recombinant techniques.

DESCRIPTION: Current biological detection systems rely on immunochemical assays which use monoclonal antibodies to detect antigenic epitopes on pathogens and toxins. The hybridoma technology required to produce these antibodies is slow, expensive and subject to the vagaries of genetic drift which often results in cessation of antibody production in an otherwise healthy culture. More recently, recombinant technology has been used to clone antibody fragments from the spleens of immunized animals. The purpose of the immunization is to bias the antibody selection process towards a particular biological agent of interest. These methods, while expedient, are still contingent upon an immunization schedule of weeks or months, and a knowledge of the identity of the threat. Given the pace of progress in biotechnology, it is possible that a unique threat may be encountered for which no detection system has been designed, and to which current hybridoma technology will be incapable of responding. It is now possible to by-pass animals completely by constructing a synthetic repertoire of antibody genes. Libraries of peptides can be prepared bio-chemically by splicing a random mixture of synthetic DNA molecules encoding the peptide of interest (e. g., receptor specific for a particular threat agent) to the gene encoding a readily expressed protein. This DNA construct is introduced into an appropriate expression system where, upon translation, the resulting peptide is synthesized as a fusion protein. Currently, one of the most common expression systems fuses the random sequences to the gene III or gene VIII coat protein of filamentous phage particles. Each viral particle contains a unique DNA sequence that encodes only a single peptide and, typically, libraries containing 108-109 different phage particles are assembled. These libraries can be screened for biological activity against antibodies, enzymes, or receptors, and affinity or activity-selection procedures can be used to isolate the phage particles expressing bioactive peptides. By their very nature, combinatorial antibody libraries in which very large numbers of different heavy and light chains are randomly combined supplicate many aspects of the mechanisms used by the human immune system. The incorporation of these libraries into surface display vectors provides the essential link between recognition and replication and thus mimic the B-cell mediated immune system selection process. Because of their high specificity, access to a much larger and structurally diverse antibody library is an important part of solving problems of recognition and stability of sensing elements.

PHASE I: The focus of this work will be the randomizing of the NCDR3 sequence, since NCDR3 is the most hypervariable region in an antibody molecule. It has been estimated that humans have the potential to generate as many as 1014 peptide sequences in this region. Additionally, HDCR3 makes the largest contribution to the total accessible surface area of an antibody combining site. The 16-amino acid sequence of the 7E HCDR3 will be randomized using PCR. The possible number of peptide sequences produced from this synthesis exceeds 1020. Antibody Fab fragments will be displayed on the surface of phage and "biopanned" according to affinity and receptor specificity.

PHASE II: The focus of Phase II will be to mature the library in order to produce high affinity clones, and to select for and express recombinant antibodies which recognize pathogenic threat agents. The library must be sufficiently diverse to recognize a broad spectrum of pathogens and toxins.

POTENTIAL COMMERCIAL MARKET: Combinatorial biology will be the primary method for drug discovery because it will allow for rapid screening of billions or trillions of compounds. This technology could also be extended to the creation of new catalytic materials for low temperature chemical synthesis, and for the creation of novel :smart: structural materials.

OPERATING AND SUPPORT COST REDUCTION: The creation of genetic super libraries would provide the ability to rapidly screen billions of compounds for recombinant antibodies which can be used to detect pathogenic threat agents. It would allow for the manufacturing of antibodies at one-tenth the cost.

A96-161TITLE:Nanotechnology and Microelectromechanical Sensors

CATEGORY: Exploratory Development

OBJECTIVE: Develop miniature, reagentless sensors based on microelectro-mechanical systems which are self-sufficient with regard to sample handling, power supply and data telemetry.

DESCRIPTION: Currently available detection systems are large, use significant amounts of power, require complex reagent handling, are not completely automated, and are subject to interferents. Miniature, self-contained, reagentless solid state sensors are needed for incorporation into UAV sensor suites, and for remote deployment. Nanotechnology refers to the manufacture of tools on a micrometer or smaller scale and/or devices for chemical or biological recognition on the molecular scale. It frequently suggests the use of photolithographic micromachining techniques, but is not limited to devices constructed in this manner. Current focus in the field is on the micromachining of valves, pumps, flow controllers, autosamplers and sensors in order to develop an analytical laboratory on a chip. Microelectromechnical Systems (MEMS) will be the underlying technology base of this effort because of the potential for MEMS sensors to be cheaply mass produced, host multiple antibody or gene probe sites on a single chip, and contain all required sampling, microfluidics and telemetry on a miniature circuit board (2" x 2"). Initial work in the commercial sector has demonstrated a micromachined pump prototype which delivers a flow rate of 200 nl-1ul per minute using less than 10uW of power, a miniature power supply capable of delivering 1 kV over 8 hrs, and a microprocessor with telemetry on such a circuit board. Operationally, these sensors could be used in implanted stations with integrated robotic collection, in arrays conformed to air frames such as UAV's, and in hand-held, real-time assays. A key feature of MEM's technology is its ability to move samples and reagents in a manner which allows sequential analysis in order to both identify the pathogen or toxin, and also to determine viability of the organism.

PHASE I: Key issues to be resolved are selective coating of MEM structures with gene probes and antibodies, electronic oscillator damping effects due to media and background, dynamic range, micro-sampling, problems of diffusion and mixing in small volumes, piezo-electric and nanomotor devices for moving samples, and design of nanoscale optical detectors.

PHASE II: The focus will be on designing a MEMS system which incorporates biological recognition sites such as gene probes and/or antibodies for detection of biological agents, and on the micromachining and related manufacturing techniques to produce the system in mass quantities and at low cost.

POTENTIAL COMMERCIAL MARKET: MEMS systems will have broad applications in robotics, microsurgery, medical diagnostics, and sensors for the auto industry.

OPERATING AND SUPPORT COST REDUCTION: The development of microelectromechanical sensors would reduce by several orders of magnitude the amount of reagents required by chemical and biological detection systems. The resultant sensors would have less parts, require less maintenance and experience fewer disposal problems.

A96-162TITLE:Imaging Automatic Gain Control (AGC) for Target Acquisition, Automatic Target Recognition (ATR), and Tracking

CATEGORY: Exploratory Development

OBJECTIVE: Provide an AGC method or image enhancement method for the real time creation of an "ideal image" such that target detection, recognition, and identification algorithms can function on the most optimum signature while providing the subsequent tracking function an optimal signature for handover initially and during missile reacquisition scenarios.

DESCRIPTION: Typical image generators, such as TV cameras and infrared imaging devices produce a considerable image dynamic range which may vary significantly, however, the target signature of interest may subtend a small or large portion of this range and in addition be at any relative position within it. In general, this produces problems both in the human perception and automatic consumption and use of this data. The potential for the image dynamic range and the target within to change drastically based on current methods used for gain control in imaging devices is quite high, where the intent of this effort is to minimize these changes and maximize the target signature(s) simultaneously.

PHASE I: Evaluate current methods which may lend themselves best to the ATR scenario. The contractor shall test, evaluate, and quantify computational requirements, dynamic range limitations, and hardware architecture requirements (including size, weight, and power) of currently implemented AGC methods and explore new methods appropriate for the optimization of target detection, recognition, and identification. Itemize limitations and provide modifications or new methodology that will allow a more optimum signature to be made available for both the ATR and the handover for tracking.

PHASE II: Implement, in real time hardware, the best AGC method selected in Phase I using an infrared camera.

POTENTIAL COMMERCIAL MARKET: There are significant potential commercial uses for the technology developed under this SBIR scope of work title. Some of the commercial uses are surveillance and security, robotics, advanced sensors development, and automated assembly line parts inspection.

OPERATING AND SUPPORT COST REDUCTION: The operating and support costs can be significantly improved by insertion of the technology produced under this SBIR topic although the topic technology is related only indirectly. The implementation of this SBIR topic technology will provide a significantly improved kill probability of the deployed missiles which have it incorporated. In addition, the missile fire control target acquisition system will have an increased survivability and consequently a reduced vulnerability because of the improved target acquisition and tracking capability. This added capability will clearly reduce unit replacement costs and therefore unit support cost. Additionally, the operational costs will be reduced because of a further minimization of operator fatigue due to loss of target lock and false alarms that will also be reduced.

A96-163TITLE:Infrared Background Clutter Metrics

CATEGORY: Exploratory Development

OBJECTIVE: To investigate and develop infrared scene clutter metrics for analyzing the performance of imaging infrared seekers utilizing staring focal plane arrays (FPA) in particular, and imaging infrared sensors in general.

DESCRIPTION: There has been a large investment by the DOD in FPAs and other imaging infrared sensors over the past several years. Although excellent analyses tools exist for describing the imaging sensor themselves, no adequate method exists for characterizing the performance of the sensors against targets in clutter. This is due, for the most part, to the fact that there is no agreed upon set of clutter metrics which describe the clutter and target to the extent that they may be discriminated from one another. Past efforts based on local first order background statistics (i.e. Schmieder-Weathersby, etc.) have achieved some success with point source targets but are not sufficient for predicting performance against spatially resolved targets. An approach which considers higher order image statistics and spatial frequency domain characteristics might more completely describe the relationship between a resolved target in a complex background. A set of image based clutter characterization metrics which help discriminate point sources and resolved targets from their clutter backgrounds in both single-band and multispectral imaging situations is desired. These metrics are needed to quantify the clutter for use for sensor models for both defense and commercial applications. The defense applications include performance analyses of target acquisition, tracker algorithms, aimpoint selection, autonomous target recognition (ATR) algorithms, and multispectral seekers. Commercial (non-DOD) applications include forest fire detection and crop/land use surveys and assessments from satellite imagery, machine vision for industrial applications (robotics, automatic assembly, sorting), and medical imaging analysis and interpretation.

PHASE I: Provide detailed analysis of background clutter and develop a set of theoretical metrics based upon those analyses. Utilize the metrics to predict imaging infrared seeker performance and/or operator image assessment. Develop a plan

for validating the metrics in Phase II including data sources, equipment and analytical software, and proposed experimental and analytical techniques.

PHASE II: Implement the plan for metric validation which was developed in Phase I. Fabricate or purchase hardware and software for conducting background clutter investigations and to demonstrate the experimental techniques for background characterization. Conduct the validation testing to relate the background metrics to machine and/or human performance.

POTENTIAL COMMERCIAL MARKET: In addition to missile seeker applications, this item can be used on any infrared imaging sensor to improve the sensor performance and improve operator effectiveness. This includes intrusion devices, law enforcement night viewing devices, forest fire detection devices, satellite imagery evaluation, etc. Other markets include machine vision for industrial applications (robotics, automatic assembly, sorting), and medical imaging analysis and interpretation (improved diagnostics using ultrasound, CAT, PET, MRI, and Xray imagery).

OPERATING AND SUPPORT COST REDUCTION: Current background descriptions for use in imaging infrared sensor/seeker simulations, tactical decisions aids and training packages are not standardized and in most cases are obtained by direct measurement of selected backgrounds. Not only is this an expensive approach, it limits the number and variety of backgrounds that can be described adequately. It is further limited by the availability of data taken during various environmental conditions. An approach is desired that allows composite infrared background scenes to be synthetically generated from a data base of background objects and types. Before this can be accomplished, a set of background metrics must be identified that allows appropriate measurements to be made. Given that these metrics can be identified there is a wealth of calibrated imagery available for reduction and analysis. The opportunities for cost savings are outstanding; aside from the obvious utilization of these metrics in missile seeker simulations, they can be applied to generating backgrounds for use in virtual reality facilities. The level of effort and cost for continuing IR background measurements in support of the practical use of Army smart IR weaponry will be reduced with success under this proposed SBIR task.

A96-164TITLE:Virtual Reality Scene Generation By Means of Open Standards

CATEGORY: Engineering Development

OBJECTIVE: Commercially available packages for Virtual Reality applications typically attempt to address the widest possible portion of users. Consequently such packages are large and unwieldy and are not suitable for real-time applications such as high fidelity missile simulation. Moreover, many such packages are written using proprietary software libraries such as Silicon Graphics' Performer. A small, compact software package based on Open Graphics Language (OpenGL) is needed for applications that require high speed and a high degree of portability among platforms. The purpose of this SBIR is to demonstrate such a package in an infrared imaging missile system simulation.

DESCRIPTION: A virtual world consisting of thousands of textured polygons must be created in order to perform simulations for imaging missile systems. As the missile system flies through its trajectory, changes in range and attitude result in a continually changing image to the missile sensor. The real-time simulation must generate, through projection or injection, an image to the missile system at a very high rate, typically 150 hertz or higher. The simulation must transform its virtual world into a planar image expected to be seen by the missile sensor. This computation must be performed in real-time for each simulation update cycle. The computational power to do this in real-time has traditionally required use of multi-million dollar, special purpose hardware and software. As more and more imaging missile systems required hardware-in-the -loop simulation, building multi-million dollar scene generators is no longer a viable solution. Commercial off-the-shelf (COTS) hardware products such as the Silicon Graphics Onyx are now capable of performing the required computations in real-time at a fraction of the cost of some specialized custom scene generators. High performance graphics subsystems now being developed for Personal Computers (PCs) will soon be available to a large number of users at a low cost. The Integraph TDZ series and the Silicon Graphics Impact series workstations are recent examples of this trend. However, current COTS software packages are typically too large and cumbersome to render the data at the required rates. Clearly, a fast, compact package is needed to address the segments of the Virtual Reality community that require higher speeds, higher portability, and lower costs. This SBIR requires that a software

package be developed to meet the stated speed and portability goals. The resulting package must be suitable for use with imaging infrared missile systems for which hardware-in-the-loop simulation is expected to be performed at the Advanced Simulation Center (ASC).

PHASE I: Develop scene generation software using open graphics standards on a Government Furnished Silicon Graphics Onyx that includes four processors and two raster managers. The scene generator shall include the following: (a) a virtual world consisting of at least 100,000 textured polygons shall be obtained as an input to the scene generator. (b) The system shall be capable of culling 2000 textured polygons from the virtual world of 100,000 textured polygons and rendering 2000 textured polygons for each simulation cycle at a deterministic 105 hertz throughput rate. The entire scene shall be re-computed for each simulation cycle at a 150 hertz rate with no missed cycles throughout an entire missile flight, including endgame. (c) Capability to support texture with a resolution of at least 12 bits shall be included. (d) The system shall be capable of varying the field of view from one to twenty degrees. (e) A complete set of documentation, including computer source code and user manuals, shall be provided.

PHASE II: In Phase II the Virtual Reality Scene Generator (VRSG) shall be integrated with an actual hardware-in-the-loop simulation for an imaging missile system. This effort shall include the following: (a) creation of a Virtual World with suitable targets and backgrounds for the particular missile systems to be evaluated in hardware-in-the-loop simulation (b) digital interface of the VRSG to an imaging projection device (c) integration of VRSG with a simulation control computer (d) investigation of the signal processing characteristics of the missile system to be evaluated to ensure that requirements are met (e) verification that the VRSG portion of the hardware-in-the-loop simulation is operating properly and is producing the correct results (f) upgrade of the throughput rate to be capable of rendering 2500 textured polygons at a sustained, deterministic rate of 200 hertz.

POTENTIAL COMMERCIAL MARKET: Virtual Reality (VR) is one of the largest growth industries in the United States today. While several VR software packages are commercially available, most are very large in size and often utilize proprietary hardware and software. Many users need a smaller, more compact VR software support package that is portable to many different computer platforms. The objective of this SBIR is to provide this type of software support for scene generation applications. Potential commercial users fall into three categories. The first category includes those who need to produce imagery at high throughput rates. Pilot training, entertainment, weather, and medicine are examples of this group of applications. The second category of users includes those who need portability among platforms. Many VR software support packages use proprietary software such as Paradigm Vega, Coryphaeus EZScene, Gemini GVS, and Sense8 WorldToolkit. Using OpenGL as a software standard, the package produced under this SBIR will be available to almost every commercial computer platform, including Personal Computers. The third category of users includes those who cannot afford large, expensive software package. This inexpensive scene generation software will reach a large number of users for which currently available software is cost prohibitive. Millions of commercial applications fall into one of these three categories. By advancing the state-of-the-art in high speed, low cost, open architecture scene generation, this SBIR will serve a significant segment of the VR community.

OPERATING AND SUPPORT COST REDUCTION: This Virtual Reality Scene Generation (VRSG) will reduce Operational and Support (O&S) costs enormously over the life cycle of U.S. Army weapon systems by several different means. The first of these is mission planning and rehearsal. A low cost method of generating a virtual world will greatly improve effectiveness of military mission planners by providing a realistic vision of the landscape and conditions involved in the mission scenario. Satellite imagery data can be utilized with the VRSG system to provide a realistic synthetic environment to the military planner. Users can than "walk through" the battlefield environment with a variety of options. Such a tool will greatly enhance situational awareness to the extent that effective military missions can be developed at a much lower cost. Another O&S cost reduction potential of the VRSG is in the area of training. Soldiers can be trained to operate both visual and infrared weapon systems using the VRSG. This training can be performed over a wide range of scenarios including adverse weather conditions. The low cost, portability, and high speed capabilities of the VRSG lend themselves well to establishment of such capabilities at a large number of sites. Another key cost reduction potential of the VRSG system is in the area of stockpile reliability testing (SRT). In order to effectively measure the effectiveness of an infrared weapon system, it is necessary to present realistic imagery to that system in real-time. The VRSG will generate such imagery, so that SRT can be performed at a fraction of the cost of a flight test. SRT

typically represents a large portion of the cost of a weapon system over its life cycle, so the VRSG cost reduction would be of very significant benefit.

A96-165TITLE:Plastic Encapsulated Microcircuit Storage Accelerated Age Model

CATEGORY: Exploratory Development

OBJECTIVE: Develop an accelerated age model, for storage risk assessment of plastic encapsulated microcircuits, that accounts for the various environmental conditions present in military storage environments.

DESCRIPTION: With the current push for the use of Plastic Encapsulated Microcircuits (PEMs) in weapon systems, efforts to gather data on the behavior of PEMs in military storage environments have begun. These efforts involve real time age storage programs which consume time. An accelerated age model would reduce the time needed to gather data for the risk assessments on the use of PEMs in weapon systems. The accelerated age model, as a minimum, should account for temperature and humidity cycling. Other environmental stresses to consider are atmospheric pH levels, atmospheric salt levels, and extreme hot and cold temperatures for various lengths of time. The accelerated age model should also be tailorable to specific environments. (i.e. tropic, arctic, desert).

PHASE I: The accelerated age model should be developed through research in the physics of failure of plastic encapsulated microcircuits. The model should also be developed for use on computer with provisions for input of all parameters.

PHASE II: The Accelerated Age Model (AAM) should be tested by inputing known data from actual age plastic encapsulated storage tests. The results from the AAM should be compared to the results from the actual age test to verify the correctness of the AAM. The AAM should also be tested by inputing projected environmental data for an actual age test at its beginning stages. The results from the AAM could then be compared to the results obtained at the completion of the actual age test.

POTENTIAL COMMERCIAL MARKET: Plastic encapsulated microcircuits are used widely in commercial industries in such areas as computer systems, avionics systems, and automotive electrical systems. Replacement assemblies for these systems are stored until needed and can sit in storage for long periods of time. An accelerated age model for plastic encapsulated microcircuits can be used to predict degradation of electronic assemblies in storage, and can help in determining the overall shelf life of electronic assemblies.

OPERATING AND SUPPORT COST REDUCTION: A Plastic Encapsulated Microcircuit (PEM) accelerated age model will provide operating and support cost reductions over the life cycle of a weapon system built with PEMs. There is an unknown risk associated with the use of Plastic Encapsulated Microcircuits (PEMs) in weapons systems subject to long term dormant storage. The development of a PEM accelerated age model will allow for the timely assessment of the risk to weapon system reliability when PEMs are used. This could provide a tremendous savings by preventing the retrofitting of numerous weapon systems that may develop reliability problems due to the failure of PEMs from long term dormant storage. On the other hand, if the PEM accelerated age model shows that a PEM will meet reliability requirements, the use of the PEM in a weapon system will provide a savings. This is due to the lower cost of a PEM when compared to its ceramic counterpart. Finally, other programs funded by weapon system project offices that involve actual age and accelerated age testing of PEMs can be eliminated after the development of a proper accelerated age model.

A96-166TITLE:Low Energy Impact Damage Evaluation of Thin Walled Composite Structures

CATEGORY: Basic Research

OBJECTIVE: To develop and validate analytical methods to predict the development of structural damage caused by low energy (<15 ft.-lb) impact and the resulting loss in post impact performance of composite pressure vessels, i.e. rocket motor

cases, cylinders/tanks, pipes, etc. Such models can be used to optimize the design of composite pressure vessels with significantly improved damage tolerance capability.

DESCRIPTION: Experimental testing has shown that composite materials exhibit a very real susceptibility to structural damage caused by low energy impact. Where system weight is a critical factor, as in rocket motor cases, structural designs are often developed with minimal (1.5 to 2) safety factors. Therefore, it must be assumed that any incidental impacts have the potential to render a structure unusable. With the costs associated with composite systems, any loss of assets are unacceptable. Analytical models which incorporate dynamic analysis, failure analysis and micromechanical models appropriate for use with composites are required to fully understand the phenomena and determine design enhancements for survivability.

PHASE I: Impact damage in a composite structure is a combination matrix cracking, fiber breakage and delamination. The Phase I objective of this work should be directed towards the development of methods to identify the type and extent of damage in a structural component based on the velocity, geometry, and the material of the impactor, and the structural and material configurations of the target.

PHASE II: The results of Phase I should be used to determine the effect of various failure modes on the post-impact burst pressure capacity of composite tubes. This entails the performance of stress analyses near damages of idealized shapes, and development of realistic fracture and failure models. This effort should result in deliverable analytical models which provide for the identification of the predominant material/structural interactions contributing to improved impact damage tolerance.

POTENTIAL COMMERCIAL MARKET: Composite materials are becoming increasingly accepted for use as structural materials in a variety of industries. While military applications encompass rocket motor components and hardware, additional uses for composite pressure vessels are found in both the aerospace and automotive sectors. For example, the high strengths and light weights associated with composites make them ideal candidates for use in space flight hardware as containers for fuels and other pressurized gases. With the environmental concerns over the use and depletion of fossil fuels and the dependence of the United States on foreign suppliers, automotive uses include fuel cylinders for LPG powered cars and trucks. Use of composite materials is not limited to just pressure vessels, other structural components can be fabricated in a wide assortment of shapes to provide for a variety of uses (Airline and Construction). If these uses happen to be as load bearing components, it is imperative that the integrity of the structure not be questioned. As it stands now, there is no method available to predict the structural response, i.e. residual strength, of a composite subjected to impact. The analytical models which result from this SBIR can help ensure the continued acceptance and safe use of composite materials.

OPERATING AND SUPPORT COST REDUCTION: The overall goal of this SBIR topic fully supports DoD OSCR initiatives. While the analytical models to be developed under this SBIR are intended to be implemented in the design stage of future tactical systems, benefits can be expected throughout the operational life of the system. It has been shown through extensive testing that low energy impacts can have a serious detrimental effect to the operational performance of composite rocket motor cases and launch tubes. Visual damage caused by impact can take the form of matrix crazing, fiber breakage or delamination. As structural composites generally incorporate alternating layers of fiber, sub- surface damage may not be evident. Therefore, it must be assumed that any incidental impacts have the potential to render a structure unusable. The analytical models which will result under this SBIR will provide the motor case/launch tube designer with tools to determine methods for improved impact damage tolerance. Damage tolerant composites systems will not have to be removed from service for replacement. Savings can be expected through reduced replacement costs, i.e. rocket motor cases and launch tubes, system down time, required man-hours, etc. Perhaps more importantly, enhanced mission readiness can be expected throughout the life of the system. This SBIR has the potential to provide "factory to the field" benefits.

A96-167TITLE:Demonstration of Optical Control of Steerable Array Antennas

CATEGORY: Exploratory Development

OBJECTIVE: The development of optically based antenna beam steering architectures has been the subject of laboratory research for nearly twenty years. This work has achieved the critical mass necessary to begin experimental development/demonstration outside of the laboratory. The objective of this topic is to acquire an optically based beam steering system capable of controlling the phased array antennas currently proposed for the next generation Army air defense radars, Federal Aviation Administration (FAA) air traffic control radars, and commercial weather radars.

DESCRIPTION: The goal of this effort shall be to design, fabricate, and test a two dimensional steerable array including the beam steering equipment. The array shall be steerable in both azimuth and elevation. The beam steering architecture shall be optically based and capable of supporting wide bandwidth waveforms with a center frequency above 18 GHz.

PHASE I: The goal during Phase I is to create a producible design for the above described antenna. This effort will include computer modeling to predict the antenna's expected performance.

PHASE II: Phase II will have two goals. First, the fabrication of the antenna designed in Phase I. Second, the testing of the antenna on an antenna range.

POTENTIAL COMMERCIAL MARKET: This technology has potential commercial use for all applications involving non-mechanically steerable antennas. The two most notable applications are FAA air traffic control radars and commercial weather radars.

OPERATING AND SUPPORT COST REDUCTION: Optically controlled array antennas offer several operating and support cost reduction opportunities. The devices currently used in electronically controlled array antennas are a cost driving item. Current projections indicate the optical devices that will replace them will be significantly less expensive; thereby, reducing both purchase and repair costs. In addition, optically controlled array antennas will be lighter in weight than their electronic counterparts. This will result in both lower transportation costs per unit as well as increasing the number of units that can be transported per transport. Also, optically based systems typically require less prime power than their electronic counterparts which will reduce their basic operating cost.

A96-168TITLE:Pulse-Coupled Smart Pixel Array

CATEGORY: Basic Research

OBJECTIVE: Design, build and test a 64x64 smart pixel array, based on pulse-coupled neural network models, which can generate pulse-train outputs for image transforms and analysis.

DESCRIPTION: The Pulse-Coupled Neural Network (PCNN) models (see references) have significant applications in image processing and analysis. They have been implemented in recent years as small integrated circuits on electronic chips so that one- and two-dimensional arrays of the basic circuitry were formed. These proof-of-principle units showed that speeds of 1 MHz and greater were possible, and gave a technology and circuit design base for similar circuits and significantly larger arrays. The work required to be done consists of performing further circuit and chip layout design, building the arrays, bonding and mounting them upon return of the dies from the chip foundry, providing the necessary control and power sources and control panels, and measuring the array outputs for a small test set of sample imagery. The arrays must include photodiodes at each pixel and, also at each pixel, either a direct optical readout mechanism such as a laser diode or liquid crystal cell or a shift register mechanism that permits real time readout of the pulse activity over the array.

PHASE I: Perform the design. The design is a deliverable item.

PHASE II: Build the array, integrate, and perform the tests. Deliver all reports and hardware.

POTENTIAL COMMERCIAL MARKET: The PCNN chips would enable robotic vision, machine vision, visual aids for the visually impaired, automobile navigation and obstacle avoidance, and automatic object recognition systems for commercial applications such as face, fingerprint, and retina recognition.

OPERATING AND SUPPORT COST REDUCTION: The objective of this SBIR topic is to develop an electronic microchip which performs data processing on an image when a camera lens images a scene directly onto the area of the chip itself. The overall goal of the research project is for automatic military target recognition, but it can apply equally well to automatic recognition of any object in the scene. Accordingly, this research indirectly supports a variety of potential applications which can reduce operational costs and promote efficiency of operation involving U.S. Army equipment. Examples are automatic machine vision systems for locating parts and equipment in warehouses, personnel aids for automatic form-reading systems, automatic continuous surveillance monitoring of storage yards, and other routine surveillance that would otherwise require trained personnel and their associated man-hour costs. These OSCR benefits are indirect, and OSCR is not the primary thrust of this research, but there are viable future applications of this technology that can support OSCR.

A96-169TITLE:Doppler LIDAR Using Edge Technique

CATEGORY: Engineering Development

OBJECTIVE: The objective of this effort is to develop and build a reduced eye-hazard Doppler LIDAR using the "edge filter" technique for determining wind velocity and turbulence in areas of interest over ranges between 1-10 plus kilometers. The spatial resolution of the LIDAR should be on the order of 3 meters and a velocity resolution on the order of 10-20 cm/s. The purpose of this system would be to aid in the detection of masked targets (i.e. helicopter) or atmospheric disturbances from signatures due to exhaust, debris particles displaced by the target(s), and/or disturbances caused by natural environmental phenomena.

DESCRIPTION: The LIDAR system should consist primarily of an eyesafe laser, telescope, receiving and transmitting optics, receiver, broadband edge filter technique using an etalon filter or equivalent, receiver(s), and a data collection and reduction mechanism which should include data processing, software, computer, etc. The system shall be portable and eye-safe, and have a performance range of 1-10 plus kilometers. The masked target will either create its own wind or turbulence, disturb the natural wind currents, and/or cause vibrations, thus making a detectable signature(s) for a Doppler LIDAR.

PHASE I: Phase I should consist of research and studies that lead to a design that will meet the needs as described in the Description above. This research and studies shall determine what components are required, the cost of the components, conceptual design based upon findings (including form, fit, and function), growth potential, risk factors (both technical and phenomenological) and their relevance, propagation at the selected wavelength as influenced by environments, data processing assessments, establishing LIDAR performance tradeoffs with range, scan times, optic size, and weight; a model of the performance of the system, and a final report.

PHASE II: Phase II should be the building of the LIDAR system, performing signature tests with the system against objective targets, provide a complete system to the Optics and Laser Technology Area of MICOM's Research, Development, and Engineering Center, and a final report documenting the LIDAR operation procedures and the results of the system tests.

POTENTIAL COMMERCIAL MARKET: There is a need for a device that remotely determines the wind velocity in aviation. Aircraft must avoid vortices that are created by other aircraft, clear air turbulence avoidance and micro burst weather conditions that may lead to unstable or upsetting flight conditions. This system has the potential to be sufficiently sensitive that it may provide threshold signatures that may act as a precursor for adverse atmospheric conditions.

OPERATING AND SUPPORT COST REDUCTION: LIDAR technology is a rapidly growing sensor field. Proof of principle tests have been completed using the edge technique in a bread board Doppler LIDAR. A system such as the one submitted that can accurately profile the wind and wind currents will greatly increase the effectiveness and accuracy of existing missile systems in the field. Having an increased effectiveness and accuracy will possibly decrease the number of missiles that are needed and thus decrease the number needed to be fielded along with the logistic burden. A Doppler LIDAR could also possibly have application in military and commercial aircraft for clear air turbulence avoidance that is created naturally and by other aircraft. In addition a Doppler LIDAR could possibly be used in aircraft to map the wind to allow aircraft to fly the nap of the earth because down-drafts and other wind disturbances could be predicted before they are encountered. It would also increase their survivability. This same technology may also have capability for monitoring the weather for related down bursts at airports. The enhanced sensitivity of this LIDAR may provide early threshold signatures of turbulence that exceed existing techniques. Another possible benefit would be the increased capability of detecting masked targets and being able to engage them before they are able to destroy our soldiers and equipment. This program supports OSCR through potential cost savings of army equipment and personnel.

A96-170TITLE:Environmental Stress Monitoring, Analyzing, and Recording System for Missile Applications

CATEGORY: Advanced Development

OBJECTIVE: Develop on autonomous environmental stress monitoring, analyzing and recording system for use in fielded and stored tactical missiles and associated support equipment. This technology should provide cost-effective prognostic capability concerning the environmental integrity of the missiles and associated support equipment. Commercial use could benefit from detection of environmental stress degradation of bridges, buildings, and power poles.

DESCRIPTION: As missiles, their components, and associated support equipment have increasing shelf and storage life requirements, and become more complex and costly, it is necessary to ensure that maintenance is not unnecessarily done or is done when needed. To determine the physics of failure and an estimated time to failure, an environmental stress exposure history is required. A method of non-intrusion querying is needed to collect this data for tactical missiles. As an integral part of the missile and support equipment this technology would allow the assurance that the missile has not degraded because of environmental stress. The system should allow the data to be retrieved directly from the missile or support hardware or by a remote system that would allow data to be gathered on a real time basis. This system will provide more accurate data to determine missile and support equipment shelf life, spare parts planning and missile health. This will result in optimizing part of the life cycle costs.

PHASE I: Leverage previous technology efforts in time stress measurement devices and microelectromechanical sensors (MEMS) to develop and design an environmental stress measurement system capable of self powered autonomous

operation for 5 to 10 years. The system shall be capable of monitoring, analyzing and recording multiple stress types from several internal locations, and make the data retrievable at any time. The environmental stresses shall include, but not be limited to: temperature, shock and vibration, and humidity stress.

PHASE II: Construct and test the system. Fully test the system capability at environmental extremes and in natural environments. Use data to optimize the design.

POTENTIAL COMMERCIAL MARKET: Bridges suffer from the vibration stress of the automobiles driving over them. With this technology the bridge could be monitored for degradation due to stress. When the stress caused damage to the bridge the monitoring equipment would detect it and could report that the bridge needed repair. This would cut the cost of inspection and down time of the bridge. Unmanned pump stations would benefit in that the monitoring equipment would detect when the equipment failed or the flow rate decreased and notify that it needed repair. Both of these examples would notify the personnel that the item that it is monitoring is in need of repair or attention, thus, it would cut down on the amount of inspection time and inspection personnel.

OPERATING AND SUPPORT COST REDUCTION: Because the stress monitoring system will have remote communication ability to inform the necessary personnel if a failure has occurred, the number of inspections required, the number of personnel and the amount of man-hours required to perform the inspections will be reduced. Also, by utilizing data from the system, a model could be developed to allow prognostic capability and estimation of failure time of the hardware. Having an estimation of when a piece part or piece of hardware may fail would allow that defect to be designed out early in the hardware's life-cycle. This would make the hardware more reliable, extend the life of the hardware and reduce down time caused by failures. The hardware would require fewer spare parts and reduce eventual replacement quantity.

A96-171TITLE:Generic Ducted Rocket Test Facility Combustion and Flow Prediction/Analysis System

CATEGORY: Exploratory Development

OBJECTIVE: Development of a Windows-based system for the prediction and post test analysis of high flow rate air breathing combustion systems, such as ramjets and ducted rockets, with interactive GUI based flow system configuration.

DESCRIPTION: Interest in high flow rate air breathing propulsion systems has greatly increased over the past several years, and has resulted in a corresponding increase of static testing and analysis. Presently, test facilities expend excessive amounts of effort in the pre-test planning and analysis of acceptable hardware configurations, post test data reduction, and correlation of results with predictions. Typically, an air breathing missile test facility consists of several primary systems: an air heating and delivery system, a fuel delivery system, a combustion chamber, and an ejector for altitude simulation. Specifically, a tool is required that operates under the Windows environment that utilizes a convenient, and logically designed Graphical User Interface (GUI) for the configuration of the test geometry that would simulate full scale missile flight conditions. The program should generate an instrumentation requirements list and display proper instrumentation locations upon the GUI built representation of the test facility. The user interface shall take full advantage of the Windows environment and be graphically based to the maximum extent, including "drag and drop" assembly of the primary components of the test facility. The system shall provide for the convenient and rapid graphical configuration of the air flow system, fuel flow delivery systems, and test article geometry. Fuel delivery systems may be either liquid, gas or solid. Solid fuel delivery systems would require a basic combustion chamber ballistics analysis to insure proper fuel flow rates, and prevent over pressurization of the test facility fuel gas generator hardware. Integration of a chemical equilibrium code will be necessary in order to set combustor nozzle geometry and chemical gas constants for any fuel/mixture and composition. A library of locally existing hardware, such as "in hand" combustion chamber hardware, air chokes and nozzles available, should be available for use in the assembly and optimization of the test facility representation. The output interface shall provide various graphical and tabular format options. It is required that tabular output can be conveniently exported to other Windows applications (spreadsheet and word processor) for incorporation in other documents. Facility generation parameters would include air and fuel flow rates, air and fuel flow velocities through the facility, predicted temperatures and pressures, nozzle, constriction and choke sizes, physical hardware dimensions, and predicted

gas constants and parameters. Post test analysis would include reporting of C*, Thermal, and Expulsion efficiencies, measured gas flow characteristics of both the air and the fuel gas, and Chemical Equilibrium Code calculations of the dynamic gas values of the input air, the fuel gas, and the combustion process.

PHASE I: Under the Phase I effort the GUI for the configuration and optimization of the test facility shall be delivered. This includes full development of the GUI based "drag and drop" features and instrumentation list generation for the facility representation. A configuration file should be generated for use by the analysis program to be produced in Phase II. To support the evaluation of the delivered software, all hardware, commercial software, custom software (including source code) required to develop and run the system shall be delivered to the Government.

PHASE II: Under the Phase II effort a fully functional facility design/analysis system shall be developed and demonstrated that incorporates all the desired features. To support the evaluation of the delivered software, all hardware, commercial software, custom software (including source code) required to develop and run the system shall be delivered to the Government.

POTENTIAL COMMERCIAL MARKET: This system could be utilized by educational institutions and commercial advanced air breathing development and testing companies. Fossil fuel fired power plant design and analysis, as well as any high velocity gas flow facility would benefit greatly from the effort.

OPERATING AND SUPPORT COST REDUCTION: This topic supports OSCR initiatives associated with the normal operations involving Army equipment and man hour labor costs. The topic, if successful, will be used to maximize the material available for Ducted Rocket Testing at the Propulsion Directorate, as well as save hundreds of pre and post test Ducted Rocket Facility setup and analyze man hours. The successful completion of the project would greatly enhance the usability of the present tests systems, as well as allow for more timely, accurate, and economical ducted rocket tests.

A96-172TITLE:Development of Fiber Optic Gyroscope Sensing Coils with Improved Thermal Stability

CATEGORY: Exploratory Development

OBJECTIVE: Develop small diameter (inner diameter 1 inch or less) fiber sensing coil design and analysis techniques which will minimize sensitivity to temperature variations and temperature-induced stresses.

DESCRIPTION: It is desirable to develop Fiber Optic Gyroscope sensing coils which are small in volume (inner diameters 1 inch or less) and designed to withstand large environmental variations over the lifetime of the sensor. When the sensing coil is exposed to temperature variations, the optical fiber undergoes both axial and radial expansions and the layers of fiber in the sensing coil pack shift and move. Pack expansion and movement limits gyroscope performance parameters such as scale factor, bias drift, and axis alignments. Lifetime and reliability of the sensing coil are also reduced as a result of the temperature flucuations.

PHASE I: Select fiber/spool materials/winding approach, analyze inner layer stresses in the coil design and select approach to minimize variations due to thermal stress. Develop and implement experimental procedures to verify design.

PHASE II: Build and test the coil design selected in Phase I, optimize the configuration. Verify the performance of the design over temperature within a gyroscope configuration.

POTENTIAL COMMERCIAL MARKET: Although the technology will enable military requirements, a commercial spin-off technology is in the automotive market for active suspension stabilization systems and map update navigation systems. This area is already starting to grow very rapidly, and it is believed that the automotive application will be significantly larger than the military application. A reliable, low cost and small-sized Fiber Optic Gyroscope will be of special interest to the automotive market. Other areas of potential market power are robotics, gyro compasses for heavy machinery and light aircraft, and oil and gas exploration.

OPERATING AND SUPPORT COST REDUCTION: The development of Fiber Optic Gyroscopes (FOGs) sufficiently good for navigation has been demonstrated in the laboratory, but advancements to achieving reliable performance over a range of environmental conditions still need to be made. The performance of a FOG is sensitive to time -varying thermal gradients present across the fiber sensing coils of a FOG. Currently, Ring Laser Gyroscopes (RLGs) dominate the market for inertial navigation grade devices and mechanical rate gyroscopes of multisensors are utilized for tactical grade devices. Advancements in thermal compensation techniques (coil design, winding techniques, etc.) may allow the FOG to quickly replace the mechanical gyroscopes/sensors. A critical O&S issue is repair costs over the lifetime of the hardware, the FOG has no mechanical parts, no gas leakage, and low power consumption in comparison with the mechanical sensors. The FOGs which are solid-state devices have lifetimes that are not size dependent and are predicted to last over the 100,000 hour category. Small RLGs have very limited operating lifetimes (several hundred hours). Another issue involves low leak rates, which are insignificant for large RLGs, but causes serious shelf-life problems for the small units. On balance, if thermal compensation techniques can be identified to improve the performance reliability over a military temperature range, the FOG is definitely a less costly device than RLGs and mechanical rotation rate sensors.

A96-173TITLE:Wide Span Structures Using Pressurized Airbeams

CATEGORY: Exploratory Development

OBJECTIVE: Explore the structural dynamics and methods of achieving adequate stiffness using inflatable airbeam structures for wide span shelters of 60 feet or more.

DESCRIPTION: Inflatable structures result in significant weight, cube and deployment time savings over currently used metal frame supported structures. Recent advances in pressurized airbeam technology has focused on advancing manufacturing techniques to enable reliable, durable and affordable construction. The technology is promising, however, to date it has focused on structures approximately 30 feet wide. There exists a need in both the military and commercial sector for wide span structures of 60 feet or more, particularly for fixed wing aircraft. This effort will focus on the structural aspects of achieving adequate stiffness for wide spans using inflatable members.

PHASE I: Define the structural characteristics of the selected inflatable airbeam construction. Identify the airbeam configuration required to meet the structural requirements of a wide span shelter. Demonstrate technical feasibility of the proposed configuration using small scale or full scale prototypes.

PHASE II: Work will focus on refining the phase I structural model and fabrication and testing of full scale prototypes of wide span inflatable airbeam structures.

POTENTIAL COMMERCIAL MARKET: Wide span inflatable structures have wide reaching commercial applications such as disaster relief, humanitarian relief, stadiums, and aircraft maintenance/protection.

OPERATING AND SUPPORT COST REDUCTION: There exists a need in both the military and commercial sector for lightweight, quickly erectable, wide span structures of 60 feet or more, particularly for fixed wing aircraft. This effort will explore the structural dynamics and methods of achieving adequate stiffness using inflatable airbeam arches for wide span shelters. Inflatable airbeam structures result in significant weight, cube and deployment time savings over currently used metal frame supported structures. Savings in operational and support costs will be achieved through reduced transportation, manpower, and labor hour requirements. The advancement of inflatable technology could also result in additional operational and support cost savings if the technology is exploited for other military applications such as mobile floating platforms, antennas or high glide deployable wings.

A96-174TITLE:Rapid Inflation Systems for Inflatable Structures

CATEGORY: Exploratory Development

OBJECTIVE: Explore techniques of rapidly inflating high pressure inflated airbeam structures.

DESCRIPTION: The Army is developing a rapidly deployable shelter capability using high pressure inflatable airbeams for structural support. This new manufacturing technology will have improved reliability, durability and producibility over current commercial inflatable technology. Off-the-shelf inflation systems (consisting of blowers and compressors) for these shelters remain unacceptably heavy, expensive and slow.

PHASE I: Explore alternative techniques (such as a chemically activated inflation system) to deploy an airbeam supported maintenance shelter in less than 30 minutes. Assume there are 10 inflatable arches, each 13 inches in diameter, 60 feet long and inflated to 65 pounds per square inch. Identify the most promising technique and demonstrate the technical feasibility of the concept using a small scale prototype system.

PHASE II: Refine the Phase I design, fabricate and test a full scale inflation system prototype.

POTENTIAL COMMERCIAL MARKET: Inflatable structures have wide reaching commercial applications such as disaster and humanitarian relief shelters, aircraft escape slides, mobile floating platforms, inflatable antennae, and flood control.

OPERATING AND SUPPORT COST REDUCTION: The Army is developing a rapidly deployable shelter capability using high pressure inflatable airbeams for structural support. Off-the-shelf inflation systems (consisting of blowers and compressors) for these shelters remain unacceptably heavy, expensive and slow. The objective of this effort is to explore techniques of rapidly inflating high pressure airbeam structures. This new technology will reduce operational and support costs by replacing larger and heavier existing systems (reducing transportation costs) and reducing the manpower and labor hours required for deployment. Additional savings could be achieved through dual use of these rapidly inflatable structures for applications such as disaster and humanitarian relief shelters, aircraft escape slides, mobile floating platforms, inflatable antennae and flood control.

A96-175TITLE:Diesel Fuel Preheater

CATEGORY: Exploratory Development

OBJECTIVE: To develop a metal-hydride preheater for diesel burners.

DESCRIPTION: The DoD conversion of combat vehicles from gasoline to diesel and JP8 has resulted in a persistent problem in similarly converting vaporizing burners to conform to this new fuel standard. A catalytic vaporizer has been developed that has demonstrated the ability to convert diesel fuel into lighter hydrocarbons, enabling the burner to operate with a blue flame that is indistinguishable from a gas burner. However, preheating the vaporizer to achieve initial vaporization of the diesel needs improvement Conventional air aspirated preheaters (blow torches) impinge a flame on the outside of the vaporizer to vaporize the fuel (<350C) prior to catalysis. They are inefficient, consume a large volume of air (that is physically added to the tanks with a hand pump), and require preheating outside the kitchen because of the noxious smoke and fuel vapor produced. An alternative to the exterior blow torch is an internal exothermic chemical heater. Metal-hydride systems have been successfully developed for automotive catalytic converters to lower emissions to ULEV standards. These systems are small and inexpensive, and reach a temperature of 400C in less than 5 seconds. They are regenerated by the vehicle exhaust (500C). The heat output, rate, and temperatures are within the operating parameters of a preheater for a diesel burner. Accordingly, the objective is to develop a metal-hydride preheater for a diesel burner to enable smokeless preheating inside the field kitchen.

PHASE I: Conduct a study to establish the feasibility of this approach that includes, but is not limited to: the design and fabrication of an experimental preheater that provides baseline performance data; identification of source bed materials, testing of the materials; and integration of the preheater within a vaporizer.

PHASE II: Design, fabricate, and demonstrate an optimized integral preheater capable of smokeless ignition of a diesel burner. Fabricate and deliver 10 prototype units.

POTENTIAL COMMERCIAL MARKET: Multifuel lanterns, burners, and heaters used for disaster relief emergencies, remote areas, third world countries, recreation, recreation vehicles (vans and yachts).

OPERATING AND SUPPORT COST REDUCTION: The M2 gasoline burner is the standard heat source used in field feeding. The current field feeding plan is to convert from gasoline to diesel cells for the replacement of the M2 with an advanced powered diesel/JP8 burner. The availability of a low cost diesel conversion kit consisting of a metal hydride preheater in combination with a catalytic vaporizer would respond to the conversion of operational fuels while extending the life of M2s allowing for a more gradual, cost saving, transition to powered burners. It also provides an option to remain with diesel M2s in selected situations e.g., for situations where no field generators are available.

A96-176TITLE:Non-system Training devices and Training Instrumentation Systems/Technology Advancements

CATEGORY: Exploratory Development

OBJECTIVE: To develop new and innovative solutions specific to Program Manager, Training Devices problem/issue areas.

DESCRIPTION: The PM TRADE's mission is to plan, control, coordinate, and manage the development, acquisition, and fielding of effective training systems for use by the United States Army, other services, and designated foreign and domestic clients. Also, it manage's the development, acquisition and fielding of instrumentation systems for the Combat Training Centers (CTC), Training Devices, Simulations, Simulators (TDSS) and Tactical Engagement Simulators (TES) for use during force-on-force training exercises. To be able to continue that mission into the 21st century, PM TRADE has identified the following areas for research and development investigation. Potential offerors may submit proposals for any or all the areas.

a. Numerous vehicular accidents have occurred during Army night field training exercises and experiments involving drivers wearing night vision image intensification devices. Subsequent night driving experiments conducted by the Dismounted Battlespace Lab have indicated the accidents are probably caused by perceptual problems experienced by the driver wearing the night vision image intensification device. Evidence indicates that a driver's night driving performance improves dramatically with experience. Therefore, there is the need for an innovative low cost high performance interactive Night Driving Simulator (NDS) concept. The envisioned concept should have "classroom and recreation room" modes of operations.

b. Existing combat engineering and construction equipment training simulators are typically not physics-based. Reasons for this include the computational burden of physics based calculations, the lack of optimized algorithms for such simulations, and simulators, such as crane-operation and driving simulators, that lack realistic behavior thus significantly reducing training effectiveness. Recent advances in computational methods and power, such as parallel processing and higher CPU rates, as well as improved visualization techniques, now make physics-based training simulators of this type a feasible reality. The need exists to develop a simulator capability which incorporates new methods for physics based virtual simulations for combat engineering and construction applications. These methods will provide more realistic simulator behavior and will allow for the efficient determination of forces imparted on equipment due to static and dynamic loads, and will support instantaneous feedback to the trainee.

c. The Army/DOD needs a low cost "small foot print" electrical energy replacement for the BA5590 LiSO2 battery. The BA5590 operates a dismounted troop training instrumentation gear for about 24 hours. Training sessions typically lasts about a week and the expense of changing batteries every one or two days is great. The BA5590 is considered to be too heavy and too bulky. The desired electrical energy device will not pose any hazards to the soldier or the environment and operate in all weather conditions for at least 5 times as long as a BA5590 and should be flexible or small enough to not interfere with a soldier's movements.

d. The current MILES standard PMT S004 for Tactical Engagement Simulation (TES) supports up to 37 weapons platforms with 4 ammunition types each. Dismounted infantry is limited to 2640 BLUFOR and 2640 OPFOR players. Future missions

envisioned could exceed the current standard's capability and could seriously limit the effective implementation of future TES exercises. Therefore, either a new and innovative TES concept or TES standard is needed to accommodate significantly increased numbers of players and weapon/ammunition types. Any new concept or standard must be downward compatible.

e. Current TES exercises as "played" at the combat training centers emulate many of the current direct-fire and indirect fire weapons via the use of basic MILES and SAWE/MILES II equipment/instrumentation. Many new weapon systems (e.g. laser based systems) and some contemporary weapon systems (e.g. the MK 19 grenade launcher, fire and forget weapons, and audio-video/IR/active-radar guided munitions) do not seem to be compatible with the basic MILES and SAWE/MILES II TES paradigm. A new and innovative TES based approach is needed to overcome these problems.

f. Realistic tactical proficiency training for intelligence collection operators require the simulated communications traffic be provided to operators in the language of interest. The current method of creating training communication scenarios in the foreign language is a time consuming and cumbersome process of integrating prerecorded segments of conversation into a meaningful whole. Moreover, the resulting product is frequently less than natural sounding. Therefore, there is the perceived need for a system that will produce a unlimited natural spoken output in a specified language which in its totality becomes the desired training communication scenario. The unlimited natural spoken output (or text output) from the envisioned system is the last phase of a near real-time transformation process which began with either a natural spoken or text input. The input language and output language will generally be different and selectible but for the proposes of this research American English is assumed to be the input language while the output languages for the initial demonstration should be two significantly different languages such as Swedish and Japanese. This language transformation process will be an integral part of the envisioned system. Other relevant parts include but are not limited to an effective man-system input/output interface, and array of productive tools to support scenario creation and manipulation, storing and retrieval of information, and visualization tools. Such a set of capabilities are envisioned for the next generation of Intelligence and Electronic Warfare Tactical Proficiency Trainers (IEWTPT). The next generation IEWTPT will allow an individual operator, or a number of operators and intelligence platforms, to interact with dynamic simulations in real-time. It will provide a good representation of speech in the target language and retain the intonation, inflection and emphasis of the speaker. It will be capable of supporting the specialized vocabulary of military operations, the addition of new words, the handling untranslatable words, and the altering of vocal characteristics.

g. There has been an increasing interest in long wavelength optical sources for various commercial and military applications, the later including both tracking and ranging. A number of practically viable military systems have been developed, in particular, accurate rangefinders as well as target designator and illuminators. A key component of such systems is a laser source whose wavelength falls within the regions of minimum atmospheric absorption (3-5um and 8-12um) that is matched with the reception band of the photo detector. The availability of such sources makes it possible to detect targets through storms and in an obscure environment. There are a number of requirements to be met in developing these sources. First, the pulse repetition rate should correlate with Multiple Integrated Laser Engagement System (MILES). Second, the output power level should be low enough to satisfy eye-safety requirements ANSI STD, Class 3A. Third, the wavelength of the source should be in an eye-safe spectral region. In this connection, NdYAG lasers which have received the most widespread use are not optimal although some techniques, in particular, Raman shifting in methane vapor or doping YAG with Er, can result in a laser operating in the eye-safe near IR spectral region. Currently, long wavelength sources based on nonlinear interactions in ferroelectric crystals (LiNb03, LiTa03, KTP, etc.) are reveling great potential for use in the aforementioned systems. In these sources, efficient generation of radiation in the wavelength range 2.5-4um can be obtained by using quasi-phase-matching techniques to compensate for the walk-off between the phase velocities of the pump wave (delivered by a powerful diode laser emitting around 0.8um) and the generated long wavelength radiation.

PHASE I: Explore concepts design possibilities in the above subject areas; develop concepts for each of the relevant design possibilities: and show the feasibility for concepts developed.

PHASE II: Taking the results of Phase I, take the most promising concept, design, or approach and develop and demonstrate.

POTENTIAL COMMERCIAL MARKET: The proposed developments would have application in many commercial environments (i.e. communications, entertainment, language training, any system needing self-contained power source, eyesafe laser rangefinder for automobile and construction industries).

OPERATING AND SUPPORT COST REDUCTION: 1) the development of a low cost driver perceptual trainer for night driving with night vision "goggles" is intended to significantly increase driver performance and reduce costly accidents, 2) the development of advance engineering models of combat engineering and construction engineering equipment and their interactions with their work environments so as to support increased equipment operator performance and more cost effective operations, and 3) the development of a low "small foot print" energy replacement for the BA5590 LiSO2 battery which would significantly reduce the O&S costs associated with operations at the Combat Training Centers (Ft. Irwin, CA, Ft. Polk, LA, & Holenfels, Germany)

A96-177TITLE:Advancements in Instrumentation Technology for Documentation Systems/Technology Advancements for Threat Targets, Threat Simulation

CATEGORY: Exploratory Development

OBJECTIVE: To develop new and innovative solutions to a set of specific problems/technical Issues of interest to the Project Manager for Instrumentation, Threat Targets & Threat Simulators.

DESCRIPTION: PM ITTS's mission includes managing research, development, design, acquisition, fielding, modification and capability accounting of targets (aerial and ground), threat simulators and major (high cost and complex) instrumentation required for U.S. Army technical and operational test and evaluation. In additional, the PM is responsible for the live segment of the synthetic environment and the implementation of Distributed Interactive Simulation (DIS) to Army test and evaluation. In order to effectively execute this mission now and into the 21st century, PM ITTS has identified the following areas for research and development investigation. Potential offerors may submit proposals for any or all the areas.

a. Existing power generation techniques for powering simulators, data collection systems and instrumentation in field conditions require sophisticated air filtration and cooling systems to operate. Current systems are a noise hazard, use oil and fuels which are hazardous to the environment and pollute the air. Dust environments encountered in the field inflict a great deal of damage on turbine and internal combustion engine powered electrical power generation equipment. The development and maintenance costs of air filtration and cooling systems capable of operating in field environments is extremely high. What is needed is a quiet low maintenance hydrogen fuel cell power generation capability in the 5kw to 50 kw range which has minimal impact on the environment.

b. Since the LAN market is driven by commercial applications, existing LAN equipment has been primarily developed for only low power, limited range, stationary, point-to-point applications. As threat simulators move into the area of modern networking multimedia and Distributive Interactive Simulation (DIS) technologies, the use of real time, wireless networking of threat simulators in a developmental and operational test (i.e. Fort Hunter Liggett, CA) environment is critical. In the expected test environment, A LAN system would have to be able to operate between entities over a 8-10 km range, while overcoming several challenges. The challenges in this area are extended range, terrain masking, rugged environment, mobility, data communication bandwidth and frequency band conflicts with other LAN equipment. A system which can meet these challenges would push Threat Simulators to a whole new level of performance and functionality. Areas which would be explored in this research include: selectable dual bands (900/1200 Mhz) to allow flexibility, higher power output for longer range, omni-directional antennas for broader coverage, product huggardization for harsh environments, and increased data bandwidth for multimedia and DIS applications.

c. Currently, Command, Control and Communications (C3) threat simulations performance does not track manned threat performance well. Specifically, they have a particular difficulty in identifying and recognizing targets. Although the holistic

man-machine level of performance is beyond the state-of-the art there are good reasons to believe that the innovative application/adaptation of neural networks and fuzzy logic technologies to the Army's Modular Semi- Automated Force structure might prove to be an effective area to pursue. This research should, whenever possible, incorporate the results of cutting edge research and off-the-shelf-technology, and be compatible with threat simulator hardware.

d. The virtual reality world is quickly evolving and being applied to many DOD and industry scenarios. To optimize effectiveness of virtual reality, all human senses should be involved. Tactile feedback is one way to fulfill the sense of touch. There are several haptic interface devices currently on the market, however most are not capable of satisfying multiple tasks or being reconfigured for vastly diverse tasks. This research is envisioned supporting the virtual testing of weapon and vehicular systems and should focus on the design and demonstration of a feasible ergonomically sound reconfigurable haptic interface system. The initial virtual testing environment would need to adapt the haptic interface for a steering wheel, joystick, gas/brake pedal, knob/switch, needle/scissor and keyhole feedback.

PHASE I: Explore alternative concepts and develop feasible approach.

PHASE II: Implement the best approach from Phase I with the objective of demonstrating the feasibility and effectiveness of the concept.

POTENTIAL COMMERCIAL MARKET: The proposed developments would have far reaching applications in a number of commercial markets such as transportation, portable electrical power generation, mobile data communications, sporting events and video games.

OPERATING AND SUPPORT COST REDUCTION: This topic includes several sub-topical areas which directly contribute to the "Reduction of Operation & Support Costs" to the Army to include: 1) the development of low foot print power generation source in the 5kw to 50kw range to support training and system testing, 2) the development of an extended range LAN (local area network) for use in system testing intended to significantly reduce the O&S range costs, and 3) the development of an advance threat models to act as surrogates for "manned" threats intended to significantly reduce cost the of weapon system testing.

A96-178TITLE:Cooling Enhancements for Radiators

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to design, fabricate and test an enhanced cooling technique for military vehicle radiator applications that allows for a more compact, lightweight, and lower cost radiator.

DESCRIPTION: Anticipate a future need for an advanced radiator that is more compact, efficient, and lighter weight than the current radiators while maintaining equivalent performance. Increases in engine horsepower in turn lead to increase in heat rejection requirements. The current Army doctrine of combat vehicles with smaller silhouettes leads to smaller under-armor space. In addition, the current radiators require a high percentage of the engine power to drive fans in order to achieve the necessary airflow for the already cramped radiator. To reduce weight of the radiator one approach might be to use lighter weight material such as aluminum. To increase the overall heat transfer coefficient, in-tube enhancements which cause mass transfer from the flow core to the tube wall, can be implemented thereby causing an increase in overall heat transfer coefficient. Such enhancements are deem desirable for a lightweight, compact, high performance radiator. Also, the concept design presented shall be consistent with army initiatives to reduce operating and support costs.

PHASE I: In Phase I, the contractor would develop a concept for the advanced radiator implementing such enhancements and perform testing of that concept in the laboratory. The concept and testing shall be documented in sufficient detail to allow the government to determine if it will satisfy the requirements for the future military application and provide the desired improvements mentioned above.

PHASE II: In Phase II, the contractor shall fabricate and test a prototype of the advanced radiator with such enhancements. the following items shall be deliverable under this effort: design drawings, test report, final report and a vehicle worthy prototype radiator.

POTENTIAL COMMERCIAL MARKET: Advancements can be implemented on fleet vehicles such as taxis, commuter buses, police cars, ambulances, fire trucks, or other vehicle exposed to rough field usage. The benefit of this technology would allow for more reliable heavy duty fleet vehicles.

OPERATING AND SUPPORT COST REDUCTION: This technology could lead to a reduced operating and support (O&S) cost for any vehicles exposed to rough field usage.

A96-179TITLE:Reducing Army Operating and Support Costs

OBJECTIVE: Identify and develop innovative process or end-item improvements which may yield significant savings in the operation and support of Army equipment.

DESCRIPTION: The U.S. Army spends more than half of its overall budget, directly or indirectly, on the operation and support (O&S) of equipment ranging from small generators to large, sophisticated weapon systems. O&S costs cover a broad spectrum of items including spare/repair parts, fuels, lubricants, and the facilities and people involved in training operators and mechanics.

O&S represents a major opportunity for savings, and the Army is seeking ways to reduce these costs as part of a broad Acquisition Reform Initiative which will ensure a ready and viable warfighting force as the Army's buying power continues to decline. To this end, the Army has implemented the Operating and Support Cost Reduction (OSCR) Program to identify and develop cost savings initiatives. The Army SBIR Program, recognizing OSCR's importance, is soliciting innovative proposals which address the broad spectrum of OSCR applications.

This topic is broad by design to allow submission of topics which do not fit under other OSCR-related topics which are more specific in nature. Firms are encouraged to submit ideas which address any items of equipment, and which fall anywhere within the life cycle of an item. A past example of a successful OSCR initiative is a gun tube exerciser for tanks. This system provides a means of exercising gun tubes on tanks stored in Army depots. The gun tube exerciser significantly reduces the amount of time needed to exercise gun tubes. Other examples include innovations which reduce power or fuel consumption, increase battery life, facilitate maintenance tasks (or require them less often), and a multitude of other ideas which will save money in the operation of Army systems. Please note that the above examples are not intended to focus offerors on specific equipment or specific OSCR applications.

PHASE I: Identify techniques/processes or design applications to be implemented, and conduct all necessary research to demonstrate the feasibility of the proposed idea(s). This effort would include any modeling efforts required to estimate the expected O&S cost savings resulting from implementation of the concept.

PHASE II: Develop the techniques, processes, or applications identified in Phase I. This effort should result in a finished product which can be delivered to the Army and further marketed (in Phase III) by the small business.

POTENTIAL COMMERCIAL MARKET: OSCR applications nearly always have a direct application in related private industries. For example, the heavy trucking, construction, and mining industries would directly benefit from OSCR successes designed for Army wheeled and tracked vehicles. The airline and rotary wing industries would benefit from helicopter and unmanned aerial vehicle OSCR applications. Additional direct commercial applications exist for communications equipment, generators, and most other Army items of equipment.