U.S. Army 93.2
Submission of Proposals

Topics

The Army has identified 309 new topics for this solicitation, many of which address Operating Support Cost Reduction (OSCR), Critical Technologies especially relevant to the Army, the Army Science and Technology Master Plan, and the Star 21 Strategic Technologies for the Army of the twenty-first century. An attempt has also been made to identify the commercial potential of these initiatives.

Dollar Caps

The maximum dollar amount from the SBIR budget for Army Phase I awards is $70,000. Additional program dollars may be added by the program activity. To reduce the funding gap between Phase I and Phase II, firms may submit an option task not to exceed $30,000 with the Phase I proposal. Exercise of such an option would be intended to allow Phase II preparatory work to be initiated; however, the option does not obligate the Army to make a Phase II award. Firms who are awarded the option should reflect the funds as a deduction on the total cost of their Phase II proposal. Future Army Phase IIs will average about $600,000. Those companies who have been invited to submit a Phase II proposal and have almost finished their Phase I work must submit a plan on how they will commercialize the technology with the government or with the private sector in addition to the technology demonstration portion of the proposal if they desire to compete for a Phase II. Cost sharing options in Phase II are encouraged and will be used as an evaluation factor for proposed Phase IIs over $600,000.

Army Technology Clusters

These topics have been grouped into ten Army Technology Clusters. They are:

A-1 Advanced Materials and Manufacturing (Structural & Energetic Materials)

A-2 Micro Electronics and Photonics

A-3 Sensors and Information Processing (Communications)

A-4 High Performance Computing and Simulation (Modeling Displays, AI, Virtual Reality)

A-5 Advanced Propulsion Technologies (Mobility and Lethality)

A-6 Power Generation, Storage and Conditioning (Directed Energy, Microwave)

A-7 Biotechnology

A-8 Life, Medical and Behavioral Sciences

A-9 Environmental and Geo Sciences (Environmental Protection and Space)

A-10 Engineering Sciences (Robotics, Dynamics, Structures, Mechanics, and Construction)

Industry-Generated Future Topics

To enhance industry involvement in the Army SBIR process, I welcome suggestions from small firms for future Army topics. Kindly forward your topic ideas to me **after** this solicitation closes. Unsolicited proposals will not be accepted.

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Army SBIR Program Manager
Commander
U.S. Army Materiel Command
ATTN: AMCRD (Mr. J. Forry)
5001 Eisenhower Avenue
Alexandria, VA 22333

ARMY SMALL BUSINESS INNOVATION RESEARCH PROGRAM

Submitting Proposals on Army Topics

Phase I proposal (5 copies including 1 red-printed form) should be addressed to:

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ARMY SBIR PROGRAM
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DEPARTMENT OF THE ARMY

FY 1993 TOPIC DESCRIPTIONS

A-1ADVANCED MATERIALS AND MANUFACTURING
(I.E STRUCTURAL & ENERGETIC MATERIALS)

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-053TITLE: Ammunition Loading Hazards Detection for Artillery/Armor

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a capability for reliably: (1) recognizing that hazardous conditions for loading ammunition into cannon have developed, (2) alerting operators that loading should be interrupted, and (3) operating in the training/operational environment of combat vehicles after full development.

DESCRIPTION: Direct and indirect fire gun and ammunition systems have a history of occasional malfunction which sometimes result in critical injury to the weapon crew. The rapid advancements in the sensor and microprocessor fields has provided a new potential capacity for automatic detection of the onset of such unsafe loading conditions in cannon. Hazards to the continued loading and operation of the gun/ammunition system have been specified; they include hot/burning ammunition residues. Experimental data are being collected on these hazards in the laboratory and in live fire experiments. A workshop on the automatic detection problem yielded a problematic approach to synthesizing automatic detection of hazardous conditions. This effort requires further technology developments in sensory systems, high performance computing capabilities and detection algorithms for application with direct and indirect fire systems. Special interests lie in the potential application of fusion of spectrographic data, focal plane arrays, laser semiconductor arrays and the chemical tagging of ammunition elements. This topic requires: (1) extension in the taxonomy of hazards in cannon/ammunition systems (including the analytical/experimental development of spectral emissions signatures for each type of hazard) (2) characterization of emission for the byproducts of combustion of ammunition (including evaluation of the influence of transmittance on the detection process) and (3) determination of the types, levels and effects of background radiation from external sources. An approach applying the development of neural nets to discriminate between hazardous and non-hazardous states in the gun could be applied. The required algorithms and coding must render a reliable detection in the very limited time available for interruption of the gun loading process.

Phase I: Develop the methodology and data base to support system design activity for artillery/armor system(s). Perform any necessary laboratory bench simulations required to confirm feasibility of the design approach. Synthesize a conceptual design (Class I drawings) for a demonstration prototype system. Identify system requirements in terms of hardware (sensors, microprocessors, cabling, installation fixturing, etc.) decision algorithm(s) and prospective software needs. Prepare an outline test plan for the demonstration of the system.

Phase II: Complete the detailed design and synthesis of a demonstration system. Provide a test/demonstration plan, maintenance test support package and on-site test support for demonstration of the brassboard in live gun firings by the government at a proving ground or comparable facility. Provide a written technical report on the work.

Potential Commercial Market: No foreign or domestic source for any such detection and warning system exists. There is no known and currently funded effort addressing the development and application of these technologies to the problem identified. Areas where its application exists include: currently fielded U.S. Army direct and indirect fire systems, the Advanced Field Artillery System (AFAS), the Advanced Tank Armament System (ATAS), gun/ammunition systems extent in the other services (U.S. Navy and U.S. Marines), foreign systems, and industrial base equipment/processes for private and consumer manufacturing. In addition, many key technology componenets would be useful in constructing a system to identify concealed explosives and their stability.

OSCR: This topic provides technologies to accomplish OSCR by application: (1) to combat systems to reduce the frequency and severity of accidents causing critical injury to personnel and/or damage to materiel, and (2) to acceptance testing of ammunition to reduce the expenditures for ammunition. These technologies are required to support automated ammunition handling in combat systems and a concomitant reduction in Operations and Support Costs.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-059TITLE: Blow-Molded Ammunition Container Development

CATEGORY: Engineering Development

OBJECTIVE: Complete development of a qualified light-weight plastic container for implementation into production for large-caliber ammunition and propelling charges.

DESCRIPTION: The blow-molded container evaluated under a PIP program during the 1984-1985 timeframe performed very well in its qualification test program. The technical advantages of the container included light weight, ruggedness, corrosion elimination and reduced ammunition logistics costs. The container was not selected, primarily due to problems with the closure design maintaining a 3 PSI seal. This program will improve the closure design, including the selection of molding process and gasket material, to achieve long-term storage capabilities. In addition, molding parameters will be established to ensure reproducibiity.

Phase I: The contractor shall work with existing container molds and tooling designs as baseline criteria. Recommendations shall be made for modifications to the closure design, material selection and processing parameters. At the end of Phase I the contractor shall deliver a report that includes proposed design, material and/or process improvements.

Phase II: The contractor shall implement design, material, and/or process changes recommended in Phase I to the existing container molds and tooling. These changes shall be such that the molded container will be able to meet the rigors of Level A military packaging as outlined in MIL-STD-1904. Upon completion of Phase II, the contractor shall deliver 50 containers of an agreed-upon design to the U.S. Government for qualification test, and a final report that includes changes made to the design/material/processing, test data and evaluation results.

Potential Commercial Market: The blow-molded container for large caliber ammunition will be developed with emphasis on the seal design for long term purposes. Once the container is qualified in the test program, the design will be phased into the ammunition packaging system. Since both the raw material and the developed processes are commercially available, no major problems would be anticipated for this transition. In addition, to phasing the design into the ammunition packaging system, opportunities exist for applying the developed technology to lightweight packaging that must maintain a pressure barrier against the outside environment.

OSCR: The blow-molded container provides significant benefits in areas of light weight, ease of handling, no corrosion problems and lower unit cost. As a result, the life cycle cost reduction is estimated to be 20% less than the current system.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-061TITLE: Formulation of Pyrotechnic Compositions with Solventless Binders

CATEGORY: Exploratory Development

OBJECTIVE: Develop Pyrotechnic Compositions containing solventless binders and identify processing techniques for such compositions.

DESCRIPTION: Many pyrotechnic compositions contain organic binders which are incorporated into the composition by dissolution into volatile organic solvents (vos) and subsequent blending with the remaining composition constituents. During mixing, the vos evaporate. Most states severely restrict the open emission of vos. Consequently, plants manufacturing pyrotechnics must use solvent recovery systems to comply with environmental laws. It would be desirable to eliminate totally or greatly reduce vos from pyrotechnic manufacture. This would yield two benefits. First, although vos emission is controlled, it would be more environmentally advantageous to eliminate vos altogether. Second, solvent recovery systems represent a considerable portion of overall pyrotechnic processing costs. Elimination of these systems would yield a cost savings.

Phase I: Select binders suitable for use in pyrotechnic compositions. Selection criteria include physical, chemical characteristics, availability, toxicity, cost. Determine processing schemes to incorporate binders into selected pyrotechnic mixes without use of vos.

Phase II: Produce bench and pilot scale batches of pyrotechnic compositions using solventless binders. Load into items and perform static functioning tests. Optimize composition formulations and processes to achieve acceptable item performance. Gather data required for scale up to load plant production.

Potential Commercial Market: Techniques developed for this project would be directly transferable to reduction of vos in other similar environmental processes.

TECHNOLOGY CLUSTER: A-1

TOPIC: A93-065TITLE: Advanced Packaging Cushioning Material to Improve Performance in the Insensitive Munitions (IM) Fast Cook-off and Sympathetic Detonation Tests

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate new and innovative materials, coatings, and designs for packaging cushioning to protect munitions during the Insensitive Munitions (IM) Fast Cook-off and Sympathetic Detonation tests. Concepts developed must continue to provide the desired cushioning properties to protect the munition during packaging rough handling environments.

DESCRIPTION: The fast cook-off and sympathetic detonation tests are two IM tests and are described in MIL-STD 2105A. Ideally the advanced cushioning developed under this topic should address both the fast cook-off and the sympathetic detonation test criteria. However, if that is not possible, only one criteria may be chosen to be addressed. Many munition containers are constructed with a steel outer container. Polyethylene or polyurethane foam, bound fiber, or some other cushioning surrounds the munition to provide protection from the impacts and shocks of rough handling and environmental conditions. The IM fast cook-off test subject packaged munitions to a large fire. The required reaction of the munition in these tests is burning only. The tests do not have a time limit, but are conducted until the munition energetically reacts. Two possible approaches which use the packaging cushioning to protect munitions during the IM fast cook-off test are discussed. One approach is to use the packaging's cushioning to thermally insulate the munition from the fire. This will delay the munition's reaction time. Although a delayed time will not directly help a munition to "pass" the IM test, it will contribute a significant real world explosives safety benefit by providing valuable time to allow personnel to either fight the fire or evacuate the area. A second approach is for the packaging cushioning to undergo a phase change from solid to gas. This phase change may absorb thermal energy, thereby insulating the munition. This approach may provide a secondary benefit of providing an internal pressure build-up within the container due to "out-gassing". This internal pressure may be engineered to result in controlled rupture and venting of the container, in contrast to the current reaction, which is often a rapid build-up of pressure culminating in a release of dangerous fragments. The IM sympathetic detonation tests and the hazard classification stack test evaluates the likelihood that a detonation reaction may be propagated from one unit to another within a group or stack of munitions. The required reaction of the acceptor munition in these tests is no detonation. Because this test is usually conducted with munitions in the packaged configuration, the packaging has the potential to mitigate and attenuate the explosive shock transferred from the donor to the acceptor munition. During the investigation, the maximum cushioning material used shall be four inches. The materials developed shall meet toxic fumes requirements as established by the Occupational Safety and Health Administration and the American Conference of Governmental Industrial Hygienists. The results of this investigation may benefit the IM performance and hazard classification of many Army munitions. The outbreak of fire in an ammunition storage area is widely recognized as the greatest hazard to explosive safety. This effort will reduce the consequences of this hazard, thereby greatly improving the safety of U.S. troops and civilians.

Phase I: Investigate new and innovative materials, coatings, and designs for packaging cushioning to protect munitions during the IM fast cook-off and sympathetic detonation tests while still providing the desired cushioning properties to protect the munition during packaging rough handling environments. Modeling and analytical evaluation shall be used to predict the success of the concepts. To address the fast cook-off test criteria, cushioning shall be developed which delays the time of reaction for a munition exposed to the IM fast cook-off tests. To establish a baseline, the investigator shall determine the insulating performance of currently used polyethylene and polyurethane foam and bound fiber. In addition to cushioning materials which provide thermal insulation, materials may be considered which may dissipate thermal energy by undergoing a change of state, such as from solid to gas. The "out-gassing" developed during this state change shall be quantified to determine internal pressure build-up leading to controlled rupture and venting of the container. Small scale testing using a heat source shall be used to simulate the

actual fast cook-off test and will demonstrate the success of the various concepts. To address the sympathetic detonation test criteria, cushioning shall be developed which provides explosive shock attenuation, thereby increasing the likelihood of preventing sympathetic detonation. To establish a baseline, the investigator shall determine the explosive shock attenuating performance of currently used polyethylene and polyurethane foam and bound fiber.

Phase II: Implement the new cushioning concepts into actual munition containers. The prototype designs shall be tested in IM fast cook-off, sympathetic detonation, packaging simulated rough handling testing, and toxic fumes testing. Modified container designs shall not adversely affect container performance in simulated rough handling tests or toxic fumes test. The prototype designs shall be optimized for producibility and cost. Detailed design drawings and specifications shall be developed.

Potential Commercial Market: This technology would have application to the commercial packaging industry and fire protection industry. The development of new and innovative packaging materials, coatings, and designs would provide improved fire and heat protection for many commercial goods, with particular application to expensive and sensitive assets.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-066TITLE: Critical Fluid Extraction of Single-Base Gun Propellant Formulations

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate critical fluid extraction (CFE) technology for recovery of strategic ingredients from single-base gun propellant formulations (M1, M6, M10, etc.). The reclaimed NC can be utilized to support current and future production.

DESCRIPTION: The Conventional Ammunition Demilitarization Inventory (B5A Account) contains large quantities of single-base propellants (including M1,, M6 and M10) contained in bulk form and in munition items. Disposal by open burning/open detonation is currently being utilized. This practice must be phased out due to environmental restrictions. Controlled incineration of bulk propellant and explosive is a potential solution. However, reclamation and reuse is the preferred approach since this technology offers both environmental and economic advantages. Technology development will permit the recovery of nitrocellulose (NC) from single-base gun propellant. The feasibility of recovering strategic ingredients from Class 1.1 and 1.3 large rocket motor propellant formulations using CFE technology has been demonstrated using near critical liquid ammonia as the extraction solvent. This technology is currently being transitioned for pilot scale development by the Joint Service Large Solid Rocket Motor Research and Development Program. A similar process using a different extraction solvent requires evaluation for application to conventional gun propellants.

Phase I: Set-up laboratory equipment to demonstrate critical fluid extraction can be employed to recover useful ingredients for recycle and reuse utilizing various extraction solvents. Testing will be performed to proveout the concept of extracting nitrocellulose (NC) from single base propellant using critical fluid technology. Different extraction solvents will be evaluated to perform the recovery. The optimum solvent will be identified. All solvents must be environmentally acceptable and capable of being completely recycled.

Phase II: Design, install the process equipment and perform bench scale testing on various single base propellant formulations using the optimum solvent identified in Phase I. Design criteria will be developed to transition the technology to the pilot phase. The physical and chemical properties of the reclaimed material will be evaluated in order to optimize the extraction process. In addition, a cost analysis will be performed to determine the economic advantages for proceeding to the pilot plant stage.

Potential Commercial Market: Critical fluid extraction technology is a proven technology that can be commercialized for recovery of NC from single base propellant. The technology can be implemented at GOGO/GOCO facilities to support ammunition production, consequently eliminating the need for disposal by open burning/open detonation. The CFE process involves the fluidization of gases to near critical liquid and supercritical fluid conditions. The fluid serves as the extraction solvent based on the solubility of the solute. The solubility of the solute in the solvent changes rapidly as process control parameters such as temperature and pressure are varied. Understanding the process chemistry based on the ingredient solubilities permits the extraction of the ingredients for recycle and reuse. Development of CFE process under the SBIR program for single-base gun propellant formulations will allow tangible and intangible benefits. The conventional ammunition demil inventory will be reduced in a more environmentally

responsible manner by eliminating the need of open burning/open detonation. The CFE approach will provide a new source of raw material. The reclaimed NC can be utilized in the production of small caliber munitions to reduce manufacturing costs.

OSCR: The SBIR proposal to develop critical fluid extraction technology for recovery of NC from single-base gun propellant formulation will provide the most efficient environmentally acceptable alternative to open burning and open detonation for conventional munitions. Recycle and reuse of NC will also support future production readiness. the technology can also be readily applied to extract and recover strategic ingredients (NC, NG, and NQ) from multi-base gun propellants. The objective of this proposal is to develop a cost efficient critical fluid extraction process to recover and reclaim high purity NC from off-spec and obsolete single-base gund propellant formulations. In addition, ammunition maintenance operating efficiency will be maximized by the recovery and recycle of NC. The estimated quantity of obsolete single-base gun propellant in the demilitarization stockpile is in excess of 10 million pounds. A cost savings at a minimum of $10 million can be realized through successful development of this program.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-068TITLE: Extended Barrel Life

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate extended barrel life through the use of wear reducing ammunition additives.

DESCRIPTION: Performance requirements for existing and future systems demand improved lethality at longer ranges. The development of high energy charges to meet these requirements has had an adverse effect on gun barrel life. While barrels manufactured using exotic materials may meet the need, the cost of such an approach may prove prohibitive. The use of wear reduction materials integral to the ammunition could improve barrel life of existing systems and complement future barrel designs.

Phase I: Select a gun system for evaluation. Using the selected gun system as a baseline develop ammunition concepts which embody barrel wear reduction additives. For each concept developed predict barrel life improvement, cost of implementation, estimate the caliber range and duty cycle in which the concept would be applicable.

Phase II: Using the base line system establish the barrel wear profile through collection of available data, gun firings and fixture testing. Build ammunition using selected wear reducing additives and test barrel life improvement. Provide complete documentation of test results.

Potential Commercial Market: Successful development of this technology may also be transitioned to the commercial gun industry for sport weapons (guns and rifles) for hunting and target shooting. In addition, other government agencies (FBI/CIA) may have a direct interest in ammunition developed with the additives developed in this proposal.

OSCR: Successful development and implementation of this technology would result in reduced life cycle costs and increased equipment availability. Life Cycle costs could be reduced in two ways. First, barrel life or existing systems could be extended without weapon modifications. Secondly, when used as a systems approach to solving barrel were concerns would result in cost effective barrel designs. Barrel life extended through either approach would further reduce life cycle cost and increase system availability through reduced supply and maintenance costs and an extended duty cycle between maintenance requirements.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-069TITLE: Diamond and Diamond-Like Coatings

CATEGORY: Exploratory Development

OBJECTIVE: Demonstration of controlled deposition and bonding of diamond and/or diamond-like coatings to weapon wear surfaces.

DESCRIPTION: Wear surfaces in small arms and automatic weapons have been lubricated with oils and greases which retain dirt and other contaminants, and whose coefficient of friction varies with temperature. Diamond and diamond-like coatings offer the potential of permanent, low friction coatings, impervious to dirt and temperature variations. This effort should demonstrate controlled deposition of the coating, proper bonding to the substrate, low coefficient of friction and controlled crystal composition.

Phase I: Determine the feasibility to deposit diamond and/or diamond -like coatings on weapon wear surfaces. Design a prototype system capable of achieving the goals outlined in the above description. Initiate development of plans for Phase III commercialization.

Phase II: Build and test prototype system capable of achieving the above goals. Test and evaluate system performance. Complete plans for phase III commercialization.

Potential Commercial Market: The proposed technology would find immediate application in many commercial areas that require low coefficient of friction between moving parts.

OSCR: Most weapon systems wear surfaces are lubricated with oils and greases which dry out and become embedded with dirt, sand and other contaminants resulting in premature wear and failure. Successful development of this process would result in an increased weapon duty cycle and large reductions in logistical costs associated with resupply, maintenance and manufacturing costs.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-107TITLE: Method for Reduced Cost Fabrication of Boron Carbide Ballistic Tiles

CATEGORY: Exploratory Development

OBJECTIVE: Develop a processing method for production of ballistic grade boron carbide ceramic which provides a minimum of fifty percent reduction in materials costs.

DESCRIPTION: Ceramic armor materials offer the benefit of high mass efficiencies to armor designers, but are limited in application by a number of factors, including cost. Boron carbide, in particular, suffers from this disadvantage with normal costs running in excess of $100 per pound. In order to obtain suitable performance levels, boron carbide must currently be produced by hot pressing or by hot isostatic pressing (HIP) techniques. This results in a material with appropriate properties such as a high elastic modulus and a high percentage of theoretical density (>99%), however, these production methods do not offer significant potential for cost savings via process optimization. An alternative processing method is sought that could yield tiles with equivalent properties at an overall cost reduction of at least fifty percent to permit expanded use of boron carbide in armor packages.

Phase I: Demonstrate process feasibility by producing fully dense materials with suitable mechanical and physical properties and deliver samples to the Army for evaluation. Determine the economic feasibility of using the proposed process for industrial production based on the cost of raw materials and the unit process steps required.

Phase II: Scale-up the process method selected in Phase I to produce tiles of sufficient size to allow ballistic testing (minimum: 6x6x1-inches) and deliver samples to the Army for evaluation.

Potential Commercial Market: Reduced cost boron carbide ceramic has a variety of potential applications aside from armor. These include high-temperature and wear applications in both military and commercial markets.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-108TITLE: High Purity Powders for Oxide and Non-Oxide Ceramics for Armor Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop high purity, sinterable powders for subsequent use in armor ceramic applications.

DESCRIPTION: Current armor ceramics are required to be processed to near full density. The primary barrier to achieving this goal is the inconsistent quality (powder size, distribution and purity) of the starting powders presently available. Recent developments in the use of exothermic reactions, sol-gel processing, plasma spraying and chemical

vapor deposition(CVD), and preceramic polymers (to name a few) to produce powders and net shape products offer the potential to produce high purity powders (single or binary phase) with a reduction in cost.

Phase I: Develop a high purity, powder processing technique for a transparent or opaque armor ceramic application. Produce and thoroughly characterize stoichiometric (or near stoichiometric) polycrystalline single or binary phase powders. Materials of interest include, but are not limited to: silicon carbide, titanium diboride, boron carbide, aluminum oxide, aluminum oxynitride and magnesium aluminate(spinel). Produce sufficient powder to meet the deliverables which will include two tiles measuring 4-inches in diameter by 0.3-inches in thickness and 250 grams of powder. The density of the processed powder must be greater than 99 percent of theoretical density (equal to or less than one percent porosity). For transparent materials, in-line transmission must be greater than 80 percent.

Phase II: Scale-up the powder production technique to produce large ceramic tiles for ballistic evaluation against various threats. Minimum deliverable is twelve tiles of 6x6-inches by 1/2 to 1-inch thickness size. Evaluate other potential compositions using the same technique. The processing cost goal is $10/pound or less.

Potential Commercial Market: Commercial markets currently exist for high purity ceramics processed to near full density. The product applications include wear, engine and electronic components.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-109TITLE: Process Control for Resin Transfer Molding

CATEGORY: Exploratory Development

OBJECTIVE: Develop resin transfer molding (RTM) technology for the innovative processing of lower cost, medium volume production of medium to very large woven and stitched structural composite components in a thermoset matrix.

DESCRIPTION: RTM has great potential for low cost and rapid production of very large structural composite components. Consequently, the technology is in a rapid development stage. Innovative processing techniques are needed to control and monitor the flow of resin within the molding cavity. The specific focus should be to develop a reliable, repeatable comprehensive system, whereby the resin can be independently "steered" in the x, y, and z directions within the mold cavity, while the resin movement and location is monitored in real time. For example, this could be accomplished through a combined application of pressure, vacuum, and the use of multiple-port injection and venting. Manipulation of the preform permeability could be another exploitable parameter.

Phase I: Develop a resin flow control system and a real-time resin location monitoring scheme. Clearly demonstrate feasibility for low part rejection rate via benchtop experimentation. Deliver RTM-processed composites to the Army for evaluation. Thoroughly critique the potential for large-scale production.

Phase II: Construct the prototype equipment and demonstrate that it is capable of meeting the resin flow and monitoring objectives described above, i.e., that, once in the mold cavity with the preform, control over resin movement and tracking its location has been mastered. Deliver test parts of varying contours, angles, and thicknesses to the Army for evaluation.

Potential Commercial Market: Availability of innovative process control for resin transfer molding would find applications for low cost, rapid production of large structural composite components in military and commercial markets.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-110TITLE: Consolidation/Compaction of Nanocrystalline Materials

CATEGORY: Exploratory Development

OBJECTIVE: Develop techniques and processing for the consolidation/compaction of nanocrystalline materials

DESCRIPTION: Recent successes in developing nanocrystalline materials opens up the opportunity for greatly improving the mechanical and physical properties of components made from those materials. An important consideration is the consolidation/compaction of the nano-sized particles into useful structure. This process must occur without the loss of the nano-scale of the powder, and hence grain size. Traditional metalworking (and ceramic) processing is not applicable due to the high temperature and extended processing times involved. Novel techniques

may be required. An additional consideration is the potentially pyrophoric nature of the nano-powder. This limits the ease by which the powder is handled and perhaps limits the consolidation methods available.

Phase I: Identify and demonstrate effective processing of nano-scale materials and/or improved handling of these materials.

Phase II: Scale-up and demonstrate the generic nature of the unit processes identified in Phase I and deliver samples to the Army for evaluation.

Potential Commercial Market: A clear need exists to develop consolidation processes for nano-scale powder. Development in nano-powder production must proceed with consolidation or no advantage will be forthcoming. The potential is as great as the range of nano-materials. Ductile ceramics are possible as well as strong, ductile metals and intermetallics.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-111TITLE: Novel Materials for Laser/Ballistic Protection

CATEGORY: Exploratory Development

OBJECTIVE: Develop novel transparent, laser- and ballistic-resistant materials/technologies for passive, dynamic, broad-band protection for both biological and instrumental sensors. Potential Phase III applications for these new materials include laser-safety glasses, goggles, windshields, vision blocks, and direct and indirect view optics.

DESCRIPTION: The Army has a need for improved laser-resistant materials against broad-band, agile lasers. Conventional polycarbonate structure incorporated with laser absorptive dyes and/or reflective filters usually has degraded ballistic properties and only provides adequate laser protection against specific wavelengths. Thus, innovative, laser/ballistic materials and technologies are needed against agile, broad-band laser threats. Proposals will be considered that address either of the following approaches/qualifications: (1) New laser resistant materials/systems effective against mid- to high-energy out-of-band lasers with ballistic protection comparable to or greater than polycarbonate. (2) Passive or active optical-switchable laser blocking materials/systems for broad-band low energy laser protection in the 400-1200 nm spectral region with at least 50 percent photopic transmission and an optical density greater than 4 when laser irradiation is present, and ballistic protection equivalent to or better than polycarbonate.

Phase I: Develop one or more hybrid transparent materials concepts to protect Army personnel and optical sensors against broad-band laser threats and demonstrate feasibility.

Phase II: Optimize and scale-up the most promising laser-blocking materials system demonstrated in Phase I. Develop a full-scale prototype system for a specific Army application and demonstrate its effectiveness against agile laser threats. Deliver the prototype to the Army for additional tests and evaluations.

Potential Commercial Market: Improved transparent laser- and ballistic-resistant materials, effective against agile laser threats, would find applications in laser-safety glasses, goggles, windshields, vision blocks, and direct and indirect view optics.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-112TITLE: Engineered Perceramic Polymers for Confined Space Conversion

CATEGORY: Exploratory Development

OBJECTIVE: Develop a preceramic polymer which is designed for conversion in confined spaces to silicon carbide or silicon nitride and which is useful as a binder and as a matrix material for a ceramic composite.

DESCRIPTION: Preceramic polymers currently serve as an important route to continuous fibers for composite materials. However, there is growing evidence that preceramic polymers can also serve important roles as binders and as precursors to the matrices of ceramic fiber composites. To optimize their use in these situations, the polymers often need to be designed for a long shelf life and low weight loss conversions to stoichiometric, crystalline conversion products without extensive and costly furnace times.

Phase I: Design a preceramic polymer which can be handled in laboratory air and which shows less than eight percent porosity during conversion to a near stoichiometric silicon carbide or silicon nitride conversion product when used as either a binder or a composite matrix material. The conversion product must be ninety-five percent crystalline

at the end of the heat schedule. Demonstrate the feasibility and usefulness of using this polymer in either a binder application or a composite matrix application through microstructural and mechanical property analyses. Deliver two plates of the final ceramic material produced, measuring about 2.5x2.5x1/8-inches or more, and 25 grams of the polymer.

Phase II: Scale-up the Phase I polymer material production process and produce large-scale ceramic materials, including a component demonstration piece using the polymer in both a binder and a composite matrix application. Demonstrate the processability and reproducibility of the ceramic materials. Evaluate the elevated temperature mechanical performance of the materials.

Potential Commercial Market: Commercial markets already exist for technical ceramics, especially for those with good high temperature mechanical properties. The material requirements specified in this SBIR topic area should lead to the fabrication of high quality materials which would be readily marketable.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-113TITLE: Smart Materials for Army Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate effective smart materials concepts for applications to Army systems.

DESCRIPTION: Recently there has been intense activity in the development of "smart" or "intelligent" materials and functionally graded materials. This activity has been pursued enthusiastically in Japan and Europe. Some typical features of these so called smart materials are as follows: -Embedded or bonded or intrinsic sensors which recognize and measure the intensity of environmental stimuli such as stress, strain, thermal, electric, magnetic, electromagnetic, chemical, biological or nuclear. -Embedded or intrinsic actuators to respond in a prescribed or desired way to the stimulus. -A control mechanism or selected response is available to respond to the stimulus in a predetermined way. The response occurs in a short or appropriate time and the material returns to its original state on removal of the stimulus. The purpose of this topic solicitation is to capitalize on such materials developments to enhance performance in applications to Army ground and air vehicles, armor, large structures and machine components. Proposal are sought on the development of smart materials to: -Reduce shock and vibration -Defeat armor piercing weapons -Enhance battle damage resistance -Act as artificial muscles for exoskeletons -In situ sensors, actuators and monitoring capability for a wide range of environmental conditions or more effective maintenance and life prediction of Army systems, components or equipment.

Phase I: Develop and demonstrate the feasibility of the smart material concept proposed for application to Army systems.

Phase II: Develop and deliver a prototype of the smart material concept selected in Phase I and demonstrate its effectiveness on a realistic application to an Army system.

Potential Commercial Market: Smart materials developments that enhance performance would find applications in military and civilian markets, etc.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-114TITLE: Tungsten Materials for Kinetic Energy Penetrators

CATEGORY: Exploratory Development

OBJECTIVE: Development of a tungsten-based material for use in kinetic energy(KE) penetrators to replace depleted uranium(DU).

DESCRIPTION: It is desired to replace DU in ordnance applications for health, safety and environmental reasons. The direct substitution of tungsten alloy for uranium alloy is not possible due to performance differences between the two. DU alloys, as KE penetrators, perform 5 to 10% better, depending upon test method and conditions. The performance gap has been attributed to an adiabatic (localized) shear that occurs in the DU alloy that prevents the formation of a mushroom head on the nose of the penetrator. The lack of a mushroom head allows greater penetration. Tungsten alloys that have been considered are two-phase composites in which the minor phase acts as a binder for the

tungsten phase. The binder is composed of nickel with iron, cobalt and/or copper. Several efforts have addressed the replacement of this binder with ones that should be more susceptible to a shear localization in an effort to mimic the DU behavior. These have not been successful. Further investigation into alloying, processing and fabrication of tungsten alloys/composites is necessary in order to meet the performance goal for tungsten-based KE penetrators.

Phase I: Demonstrate the proposed concept for application as a KE penetrator. Deliver scale-model penetrators for sub-scale testing.

Phase II: Scale-up processing, as necessary. Prepare Sub-scale projectiles for further testing and also develop material scale-up for full-scale tests.

Potential Commercial Market: Commercial markets include penetrators for mining and oil exploration. Other potential applications for tungsten alloys developed include sporting goods, electrical and electronic and counterweight applications.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-115TITLE: Micromechanical Measurement System for Thin Films on Polymeric Substrates

CATEGORY: Exploratory Development

OBJECTIVE: Develop a micromechanical measurement system to assess and enhance the structural reliability designed into transparent polymeric products such as canopies and windshields, vision blocks, goggles and face shields.

DESCRIPTION: Transparent organic plastics have a variety of military and civilian applications including helicopter canopies and aircraft windshields, vision blocks for vehicles, goggles for soldiers and chemical laboratory personnel, and face protection for police and riot control personnel. Unfortunately, plastic materials, specifically polycarbonates, are susceptible to scratching as well as degradation from exposure to organic solvents. Potential hardcoatings, such as diamondlike carbon and other inorganic oxides, have shown the capability of providing polycarbonate with significant enhancement in resistance to abrasion and chemical attack. The thicknesses of these high performance coatings are generally on the order of 0.05-0.1 microns, much thinner than commercially available hardcoatings. Although fabrication techniques recently developed for producing such ultra-thin film materials or coatings on temperature sensitive polymeric substrates have shown much progress, our understanding of the micromechanical properties of the interfaces at these extremely small dimensions lags far behind. A device is needed to measure the micromechanical properties to assess the adhesive strength and fracture toughness, and to evaluate the micromechanical failures of critical high performance protective hardcoatings used in Army systems. Since polymeric materials are of relatively low hardness and these ultra-thin coatings can delaminate or fail at extremely small applied loads, the proposed test apparatus should posses high resolution in the applied load and displacement measurements. The proposed system should be practical and versatile, and efficient in terms of sample preparation.

Phase I: Determine the feasibility of designing and developing a micromechanical system to effectively measure the adhesive strength and fracture toughness of ultra-thin films coated on polymeric substrates. Demonstrate the feasibility of the systems capability to achieve high resolution in the applied load and displacement measurements and to facilitate correlation of micromechanical properties with micromechanical failures.

Phase II: Develop and deliver an optimized prototype of the proposed micromechamical measurement system addressed in Phase I. Demonstrate the capability of this prototype to measure the adhesive strength and fracture toughness and to characterize the mode of failures of transparent polymer-based armors used in Army systems.

Potential Commercial Market: Development of a new micromechanical measurement system to assess and enhance the structural reliability designed into individual protection transparencies products for military and commercial markets. Prospective product applications include: canopies and windshields, vision blocks, goggles and face shields.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-116TITLE: Ambient-Temperature-Storable Thermoset Resin

CATEGORY: Exploratory Development

OBJECTIVE: Develop an ambient-temperature-storable thermoset resin system that does not require refrigeration or special handling and maintains its properties over a six-month minimum storage period.

DESCRIPTION: Structural polymer composites today use either a thermosetting or thermoplastic matrix, the large majority being thermosets, such as epoxies and polyesters. One of the most attractive advantages of thermoplastics (and conversely one of the least attractive aspects of thermosets) is an unlimited shelf life at ambient temperature. From a practical logistics standpoint, this feature is superb. It eliminates the task of ratio mixing the resin components and, more importantly, eliminates the need for refrigeration and special handling. On the other hand, thermosetting systems are much easier to process, making them the more popular matrix resin system despite the fact that they have a limited shelf life (even when refrigerated). A mixed, ready-to-use thermoset resin that does not require refrigeration or special handling, with properties similar to current resin systems, would be an important practical advantage to the military and industrial community. Some potential approaches to the solution include a scheme for keeping the reactive chemical components physically separated in the mixed state, or a chemical scheme whereby a third party chemical additive blocks the curing reaction.

Phase I: Identify the most promising approach to meet the objectives. Demonstrate clear feasibility of the selected approach to allow a mixed thermosetting resin system to meet a specified 72 degrees Fahrenheit, six-month storage requirement. Supply samples of the resin to the Army for evaluation.

Phase II: Fully develop the most successful approach in Phase I and formulate the resin system. Clearly demonstrate the capability of the resin system to meet the storage requirements, cited above, followed by chemical and physical property evaluations. The cured resin properties must be similar to those of current elevated-temperature-cured structural systems. Supply resin and glass cloth preimpregnated with the resin to the Army for evaluation.

Potential Commercial Market: A ambient-temperature-storable thermoset resin would find wide applicability throughout the composites community because of the cost savings involved in reduced waste and the availability of reliable thermoset resin systems.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-117TITLE: Bonding of Ceramic Materials for Structural Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop a bonding technique suitable for a variety of technologically important ceramic materials which will allow them to be bonded together and used in elevated temperature (greater than 1000 degrees centigrade) applications.

DESCRIPTION: As monolithic and composite ceramics are used in high temperature applications, such as engines and exhaust systems, there is a growing need to be able to bond similar and dissimilar ceramics materials to each other. While a variety of joining techniques already exist, e.g., microwave joining or joining by slurry at either the green body stage or after firing, they typically have at least one drawback, such as: (1) they are limited to the bonding of two very specific materials, and/or (2) the resulting joint greatly limits the elevated temperature mechanical properties.

Phase I: Demonstrate a bonding technique which can be employed to join both oxide and non-oxide ceramics, as well as both similar and dissimilar compositions (ceramic materials to be joined can be either monoliths or composites). Any degradation of the mechanical properties of the bonded system, when compared to the properties of the unbonded material(s), must not be greater than five percent at temperatures ranging from 20 to 1300 degrees centigrade. The surfaces to be bonded must be at least 1/2x1/2-inches in dimensions.

Phase II: Optimize and scale-up the technology to effectively bond larger surface areas and complex surfaces and produce component demonstration pieces. Demonstrate the processability and reproducibility of the joining techniques for both an oxide and a non-oxide ceramic system, when joining both similar and different compositions.

Determine the mechanical properties of the bonded materials at temperatures ranging from 20 to 1300 degrees centigrade.

Potential Commercial Market: The ability to bond ceramics would have applications in two areas. First, complicated ceramic shapes, which cannot be mass produced reliably and which are prohibitively expensive to machine, can be produced by bonding together simpler shapes. Secondly, as ceramics play a larger role in areas such as engines and exhaust systems, different ceramic materials will be used for different components due to the requirements of the applications. There will be a growing need to be able to reliably join these components together.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-118TITLE: Nondestructive Method for Detecting Chemical Warfare Agent Contamination of Composite Materials

CATEGORY: Exploratory Development

OBJECTIVE: Develop a nondestructive method for detecting and identifying chemical warfare agent contamination of organic matrix composite structures.

DESCRIPTION: Fiber reinforced organic matrix composite materials are finding increased use in structures for Army applications. One of the threats facing Army materiel in the field is contamination by chemical warfare (CW) agents. Although these agents are delivered in the form of small droplets, they represent considerable danger to personnel. Undetected agents on the surface are an immediate hazard. Subsequent decontamination treatments may or may not completely neutralize them. In addition, agents may diffuse into the organic matrix. Surface decontamination may not neutralize interior agents, which can then diffuse back to the surface after days or weeks to recontaminate the surface, unbeknown to personnel. A nondestructive evaluation (NDE) technique is needed to alert personnel to dangerous CW contamination on the surface or just beneath the surface of composite materials. Critical regions of the structures must be scanned, perhaps by an optical or spectroscopic means or by generation of surface color changes by an applied detection medium. Next to be performed could be local heating of the surface by a hot air gun or radiant energy source, followed by scanning as above, to reveal any significant subsurface contamination. The proposed NDE system must be field-portable, easy to use, environmentally benign, and not harmful to the composite materials.

Phase I: Demonstrate the feasibility of detecting and identifying surface and subsurface CW contamination of organic matrix composite materials of potential use to the Army. The technique should be nondestructive and should provide a means for scanning selected areas of the composite structure.

Phase II: Develop and deliver a field-portable NDE prototype system as proposed in Phase I. Demonstrate the capability of this prototype to detect and identify surface and subsurface CW contamination of composite structures.

Potential Commercial Market: A new field-portable NDE system to detect and identify CW agent contamination of organic matrix composite materials.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-119TITLE: Novel Approaches to Bond Quality Nondestructive Evaluation

CATEGORY: Exploratory Development

OBJECTIVE: To identify and demonstrate the feasibility of previously unexplored methods for the nondestructive evaluation (NDE) of adhesive bond quality, both as initially fabricated and as a function of service in extreme (hot/wet) environments. Bond quality implies at least a semi-quantitative indication of bond strength.

DESCRIPTION: At present, a major barrier to the optimum utilization of adhesive bonding as a joining method in primary structure in Army materiel is the absence of a NDE technique capable of indicating bond quality and thus, structural integrity. The extent to which this is a barrier may be judged by the position taken by the aerospace community: "IF YOU CAN'T INSPECT IT, YOU CAN'T FLY IT." Current techniques, such as ultrasonic inspection and infrared(IR) thermograpy, are capable of detecting voids and delaminations, but these defects usually have little to do with bond quality. An extreme case in this regard is the so-called "kissing bond" in which there is intimate contact between adhesive and adherend, but no bond exists. This condition cannot be detected by current methods. Since bond

strength is determined by and deterioration most often occurs in the interphase region of a bond, techniques which can provide information as to the physical, mechanical and chemical properties of this region are required as a basis for new approaches to bond quality NDE. Instruments/equipment to be derived from any such new approach must be factory as well as field deployable.

Phase I: Identify a particular approach to be taken and show feasibility by demonstrating a strong correlation between predicted bond quality for a range of appropriately flawed test specimens and the results of destructive testing of these same specimens. Both initially fabricated and hot/wet aged conditions should be addressed.

Phase II: Develop and deliver an optimized version of equipment based on the approach demonstrated in Phase I. Conduct both factory and field demonstrations of appropriate prototypes.

Potential Commercial Market: There is a major market in the commercial aviation sector for an instrument capable of bond quality NDE.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-120TITLE: Ion Beam Modification of Polymer Surfaces for Chemical Protection Applications

CATEGORY: Exploratory Development

OBJECTIVE: Modify the surface/subsurface of plastics and elastomers using ion beam technology to enhance chemical resistance and reduce chemical vapor permeation.

DESCRIPTION: Chemical resistance and organic vapor permeation in polymeric materials is affected by a number of factors, such as mean free volume, surface functionality, cross-link density, surface wettability, and solubility of the organic penetrant in the polymer, to name a few. Ion beam modification of polymers has been shown to affect all of these properties to various extents. There is often a trade-off made when chemical resistance is required, in that other polymers with less desirable physical properties are selected. Ion beam modification may provide enhanced chemical resistance without altering bulk physical properties. The process will not suffer from bond delamination, as chemical resistant coatings can, since ions are implanted below the surface and become a permanent part of the material. For an ion beam modification technique to be successful, many beam conditions would need to be explored and optimized. New instrumentation may need to be constructed to process numerous end-items, with complicated shapes.

Phase I: Demonstrate the small-scale utility of ion beam processing to the enhancement of chemical resistance and/or the reduction of chemical vapor permeation rates/breakthrough times for plastics or elastomers.

Phase II: Develop or utilize large-scale ion beam equipment capable of rapid, inexpensive implantation of polymeric end-items with potentially complex shapes.

Potential Commercial Market: Provide enhanced surface resistance to chemical attack and vapor permeation for elastomers and plastics using ion beam surface preparation. Applications exist for medical, petroleum and other industrial fields that utilize polymers for chemical resistance/protection.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-121TITLE: Functionally Gradient Materials for High-Temperature and Severe Environment Structural Applications

CATEGORY: Exploratory Development

OBJECTIVE: Design and develop an effective fabrication technique to produce a selected metal/functionally gradient material(FGM)/ceramic system suitable for structural applications.

DESCRIPTION: Severe service conditions, including high temperature differentials and high thermal stresses, warrant the development of high-performance materials to join metals and ceramics. Example applications include a protective shield in a corrosive engine environment and a heat shield in space planes, where the surface temperatures can reach 1800 degrees centigrade and an oxiding environment exists. A ceramic layer on a structural metal imparts desirable heat-, abrasion- and corrosion-resistant characteristics to the structure and allows it to be used in more severe environments. Pairing a ceramic with a metal leads to various processing problems including: wetting and bonding of the metal to the ceramic, interface reactions, and a mismatch between the thermal expansion coefficients of the

materials which leads to residual stresses. The prospects of using FGM's as a solution to these problems has generated much excitement, but an effective, practical, reliable and affordable fabrication technique needs to be developed to implement the technological development.

Phase I: Target a specific application and environment and select an effective metal/FGM/ceramic system. Demonstrate the feasibility of fabricating such a system and assess the economics of industrial production. The demonstration should include a testing program suitably outlined to measure/examine the system's structural integrity/reliability and properties after repeated exposure to the targeted environment, i.e., thermal cycling or exposure to corrosive propellants.

Phase II: Develop and fabricate the proposed system addressed in Phase I. Demonstrate the capability of the system by producing and performing validation tests on optimized samples of the selected metal/FGM/ceramic system. Deliver the samples to the Army for additional evaluation.

Potential Commercial Market: A new fabrication technique to increase the reliability of joining ceramics to metals to withstand severe environments in high performance structural applications in military and commercial markets.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-141TITLE: A Device for Inserting Discontinuous Through-The-Thickness Reinforcements in Thick Dry Fiber Preforms

CATEGORY: Exploratory Development

OBJECTIVE: To Develop a Single Barrel gun that will shoot Through-The Thickness (TTT) reinforcement rods through thick dry fiber preforms. The concept developed shall be extendable to multibarrel configurations.

DESCRIPTION: General - Damage tolerance and fabrication cost are driving issues in the design of composite primary structure. Some success has been achieved in the reduction of fabrication cost by utilizing textile technology to produce dry fiber preforms. Improvements in damage tolerance is achievable through toughened resigns and through-the-thickness (TTT) reinforcement. Methods of producing TTT reinforcement are stitching and tufting and integral weaving of braiding. The integral weaving or braiding of preforms with TTT reinforcement is applicable to a limited range of structure. Stitching and tufting have been only applied to flat or structures having slight curvature, such as wing skins. Stitching has typically been limited to preforms of less than an inch of thickness. Stitching is a slow method of inserting TTT reinforcement. For example on a typical wing skin of a commercial transport wing using a nominal stitch density of 60 stitches per square inch, 4 to 5 million stitch penetrations are required. utilizing a state-of-the-are multi-needle machine operating at 1hz required hundreds of hours to stitch a single wing skin. Furthermore, a thick stitched structure must be stitched to final shape because the stitched preform will not readily conform to other shapes without severely distorting the inplane fiber architecture of the preform. An alternate approach to stitching as a method of TTT reinforcement is to shoot a discontinuous rod (possible a cured composite rod) through the thickness of the preform. The technique envisioned is similar to a nail gun used in building construction. In this case instead of a fixed length nail, a continuous supply of rod would pay out, cut and loaded into the gun. Depending upon the thickness of the preform, its permeability and the type of fibers in the preform, the propellant (probably air) would be adjusted and the rod shot into the preform. A fully-automated high-speed, multi-barrel gun of this type would have many advantages over current stitching method of TTT reinforcement. Preforms could be assembled and debulked on the infiltration and curing took prior to the insertion of the TTT reinforcement. This would reduce the manipulation of the preform between stitching tools and infiltration and curing tools. It would also eliminate the need for stitching tools. Preforms having complex shapes and curvatures could be accommodated whereas this is not the case with stitching. Furthermore, preform thickness would not be an issue with a gun system. A gun system could be operated at rates approaching a machine gun firing rate which would reduce the time required to reinforce a large preform. The discontinuous nature of the rod TTT reinforcement eliminates the bending of inplane fibers which reduces compression strength of stitched composite laminates.

Phase I: Design, build, and demonstrate a single barrel gun for TTT reinforcement.

Phase II: Build and demonstrate a fully-automated high-speed, multi-barrel hun for TTT reinforcement.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-142TITLE: A Variable Geometry Reed For Weaving Biase Directional Fabric That Has Variable Width

CATEGORY: Exploratory Development

OBJECTIVE: To design and fabric a reed for a loom whose reed dent wires can be arranged in such a manner as to simultaneously tailor the fiber orientation and shape of the fill yarn and the width of the fabric. If it is anticipated that this modified reed will require substantial computer control.

DESCRIPTION: Reduced fabrication cost and structural weight can be achieved in a composite structures through the development of advanced structural concepts. These advanced concepts are producible utilizing textile technology provided it is possible to change the angles to the warp yarns. When the fill yarn is inserted into the shed formed by the warp yarns and beatup into the fabric, the fill yarn conforms to the surface of the reed's dent wires. If the woven fabric is a unweave construction where the warp yarns represent only a few percent of the total yarn in the fabric, then the fill yarns are the only structural yarns in the fabric and the width of the fabric is controlled by the spacing of the warp yarns. Therefore, the reed plays a major roll in defining the architecture of the fabric. If it is possible to simultaneously change the shape of the reed during the weaving of a fabric, a significant cost and weight benefits could be achieved.

Phase I: Design and fabric a prototype reed for a loom whose reed dent wires can be arranged in such a manner as to simultaneously tailor the fiber orientation and shape of the fill yarn and the width of the fabric.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-144TITLE: Algorithmic Aspects of Computational Terminal Ballistics

CATEGORY: Basic Research

OBJECTIVE: Improvement in the quality, reliability and performance of computational terminal ballistic simulations, focusing on the accuracy of material flow and failure algorithms. These simulations are characterized by conditions of large deformations, very high deformation rates, shock pressures and temperatures to a substantial fraction of melting.

DESCRIPTION: The performance of modern armor/anti-armor systems hinges upon the complex and often ill-understood flow and failure behavior of exotic materials (e.g., heavy metal alloys, advanced ceramics, energetic materials) loaded under conditions of ballistic impact. Areas of concern for large-scale terminal ballistic simulation include but are not limited to: physically-based penetrator/target interface erosion algorithms, physically-based algorithms for computation of behind armor debris, contact algorithms ported to massively parallel computer architectures, physically-based damage models for ductile and brittle materials, algorithms for the initiation of energetic materials, algorithms to handle phase changes and mathematical change of type in the governing equations.

Phase I: A successful effort will provide a description/analysis of algorithm(s) addressing one or more of these or related problems and a trial implementation in a 2D terminal ballistic code.

Phase II: A successful Phase II will demonstrate utility of the improved algorithm(s) implementation in a 3D terminal ballistics code approved by Army researchers. Demonstration of utility will involve comparison with relevant physical experiments.

Potential Commercial Market: This work is relevant to the simulation and modeling of high-rate forming and machining operations and for simulation of impact response of materials.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-145TITLE: Material Modeling in Computational Terminal Ballistics

CATEGORY: Basic Research

OBJECTIVE: Improvement in the quality and reliability of computational terminal ballistic simulations, focusing on better experimental characterization and analysis of material flow and failure response. These simulations are characterized by conditions of large deformations, very high deformation rates, shock pressures and temperatures to a substantial melting.

DESCRIPTION: The performance of modern armor/anti-armor systems hinges upon the complex and often ill-understood flow and failure behavior of exotic materials (e.g., heavy metal alloys, advanced ceramics, energetic materials) loaded under conditions of ballistic impact. This loading environment is characterized by very large strains, strain rates and stresses experienced at temperatures from ambient to a substantial fraction of melting and over a wide range of pressures. Areas of concern for large-scale terminal ballistic simulation include but are not limited to: 1). Novel experimental techniques to characterize material response under CONTROLLED conditions approximating the ballistic impact environment. Such tests would feature high-rate biaxial loading with independent stress/strain measurements in both directions, nonproportional load paths, sudden changes in load path direction. 2). Novel techniques to excite particular material flow and failure modes such as ductile deformation twinning, shear banding, void growth, brittle compressive cracking, faulting, comminution, granular flow. Characterization of the macroscopic mechanical response of the material during such experimentation is essential.

Phase I: A successful effort will provide a description and analysis of proposed experimental technique(s) addressing one or more of these or related problems. The analysis should indicate that the proposed technique has particular relevance to the above noted concerns.

Phase II: A successful phase II will demonstrate that the proposed techniques are capable of generating useful material characterization data for at least one relevant in the class of materials to which the technique applies.

Potential Commercial Market: This effort is relevant to critical materials characterization and evaluation and is of interest to high-rate forming and machining modeling and simulation.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-150TITLE: Advanced Lightweight Armor Concepts

CATEGORY: Exploratory Development

OBJECTIVE: Develop an innovative approach to armor design which will decrease weight of helicopter armor.

DESCRIPTION: Helicopter armor weight has been reduced significantly over the past 20 years, however, the need for further weight reduction remains in order that more coverage and therefore more protection can be provided to helicopter aircrews where weight is very critical. The current state of the art armor has evolved through the use of improved ceramics and backing materials laminated together to reduce the areal density or weight of the armor. There are ongoing research programs to attempt to reduce these armor weights even further by varying the ceramics and backing materials through new design or fabrication techniques. A need exists for a research program to be conducted in the area of lightweight armor which addresses innovative approaches to armor design. Some innovative design approaches may be spaced armor design, fluid layers, or use of new exotic space age developments. A detailed discussion of the design approaches to be studied shall be presented along with any fabrication or test data available.

Phase I: Develop armor design concepts which demonstrates potential for substantial weight reduction by utilizing new and innovative material and fabrication techniques.

Phase II: Fabricate samples of the armor design developed in Phase I and conduct ballistic tests to determine if armor shows any potential against specific threats.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-159TITLE: "More Electric" Advanced Magnetic Materials

CATEGORY: Exploratory Development

OBJECTIVE: Develop magnetic materials which possess a minimum energy product of 60 MGOe with minimal hysteresis and eddy current losses, good strength characteristics, and high temperature (200 degrees F) capability. Development of this technology has the potential to reduce the Army's O&S costs by reducing electrical/mechanical replacement costs.

DESCRIPTION: Several studies for military and fixed-wing aircraft indicate that the More Electric approach has the potential for substantial improvements in weight, fuel savings, reliability, severely limiting true benefits of the "electric" approach is magnetic materials. Advanced higher flux materials will increase torque capability while dramatically reducing packaging volume, weight, power required, and cooling requirements in such systems as starter/generators, electromechanical/electrohydraulic actuators, and magnetic bearings for turbine engines.

Phase I: Develop a magnetic material which will have a minimum energy product strength of 60 MGOe while exhibiting very low hysteresis/eddy current losses, high physical strength, and high temperature (200 degrees F) capability.

Phase II: The magnetic material in Phase I will be incorporated into a proof-of-concept, high-torque aerospace electromechanical actuator or electrohydraulic actuator, or aerospace generator. The appropriate parameters will be defined. Baseline contemporary materials will be compared to the material under investigation in a parametric analysis. Performance of the magnetic material in the motor will be demonstrated and compared to a baseline system.

Potential Commercial Market: This technology offers enormous potential for various commercial markets involved with electric motors, generators, and actuators.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-167TITLE: Affordable Development/Rapid Prototyping of Complex Aircraft Components

CATEGORY: Exploratory Development

OBJECTIVE: Develop a design/manufacturing system which can rapidly generate a functional model of an aerodynamic or mechanical component which can be subjected to limited performance testing.

DESCRIPTION: Due to the complexity of modern weapons systems, the time and costs associated with their successful development and qualification are rapidly becoming unaffordable. A revolutionary improvement in affordability could be realized if a prototype model of critical system components could be rapidly produced and subjected to proof testing. Furthermore, the ability to conduct early tests would allow many more iterations of a design to be conducted, thus improving reliability and allowing early incorporation/evaluation of maintainability features. The 3-D solid models available using stereolithography, currently the most popular rapid prototype method, have very poor strength, ductility, surface finish and dimensional stability over time. An advanced process or technique which significantly improves these deficiencies and provides high temperature (150-250 deg F) strength and ductility is desired. Fabrication of the model from ceramics, powdered metals, high-quality photoelastic materials or high-strength engineering plastics would potentially improve some of these limitations. It is desired that these models (scaled or full scale) be suitable for airflow, vibration, and potentially, heat transfer and limited structural testing. For example, scale models of compressor rotors, gearbox housings and structural mounts for electronic sensors can currently be produced in less than ten hours using stereolithography. Due to the limitations of the model material and the relative accuracy versus the actual part, the model is unsuitable for testing.

Phase I: Develop a design for a rapid prototyping system capable of producing solid models suitable for limited functional testing. The system should be able to utilize geometric data from currently used computer aided design (solid modeling) systems. The system should produce models with strength, dimensional accuracy, and thermal stability significantly above those currently available using stereo lithography. The effect of process variations on accuracy and stability shall be determined. Unique technical aspects of the system design should be demonstrated by bench testing. Results of this testing will be used to evaluate the concept's potential for successful development. Small gas turbine engine components such as cooled turbine blades, compressor rotors/blades along with aircraft structural components such as weapons and sensor installations and environmental control systems installations are of primary interest.

Phase II: A detailed design of the entire rapid prototyping system shall be conducted. A prototype of this system shall be fabricated. Small gas turbine engine or airframe manufactures shall be contacted to obtain trial part geometries. Several different trial parts shall be prototyped and subjected to functional testing. The ability of these tests to reproduce the component performance characteristics shall be evaluated.

Potential Commercial Market: If successful, the technology resulting from this topic would be applicable to a vast array of commercial products/markets. Companies producing aircraft, ground vehicles, gas turbines, internal combustion engines, electric motors, and many other commercial and residential products involving mechanisms and/or energy conversion would greatly benefit. All the major producers of the above products employ rapid prototyping systems to some degree in their current development activities. A system with the advantages to be developed by this topic would allow these companies to drastically reduce the time and cost of bringing new, high-quality products to market. A direct competitive advantage would be gained by companies utilizing this technology.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-179TITLE: Reduced Weight Power Generation and Air Conditioning Units to Improve Army Mobility
CATEGORY: Exploratory Development

OBJECTIVE: To improve Army mobility without reducing mission equipment.

DESCRIPTION: With the Army becoming more mobile it is essential that the weight of all operational equipment be optimized to allow the use of the smallest possible carrier. The best method for providing power and air conditioning for a mobile operation is to take full advantage of the carrier engine and batteries. This means that the carrier engine should run an air conditioner and a high capacity battery charger system to provide operational power and air conditioning (Army ambulances have such a system). However, in situations where full power from the engine is required by the carrier for transport or in situations where it is not practical or fuel efficient to run the carrier engine, an on-board auxiliary power and air conditioning unit is needed to provide DC power and air conditioning. The DC generator and air compressor could be belt driven to optimize engine size, rating and weight. An electrically controlled

hose and valve system should be used to utilize existing air conditioning components, including the evaporator and air handling systems. The shelter power distribution system would be from a common DC buss. This approach for providing on-board power and air conditioning for mobile operations provides equipment redundancy and should assure a high availability for power and air conditioning without having to tow trailer mounted generator sets. It should provide the maximum weight allowance for mission equipment. It would have an added advantage of eliminating separate DC power supplies now required for much of the typical communications equipment and allow the vehicle batteries to be used for an uninterrupted power supply. A 30 percent decrease in the weight and fuel consumption of the APU might be realized.

Phase I: Preliminary design and breadboard testing of the power generation air condition system.

Phase II: Detail design, packaging and fabricating, installation and testing of complete system.

Potential Commercial Market: limited procurement of test quantity and field testing, before type classifying. This effort addresses S&T Thrusts in Advanced Land Combat and the Star 21 focal values of electric drive technology.

OSCR: 1, 4 and 6 Erosion/Wear and Fatigue improvements; Improve the life of components or systems through corrosion/material improvements. New technologies which reduce generator/battery size, improve the efficiency of the power generation/storage system, and/or provide alternate power sources which reduce logistics burdens will be considered under this topic. Fuel Consumption determines the Army's costs for fuel and its distribution. Significant reductions in fuel consumption or policy/procedure changes are needed.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-189TITLE: Direct Optical Fiber Glass Formation Techniques using Chemically and/or Physically Removable Filamentary Substrates

CATEGORY: Advanced Development

OBJECTIVE: To develop a process for the manufacture of optical glass fiber, and more specifically relates to a novel process in which glass precursor coatings are formed on a continuously moving filamentary core of material which is removed from or becomes an integral part of the ultimately formed optical fiber.

DESCRIPTION: Conventional preforms require complicated processing steps and repeated batch-type handling and increase the cost of the ultimate fiber. Thus, the preform may constitute 75% of the cost of the fiber. Furthermore, since fiber is drawn from a rod of given volume, the length of the fiber which can be drawn is limited. This increases the number of optical couplers and amplifiers needed to connect a number of relatively short segments into a very long signal path. An optical fiber shall be formed by continuously coating a precursor core filament with a glass-forming coatings. The precursor's volatile host shall be continuously moved from a storage reel through a coating station. The filament shall be moved through a stationary glass-forming station and continuously processed to convert the coating to a glass, with the core either removed from the fiber during glass forming or becoming an integral part of the ultimate fiber during glass forming. The glass fiber shall be densified in a continuous process. The fiber shall be provided with a protective coating as it moves through a stationary coating station and the completed optical fiber is continuously reeled.

Phase I: A thorough investigation of state-of-the-art processing for volatile organic fibers or filaments that will allow for sol-gel glass coating to be vitrified on to a volatile host into an optical silica glass fiber having the low optical loss and high mechanical (tensile strength) equivalent to its conventional fiberizable glass preform.

Phase II: Will continue on-going R&D efforts of phase I aimed towards the production and commercialization of low cost optical glass fiber.

Potential Commercial Market: This process shall eliminate the expensive fiberizable glass preforms used in military and commercial applications for communications systems. It will also utilize domestic U.S. materials for processing a non-preform fiber which currently depends on foreign sources.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-225TITLE: Synthesis of Conducting Polymers for Screening in the Microwave Region of the Electromagnetic Spectrum

CATEGORY: Exploratory Development

OBJECTIVE: Produce conductive polymers which are environmentally stable, non-toxic, and less expensive than those currently synthesized. When used as a military screening smoke, these materials will screen in the infrared (IR) and millimeter wave (MMW) regions of the electromagnetic spectrum.

DESCRIPTION: The Army is looking for a novel way to make conductive polymers as obscurant materials. These materials could be produced by inducing conductivity in off-the-shelf commercially available non-conductive polymers. Currently available conducting polymers (e.g., polyacetylenes or polydiacetylenes) are brittle, not air stable and oxidize rapidly when exposed to air.

Phase I: Would consist of determining existing non-conductive polymers that could be used as a military obscurant for IR/MMW screening and explore methods to increase conductivity.

Phase II: Would produce conducting polymer materials from non-conductive, commercially available precursors by heating in an electrical field to induce conductivity. This process could be applied to a polymer coated metal or non-conductive substrate.

Potential Commercial Market: Proposed commercial potential for the materials include lightweight conductors, battery electrodes, solar cells and semiconductors.

TECHNOLOGY CLUSTER: A-1

TOPIC: A93-266TITLE: Alternative Manufacturing Techniques for MMW Mechanical Assemblies

CATEGORY: Exploratory Development

OBJECTIVE: This project will develop the production process necessary for the development and application of superplastic deformation techniques that are capable of providing the stringent mechanical dimensions and tight tolerances required at millimeter wave frequencies.

DESCRIPTION: Superplasticity is a unique phenomenon of large neck-free elongations. Laboratory elongations as high as 5500% have been reported, although elongations in the range of 300% to 1500% are more common in production applications. Alloys which exhibit this unusual ductility have a very low flow stress are easily deformed in compression. To this date, commercial and military applications of superplastic forming/forging techniques have been limited to making exotic and complicated aircraft structures which require large percentages of elongation. This project has the potential to revolutionize the manner in which small complicated and arduous features such as those found in millimeter wave seeker sensors are produced. This high rate, low cost, production process, once developed, will virtually eliminate numerically controlled machining of mechanical RF components in all Navy, Air Force, and Army missile systems regardless of frequency.

Phase I: The initial phase of this effort will be a producibility analysis of two millimeter wave seeker sensors (one a Ka-Band and one W-Band Seeker Sensor). This producibility analysis will define the mechanical tolerance requirements, surface finish, geometrical shape, and desired electrical characteristics, definition of requirements for the superplastic alloys and lubricant selection analysis of fabrication methods, special tooling requirements, special test fixtures, initial die design, mechanical tolerances and necessary draft angles for ease of release.

Phase II: The second part of this effort will be to develop and establish production processes for the selected superplastic alloys and lubricants. Manufacture "Most Arduous Features" dies based on FEM/AGM analysis and simulation. Manufacture blanking and sizing dies for all seeker sensor elements. Separately manufacture and test all elements of the seeker sensor. Included will be such items as the development of a pilot production line, the design fabrication of prototype production equipment, the development of new production techniques, the development of quality control parameters, and the development of cost schedules.

Potential Commercial Market: Collision Avoidance Radar Modules for aircraft and automobiles.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-268TITLE: Integration Of Reliability, Maintainability, And Product Life Of Missile Systems With Affordable Technology

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-282TITLE: Multispectral Camouflage Printed Uniforms

CATEGORY: Exploratory Development

OBJECTIVE: To produce a combat uniform with camouflage properties in at least three areas of the electromagnetic spectrum. The uniform will have a minimum of visual, near-infrared (NIR), and thermal-infrared (IR) camouflage properties, and if possible, will also include radar-absorbent properties.

DESCRIPTION: Current combat uniforms provide camouflage protection in the visible [400 nanometers (nm) and 700 nm] and NIR [600 nm to 900 nm] regions of the spectrum. With the advancement of technology, thermal imagers, radar sensors and multispectral sensors have become an increasing threat to the individual soldier. A means to camouflage the soldier against these sensors must be developed.

Phase I: Phase I will apply a thermal disruptive camouflage pattern, consisting of various emissivities, to a textile substrate. Care should be taken to choose coatings, dyes or pigments that will not interfere with the visual and NIR properties of the uniform. If possible, the thermal IR properties will be integrated into the pigments used to print current camouflage printed uniforms.

Phase II: Phase II will consist of successfully integrating the thermal disruptive pattern with a visual disruptive pattern and NIR camouflage on a textile substrate (such as cotton, nylon/cotton, and Nomex, blends) while complying with a military cloth specification used for combat uniforms. Upon successfully applying the patterns to one textile substrate, the contractor shall work to apply the patterns to other textile substrates used in combat uniforms. Once this is completed, if possible, radar-absorbent properties will also be integrated into the materials. A minimum of 50 yards each of three multispectral materials (best effort) will be furnished to the government, each being on a different textile substrate.

Potential Commercial Market: This technology can potentially be used in clothing for undercover narcotics, CIA and FBI agents. The technology could also be used as a means of labeling objects, such as circuit boards, which are to be examined by thermal imagers for problem areas.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-285TITLE: Materials and Manufacture Methods for Chemical Protective Gloves

CATEGORY: Basic Research

OBJECTIVE: Develop easily producible gloves that would have enhanced durability and resistance to chemicals.

DESCRIPTION: Due to its excellent low temperature properties and conformability, silicone rubber would be the material of choice for military applications where flex and fit are important for wearability, or where flexibility is essential at extreme temperatures (protective gloves, clothing). Unfortunately, silicone rubbers have very poor barrier properties to chemical warfare agents. Similarly, other elastomers have desirable characteristics for CP gloves, such as fuel resistance (nitrile and epichlorohydrin rubbers), or ozone resistance (EPDM elastomer), but do not provide the necessary resistance to CW agents. Using a process called chemical grafting, it may be possible to modify the surface of elastomeric gloves and thus enhance their chemical resistance. This technique, which could be used as a finishing step in the manufacturing process, involves the attachment of selected monomers with desirable properties to a backbone substrate through the growth of "whiskers". The effectiveness of chemical grafting has been proven through property modification of gloves for medical applications. In addition to chemical protection, it may be possible to improve durability, and also flammability and petroleum, oils, and lubricants (POL) resistance.

Phase I: Phase I will develop a method to modify the surface of commercially available protective gloves, fabricated from a variety of elastomeric materials, and determine mechanical properties and chemical resistance of the modified gloves. A report should include comparisons with the unmodified gloves, as well as with butyl rubber gloves which are currently used for chemical protection (MIL-G-43976C).

Phase II: Phase II will optimize the process and demonstrate the producibility of improved gloves by manufacturing 500 pairs of surface-modified gloves from each of the three most promising elastomers, in each of two sizes and two thicknesses.

Potential Commercial Market: Gloves for protection from hazardous chemicals.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-287TITLE: Improved Ballistic Protective Material System(s) for Integrated Multiple Threat Protection
CATEGORY: Exploratory Development

OBJECTIVE: Develop novel material technologies for improved, light- weight ballistic protective armor systems for integrated multiple threat protection (fragment, small arms).

DESCRIPTION: Fragmenting munitions are identified as the primary threat to the infantry soldier. However, as the world scenario changes, the type of ballistic protection offered to the individual soldier must be adaptable to a change in threats. Certain Army elements are already specifying upgraded protective requirements and are suffering the penalties of available material systems. Current technologies for small arms defeat are heavy and bulky and tend to be threat specific. Significant advancements in the ballistic protective materials area are necessary to develop a lightweight armor material system to provide protection from high velocity small arms rounds, which can be integrated with improved fragmentation protective items. The goal of this effort will be to improve the capability of the soldier (endurance, survivability, mobility and lethality) through the development of a materials systems that will reduce

weight (30%) and minimize bulk over current small arms protective systems and that will provide or can be integrated with current levels of fragmentation protection offered by the Personnel Armor for Ground Troops vest.

Phase I: Identify and investigate novel approaches to increase/improve ballistic protection against a combination of threats, including fragmenting munitions and small arms threats (0.30 cal) with applicability to body armor applications.

Phase II: Produce and optimize selected systems, complete full evaluation (ballistic and environmental), and provide final technical report with full specification for material system(s).

Potential Commercial Market: Improved lightweight armor materials will be applicable to other military armor applications and most certainly to the civilian and law enforcement body armor market.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-289TITLE: Development and Evaluation of Unique Flame-Resistant, Insulative Battings

CATEGORY: Exploratory Development

OBJECTIVE: To develop and evaluate unique, highly efficient, lightweight, flame-resistant insulative battings for military sleeping bag and cold weather clothing applications.

DESCRIPTION: Presently, the military uses insulation for clothing and individual equipment manufactured from fiber locked (needle punched) aramid fiber when flame resistance is required. However, these materials are heavy and inefficient relative to their insulation performance.

Phase I: Small quantities of one or more unique, flame-resistant, insulative batting concepts in a minimum of four weights will be developed and evaluated. Properties measured will include thermal conductivity, flame resistance, weight, resiliency, recovery, thickness, density, launderability, and wet loft retention.

Phase II: Based on the results of Phase I, the most promising candidate(s) will be manufactured in a minimum of 100 yards in both 2 and 4 ounces per square yard weights. They will also be evaluated for the same properties as in Phase I.

Potential Commercial Market: Civilian applications for cold weather clothing including firefighters, law enforcement personnel, and campers.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-290TITLE: Biomimetic Ceramics

CATEGORY: Basic Research

OBJECTIVE: Develop an approach to mimic a process leading to the formation of structural ceramics.

DESCRIPTION: A number of studies are ongoing to elucidate the key processes involved in biological systems relative to the formation of crystalline composite materials. Key proteins and proteoglycans have been isolated and characterized. A number of approaches are also being explored to mimic this process using Langmuir systems, miscelles, and solid substrates. An approach is needed to mimic the natural process to lead towards the formation of useful structural ceramics or ceramics with useful electronic or optical properties.

Phase I: Phase I work will involve the choice of a suitable ceramic material for the work, the choice of an appropriate set of organic macromolecules and system to mimic the natural process, and the initial demonstration that useful ceramics or ceramic composites can be generated with the process. Characterization of the materials formed will be essential and must include Scanning Electron Microscopy and X-ray Diffraction analysis at a minimum.

Phase II: Phase II work will involve the optimization of the process demonstrated in Phase I, scale up of the process to produce sufficient quantities of materials for follow-on processing work, processing of the ceramics into a final product or products, and evaluation of the products against similar products formed by traditional approaches to determine benefits. A full evaluation of costs and competitiveness of the process will be required.

Potential Commercial Market: Extensive potential in structural, optical and electronic industries.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-293TITLE: Smart Membranes From New Polymer Gels

CATEGORY: Basic Research

OBJECTIVE: Identify candidate gels for membranes that have potential in a chemical protective system that responds by contraction during pH changes induced by the presence of chemical agents and water.

DESCRIPTION: Hydrated gels of polymeric ionomers have been shown to expand or contract up to 1,000 times their original volume in response to external stimuli (solvent composition, pH, electrical fields and temperature have been shown to induce dramatic contraction and expansion in gels). Membranes of these gels have never been made, and have potential in a chemical protective system that responds to pH changes induced by the presence of chemical agents and water. The problem is that the contractile gels demonstrated to date are ionomers that must be hydrated. It may not be practical to maintain a hydromembrane in a chemical protective system. The interaction of the gel with the swelling solvent is the key to the critical responses of interest. New polymer gels need to be identified that respond with large density and volume fluctuations to external stimuli. It is not known how the extent of crosslinking affects the gel's critical phase transition. The importance of the extent of gelation on critical phenomena must be explored.

Phase I: Desired results in Phase I include a) identification and selection of new polymer gels; b) demonstration of membrane construction; and c) evaluation of membrane contraction/expansion properties induced by external stimuli (pH, temperature, electricity).

Phase II: Phase II goals include a) refined membrane construction; b) optimized gel with respect to chemistry, crosslink density, critical gel point (gelation reaction); and c) tested chemical protective effectiveness with respect to temperature, humidity, agent concentration and type via diffusion measurements.

Potential Commercial Market: Health and safety industries and clothing industry (membranes have potential for environmental protection).

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-294TITLE: Dual-Ovenable, Recyclable High Barrier Polymeric Food Container

CATEGORY: Exploratory Development

OBJECTIVE: To design and develop a polymeric food container that is recyclable and reportable, and will provide individual and group military rations with a dual-ovenable reheating capability and a 3-year shelf life. To promote recyclability, the container will be composed of a monolithic material rather than coextruded, multilayered materials. The tray will provide operational and support cost savings by eliminating the trash disposal cost and continuous use of sanitary landfills.

DESCRIPTION: The TMT, polymeric Traypack and 3-year shelf life containers currently under development will partially fulfill Army and Air Force field feeding requirements for shelf stable individual and group meals. However, the reportable high-barrier materials used to construct these shelf stable containers may only be heated by hot water submersion or in microwave ovens, and are not readily recyclable. Also, trilaminate material (i.e., CPET) are commercially available but are limited to packaging frozen foods due to the limited barrier properties. By using new and improved monolithic polymeric blends, a recyclable three-year shelf life food container that may be reheated in a conventional as well as a microwave oven is attainable.

Phase I: Demonstrate the feasibility of developing a polymeric monolithic thermoformed food container and film lid material that is recyclable that will provide dual-ovenable and rations with a 3-year shelf life.

Phase II: Design and develop prototypes of a food container and lid material, and demonstrate the containers ability to be retorted, provide rations with a 3-year shelf life, reheated in both convential and microwave ovens and recycled.

Potential Commercial Market: Commercially available shelf stable foods in coextruded polymeric trays are not dual-ovenable nor readily recyclable. This technology would expand the commercial industry's product line and enhance sales by promoting the new recyclable benefit of shelf stable food containers.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-295TITLE: Oxynitride Glass Fibers

CATEGORY: Basic Research

OBJECTIVE: Development of High Strength/High Stiffness Glass Fibers.

DESCRIPTION: Oxynitride glass fibers have been shown to have a higher modulus than any other available glass fiber. Laboratory quantities of these fibers are currently available that have a strength and flaw distribution indicative of fibers which may have tensile strengths that are higher than any other available glass fiber. The potential for improved ballistic protection performance of these fibers is thought to be directly proportionate to strength and stiffness.

Phase I: Demonstrate that laboratory quantities of high strength (at least 40% stronger than Englass) oxynitride glass fibers can be produced. Economical analysis of the scale-up operation will be performed under this phase of the program.

Phase II: Scale up production to pilot plant scale operations, and demonstrate strengths at lease 75% stronger than Englass fibers. Limited optimization of the fibers for ballistic impact applications will be conducted.

Potential Commercial Market: These relatively low-cost fibers may be used in composite materials, and in civilian body armor.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-296TITLE: Ultrasonic Quilting of Insulation Batting Materials

CATEGORY: Exploratory Development

OBJECTIVE: To develop ultrasonic quilting techniques/cover fabrics for military insulative battings.

DESCRIPTION: Currently, insulation batting materials for military cold weather clothing and individual equipment are quilted between two layers of cover fabrics using thread and stitch quilting machines. This process is labor intensive and costly. Also, the stitch holes provide a source for heat leakage and fiber migration through the cover fabric. Additionally, threads can be broken by toe nails contributing to a loss of durability. Ultrasonic quilting should eliminate these deficiencies, but will require compatibility between the cover fabrics and the insulation material.

Phase I: Determine the potential for ultrasonic quilting using commercial patterns or the government offset dumbell pattern. A minimum of four samples will be manufactured by varying materials and processing conditions. The quilted material will be evaluated for thermal conductivity, weight, resilience, recovery, thickness, durability, launderability, wet loft retention, and then compared to standard stitch quilted material.

Phase II: The most promising ultrasonically quilted material configuration(s) will be manufactured in minimum of 100 yard quantities using the military off-set dumbbell pattern. They will be evaluated as in Phase I.

Potential Commercial Market: This system will provide more efficient and economical insulation material for commercial cold weather clothing and sleeping bags.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-297TITLE: Loaded Semipermeable Membranes for Chemical and Biological (CB) Protective Clothing
CATEGORY: Exploratory Development

OBJECTIVE: To develop and characterize low cost technologies that will enable sorptive and/or reactive media to be incorporated in semipermeable membranes.

DESCRIPTION: Convential semipermeable membrane/fabric systems allow the evaporative cooling process to take place, and prevent liquid and aerosol CB agent penetration; however, a separate sorptive layer, which is bulky and heavy, is required to adsorb chemical agent vapors. This layer adds unnecessary heat stress, weight and bulk to the fabric system. This proposal is aimed at developing loaded semipermeable membranes that offer full chemical, biological, and aerosol protection and are thin, lightweight, durable, low cost and minimize soldier heat stress.

Phase I: Efforts should be focused on demonstrating membrane technologies that can be used to load sorptive/reactive materials in a membrane without inactivating (poisoning) the activated carbon/reactive materials. Laboratory samples will be prepared and characterized.

Phase II: Efforts should be focused on optimizing material performance, the development of bonding techniques to woven fabrics, and the production of pilot plant quantities for uniform fabrication. This material will be bonded to protective shell and liner fabrics. Possibility of commercial-width material production will be addressed.

Potential Commercial Market: This material has potential use in protective clothing in industrial chemical and pesticide contaminated areas.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-299TITLE: Adaptive Camouflage

CATEGORY: Exploratory Development

OBJECTIVE: Reduce visual detectability of soldier in different climatic areas, and still maintain near-infrared camouflage properties inherent to the current uniforms.

DESCRIPTION: The current combat uniforms provide broad visual camouflage protection in various climatic areas. A need exists to develop a camouflage uniform system that will adapt to different background scenarios within the

same climatic area (e.g., meadows, dense brush) as opposed to a forest setting for the temperate woodland pattern Battledress Uniform (BDU).

Phase I: Demonstrate the effectiveness of using photochromic, thermochromic, or electrochromic colorants on a textile material as a means to impart the required color change to match different scenarios without jeopardizing the present durability and near-infrared camouflage properties. Data resulting from Phase I should determine the feasibility in continuing to Phase II effort.

Phase II: Develop printing patterns using appropriate color combinations of colorants selected in Phase I to design the optimum adaptive camouflage system. Selected patterns shall be printed on sufficient yardage to fabricate uniforms for field testing.

Potential Commercial Market: This technology can potentially be used in clothing for undercover narcotics, CIA and FBI agents.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-303TITLE: High Energy Laser Material Science Basic Experimental Controls Design

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-324TITLE: Large Area Passive Broadband Laser Filters

CATEGORY: Exploratory Development

OBJECTIVE: Development of an acceptable approach for a broadband filter for unity vision equipment and the successful fabrication and demonstration of a broadband filter which can be integrated and used with existing unity vision equipment designs.

DESCRIPTION: General - The U.S. Army, Navy, Air Force, and Marine Corps consider the protection of the eyes of military personnel against laser radiation to be a priority objective. The human eye is most susceptible to laser radiation in the range of wavelengths from 400 to 1400 nanameters and must be protected throughout this region. The non-visible portion of this spectral range should be denied access to the eye by fixed attenuation. Transmittance in the region from 400 to 700 nanometers must be preserved to maintain vision under all conditions of illumination. Increasing the number or width of fixed attenuation bands in the visible spectrum will result in unacceptable degradation of the transmittance of visible light through the protective material. New concepts are therefore required. The effort sought in this solicitation is for new technological approaches to protect the eyes of combat vehicle crews, when using unity vision equipment, against emerging multi-wavelength and frequency-agile lasers. The basic desired attributes of a broadband filter usable in unity vision equipment include: capable of being integrated into a unity vision device such that the resulting integrated system has good optical properties, useful durability and ruggedness characteristics, and minimal increase in the unity vision device's bulk and weight, capable of meeting minimum optical density requirements regardless of the angle of incidence of the laser radiation; capable of not interfering with normal color vision and stereo vision; response time for activation of attenuation of less than one (1) nanosecond; recovery time from attenuating condition of less than 0.1 second; visual transmittance-both photopic and scotopic-of at least 50%; capable of functioning without sources of power or input energy other than the incoming radiation; capable of operating without concentration of energy at a focal plane; capable of functioning in temperature extremes (0 degrees to 50 degrees C) and humidity extremes (0% to 100%), resistant to abrasion, salt spray, chemicals, and laser damage; and capable of fabrication in area of at least 100 square centimeters.

Phase I: The contractor shall investigate, design, and provide a proof-of principle demonstration of a broadband laser filter suitable for use in unity vision devices and meeting the requirements set forth in the project description.

Phase II: The contractor shall fabricate and demonstrate the protection approach developed in Phase I. An initial demonstration utilizing the protection approach only may be done, but a final demonstration shall be conducted with the protection approach integrated into the unity vision devices. Requirement: This project is essential for the future development of broadband filters for use in unity vision devices. The lack of a focal plane in current unity vision

equipment forces the use of unique and novel approaches in order to meet the developmental and operational requirements.

Potential Commercial Market: The approach developed under this project has potential applications for safety and health equipment needed for ocular welding systems and for optical switching components in communication and computing systems.

OSCR: This project has the potential to reduce optical equipment replacement costs due to the use of a broadband laser filter in such equipment as opposed to filters offering only discrete wavelength protection. Devices with broadband filters would not require refit or replacement as the threat changes or expands, resulting in a lower total lifetime system cost.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-327TITLE: Subsystem Research - In-Situ Multifunctional Monitoring Systems

CATEGORY: Exploratory Development

OBJECTIVE: Examine and develop in-situ systems to monitor the composite material system from material fabrication through disposal.

DESCRIPTION: Emerging combat and tactical vehicle systems are incorporating increasing amounts of composite materials in structural components. Manufacturing techniques for these composite materials are not yet fully matured. Further, once in use in a vehicle, the soundness of the composite structure cannot always be determined visually as damage within the composite material is not always evident on the surface of the material. Such damage generally requires highly trained technicians and special equipment to determine the structural soundness of the composite material. A single system to monitor the fabrication and structural integrity of the composite system must be developed. This single system would be sewn into the fabric preform (fibers), monitor the wetting (or mold fill) of the fibers by the resin (matrix), monitor the cure of the composite part, and provide continuous structural integrity monitoring for the life of the composite part or vehicle.

Phase I: The contractor will conduct a technology assessment of in-situ multifunctional monitoring systems, and expand/develop systems for use in composite vehicle structures. The government will evaluate the research and concepts to determine the potential for use in composite structures. A final report will detail the Phase I effort.

Phase II: The contractor will continue to develop the monitoring systems, fabricate a thick section composite panel with the embedded monitoring system to demonstrate the effectiveness of the design.

Potential Commercial Market: In-situ multifunctional monitoring systems support both military and civilian needs. The Composite Armored Vehicle and potential follow-on production of military vehicles with composite structures require structural integrity monitoring systems. Aircraft (Army, Air Force and Navy) make extensive use of composite materials in wings and other primary and secondary structures. Currently they require extensive laboratory nondestructive evaluation to determine structural integrity, and have no means to determine proper cure of composite parts. The automotive industry is making more and more parts out of composite materials. A method of monitoring fabrication and structural integrity would greatly enhance their use of composite materials by alleviating the liability concerns of using composite materials for primary structures.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-328TITLE: Adaptive/Tunable Composite Structures

CATEGORY: Exploratory Development

OBJECTIVE: Develop and integrate rheologically adaptive vehicle structures into Composite Combat Vehicles.

DESCRIPTION: Vehicle structures are sized to excessively high loads that occur only a few times during its service life. The result is that these designs are often times very conservative in nature. The loads may be induced by the terrain, collision with trees and other obstacles, or from ballistic events. Development of a structure that reacts/responds to these loads on demand thru the use of rheological fluids would reduce design requirements to a lower level. Damage containment would also be possible since the structure would be designed to react to peak loads. This approach leads to a more balanced and optimized design.

Phase I: Model a rheologically adaptive structure for automotive use and conduct testing to verify the approach.

Phase II: Prototype a given component that will react/adapt to given peak loads without damage. The system would respond to inputs from the Vehicle Integrated Defense System (VIDS) or a system that monitors terrain conditions.

Potential Commercial Market: This technology has application for both the military and the commercial market. It can be used in any structural application where the is a need for vibration dampening, shock mitigation, or load redistribution, such as automotive use or developing/repairing the country's infrastructure (bridges, buildings, etc.)

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-330TITLE: Joining of Composite Materials

CATEGORY: Exploratory Development

OBJECTIVE: Examine and develop new composite joining techniques.

DESCRIPTION: Presently composites are joined by fastening, adhesive bonding or resistance induction welding to form large panels, and to repair damaged panels in field locations. New innovative technique(s) are desired that will improve bonding and field operator efficiency. The joints produced must be sound and result in components with high structural integrity, joint quality and performance. The technique must also be adaptable to field (depot) level use.

Phase I: The contractor will research new techniques for joining composites to form large new panels, and/or repair damaged panels. Techniques developed must be capable of joining composites from a variety of matrices. Such composites are used in several modules, boxes for electronics, and floor beams, trusses, side panels and numerous other structural applications in the auto industry. The technique(s) recommended should allow for the introduction of intelligent manufacturing systems that could facilitate the rapid production of extremely large sized panels/joints at low costs. The technique must also be adaptable to depot level applications.

Phase II: The contractor shall demonstrate the technique developed in Phase I by joining and testing several composite panels. A detailed final report on the joining technique(s) will be prepared.

Potential Commercial Market: Commercial applications for this technique must exist in the automotive, aerospace, satellite, biomedical, and defense industries.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-331TITLE: Tribological Coatings for Wear Applications

CATEGORY: Exploratory Development

OBJECTIVE: Improve wear resistance of piston rings, cylinders, shafts, sprockets, etc. by depositing an abrasion-resistant coatings on the wear areas.

DESCRIPTION: Current practices improve wear resistance by selectively hardening wear areas in a separate operation after heat treating the base steel substrate to its final condition. By exploiting the growth in novel deposition and coating technologies, incorporate the coating process directly into the heat treatment schedule. Inexpensive diamond, carbide, nitride, boride or oxide wear coating must be deposited by reacting the metal surface with a quenching or tempering media during the base metal's normal schedule. Method must demonstrate the flexibility to produce adherent wear coatings on alloy steel substrates heat treated to a full range of conditions.

Phase I: Evaluate using gases or liquids to react with a predeposited metallic film on hot steel substates to form the hard coat during quenching or tempering, instead of making hardening a separate treatment. Deposition of the metal film prior to reaction should also occur within the normal thermal schedule. Determine what wear coating best meets Army requirements and conduct cost-benefit analysis comparing it to traditional methods like induction/flame hardening and nitriding. Deposit film on suitable substrate and form hard coat by reaction with a gas jet or liquid bath. Final report of findings with recommendations concludes PHase I.

Phase II: Optimize deposition, and head transfer variables to produce strongly adherent coatings. Test wear resistance of coatings and compare with traditional methods. Adapt reaction process and incorporate it into the quench and temper cycle of an alloy steel substrate. Demonstrate coating process and produce coatings for a full range of base metal conditions. Evaluate propulsion applications and determine if any existing specifications can be set by producing coatins in this way. End project with final report summarizing all findings.

Potential Commecial Market: Novel reactive processing of automotive transmission gears and shafts should provide superior wear at low cost. This manufacturing technology benefits agricultural, mining, petrochemical and electronic industries as the principles should apply to numerous substrates and coating types.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-332TITLE: Subsystem Research - Appurtenance Attachments for Composite Systems

CATEGORY: Exploratory Development

OBJECTIVE: Examine and develop systems for attaching hardware ranging from racks and brackets to modular armor to composite structures.

DESCRIPTION: Combat and tactical vehicles typically have all kinds of brackets, attachments and other types of hardware attached to them. In metal structures, bolting or welding these brackets or attachments for brackets is the accepted method. In composite structures, welding (as in metals) is not possible and bolting has its own set of problems (cutting the hole in the composite, the rubbing action of a stressed fastener on the softer composite, etc.). A method or set of methods for appurtenance attachments needs to be developed that at the least does not diminish the structural characteristics of the composite, and possibly adds to the capabilities of the composite structure.

Phase I: The contractor will perform a literature/vendor search for existing means of attaching hardware to composite materials. The government will evaluate the existing means and determine if any are feasible at which point the contractor will begin to develop the concept for applicability to combat vehicles. If none are acceptable to the government, the contractor will present a variety of potential methods that require further development for evaluation by the government.

Phase II: The contractor will develop the selected method(s) for use on composite materials and also investigate the methods for possible use as hard attachment points (road arms, engine, transmission, etc.).

Potential Commercial Market: With the projected further use of composites on military vehicles, a sound means of attaching hardware to the structure is required. Additionally, in the automotive industry, the move is also towards composites, and they could benefit from the developed attachment means (moldings, fenders, door handles, even hard attachment points). The aircraft industry could also benefit because of the wide variety of lines, cables, etc. that are attached to the inside of aircraft.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-336TITLE: Self-Healing Primers for Long-Term Corrosion Protection of Metallic Substrates

CATEGORY: Exploratory Development

OBJECTIVE: Develop a self-healing primer for long-term corrosion protection of metallic substrates.

DESCRIPTION: Chromium containing pigments are frequently used in corrosion inhibiting coatings for the protection of both ferrous and non-ferrous alloys. Alternatives to these traditional anti-corrosion materials are sought. Develop an environmentally begin pretreatment process to form stable, low permeability, self-healing primer layers over ferrous or non-ferrous metal surfaces. The benefits of a non-chromate corrosion inhibition method for structural metals include reduced workplace health hazards, lower pisposal costs, faster turn-around time and potentially, more environmentally durable metallic structures.

Phase I: Identify materials and processes by which self-healing, damage tolerant coating can be applied to metallic surfaces. Establish feasibility by coating metal substrate and demonstrating ability to heal and continue protecting substrate after damage.

Phase II: Phase II objectives would be to optimize self-healing coatings for specific corrosion prevention applications and to comprehensively test coating system to allow use on military vehicles.

Potential Commercial Market: In addition to paint industries, self-healing primers are a material technology benefitting commercial, recreational, agricultural, and military vehicle producers, ship builders, as well as agencies building and maintaining large metal structures such as pipelines, tank farms, refineries, bridges, port facilities and off-shore drilling platforms.

OSCR: Proposed processes lower waste disposal costs, streamline manufacturing operations and reduce necessary worker safety measures by eliminating chronium. Improved corrosion protection offered by these primers would reduce maintenance costs and improve readiness.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-338TITLE: Flexible Chemical Agent Resistant Coating (CARC)

CATEGORY: Exploratory Development

OBJECTIVE: Develop a CARC capable for use on surfaces having excessive vibrational, rotational or flexible movement.

DESCRIPTION: Current CARC is too inflexible to paint surfaces that have excessive vibrational, rotational or flexible movement (springs, torsion bars, etc.). In many of these cases, coatings and coating systems that provide inferior corrosion protection, as well as no DS2 resistance, are specified for use. By researching and developing a flexible CARC system, the army can increase the protection of the troops from chemical attack.

Phase I: The contractor will research current coating technologies through market surveys and literature searches to determine the feasibility of their implementation and adaptation to the CARC system. The government will determine, based on this research, if there is sufficient grounds for implementation into current and future vehicle systems. A final report will detail the Phase I effort.

Phase II: The contractor will continue the feasibility study of using or modifying commercially-available products for the flexible CARC system. If none exist, the contractor will experiment and develop, using new technologies, a modified flexible CARC system. The deliverables from this phase include a process application guide explaining proper application procedures and surface conditions and a final report.

Potential Commercial Market: An environmentally-friendly, CARC-compatible wood sealant/preservative will suit both military and civilian needs. This technology will insure adherence of the CARC to a wood component used on a variety of combat vehicles and other army and DoD material. Civilian applications include any currently-developed equipment requiring life cycle adherence of a polyurethane topcoat to a wood surface.

OSCR: The army can achieve large cost reductions in the area of component replacement by rendering fewer components susceptible to corrosion, thereby increasing its service life.

TECHNOLOGY CLUSTER: A-1
TOPIC: A93-341TITLE: Lightweight Carbon-Carbon Pistons for High Temperature Engines

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this program will be exploratory work on the design, development, and characterization of Advanced Carbon-Carbon (C_C) Pistons. The C-C pistons developed will be provided to TACOM for engine test bed evaluation. Modifications to the design and improvements in the processing of the piston will result in an optimum design to be used for field evaluation studies.

DESCRIPTION: The need for increased fuel efficiency, decrease in atmospheric pollution, higher operational temperatures in engines, and the requirement for a reduction in overall engine weight and size calls for advanced materials with extended service capabilities. Selected army testing of small high RPM engines has demonstrated the tendency for aluminum pistons to seize with subsequent bearing failures. C-C composites have proven to be excellent candidates for offering unique high temperature properties in addition to light weight to offset these deficiencies.

Phase I: The contractor will research and evaluate current state-of-the-art C-C technology (2D, 3D and 4D) piston designs, coatings, and production techniques; and recommend selection of a specific material and piston size for fabrication and testing in Phase II. A final report will detail the recommended C-C piston size, fabrication techniques, and provide a few demonstration samples. An economic analysis will also be performed for producing a variety of piston sizes.

Phase II: The contractor will design, fabricate, and provide TACOM with two sets of C-C pistons for engine test bed evaluation. The contractor will participate in the engine test bed effort and conduct post test characterization of the C-C piston performance. In addition, the contractor will prepare a detailed final report including all design schematics, experimentation procedures, recommended coating techniques, and characterization results.

Potential Commercial Market: Carbon-carbon composites have applications in automotive, aircraft, and aerospace propulsion industries, as well as small engine manufacturers. These applications include pistons, aerospace structures and heat shields. Fuel consumption will be reduced by 20%-25% resulting in tremendous national savings.

TECHNOLOGY CLUSTER: A-1

TOPIC: A93-345TITLE: Deformable Mirror Device Dynamic Infrared Scene Projector

CATEGORY: Exploratory Development

OBJECTIVE: Design and develop a dynamic infrared projector system for mid and long wavelengths which utilizes deformable mirror devices suitable for integration into hardware-in-the-loop simulation systems mounted on both stable and motion platforms.

DESCRIPTION: Based upon the progression of future smart weapons, imaging infrared seekers/sensors are expected to thrive as a primary technology thrust well into the 21st century. The Redstone Technical Test Center (RTTC) has determined a need for development of a dynamic infrared complex scene projection system. The system is to be used to support post-developmental hardware-in-the-loop (HWIL) simulations for testing and evaluation of infrared (IR) missile seekers/trackers as well as Forward Looking Infrared (FLIR) systems and subsystems in all scenarios. The anticipated operational and support concepts require development, implementation, and maintenance of a simulation system capable of generating and presenting complex multi-color IR imagery. Although deformable mirror technology is available, application of this technology to dynamic scene projection requires significant innovation before becoming acceptable as a viable test capability. Initially, the hardware capability will be demonstrated on a "bench-top" with continued development towards a robust, compact, flight/rate table-mountable configuration.

Phase I: Conceptual design and laboratory demonstration on a stabilized platform of a prototype projector in mid and long IR wavelengths which utilizes deformable mirror devices.

Phase II: Extension and upgrade of the laboratory demonstration prototype deformable mirror projector on a motion platform for use in all-up-round missile HWIL simulations.

Potential Commercial Market: Applications include hardware-in-the-loop simulations of infrared scenes for other defense and commercial uses of infrared sensor technology.

A-2MICRO ELECTRONICS AND PHOTONICS

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-074TITLE: Affordable Design of Electronic Structures Incorporating Resonant Tunnelling Elements
CATEGORY: Basic Research

OBJECTIVE: To conduct research on the efficient design of electronic devices and circuits using resonant tunnelling diodes.

DESCRIPTION: To provide for the efficient and affordable design of the next generation of ultrafast devices and circuits, proposals are solicited on the formulation and optimization of charge transport codes and algorithms for the efficient design of electronic devices and circuits incorporating resonant tunnelling diodes as integral parts of basic electronic components. Examples of such devices and circuits include: resonant-tunnelling-diode circuits for the frequency multipliers, parity generators and multiple valued logic, resonant tunnelling bipolar transistors for circuit applications including parity generators, multiple state memory, and analog to digital converters; and resonant tunnelling unipolar transistors.

Phase I: Will include optimization of the basic quantum transport algorithms and identification of candidate devices and systems.

Phase II: Will include design of candidate electronic devices and circuits incorporating resonant tunnelling diodes as integral parts of basic electronic components.

Potential Commercial Market: Research and development efforts under this topic have potential for commercialization in all segments of the U.S. electronics industry focussing on fast, dense devices with feature sizes less than about 500 Angstroms, including but not limited to the devices listed above under "DESCRIPTION" and circuits incorporating resonant tunnelling structures will require techniques and tools for affordable design. Without the tools and techniques identified under this topic it will be impossible to competitively design all of the high-performance devices listed above under "DESCRIPTION". The topic of this solicitation directly supports the DoD S&T thrusts of Technology for Affordability, Global Surveillance and Communications, Precision Strike, Air Superiority and Defense, Advanced Land Combat, and Synthetic Environments.

OSCR: Resonant tunnelling elements require very little power to operate and generate little heat. As a result, they will reduce electronic failure rates and result in systems which require very low power consumption, thus reducing operating costs, providing support for the Army Operating and Support Cost Reduction program.

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-083TITLE: Temperature Insensitive Laser Diode Arrays

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop, and demonstrate novel laser diode structures whose output wavelength, threshold and efficiency are less sensitive to operating temperature than conventional laser diode structures. The goal is to produce a diode array that can operate without thermoelectric coolers or other such active methods of refrigeration and still maintain output power and wavelength over a broad temperature range.

DESCRIPTION: General - The cost and weight of military systems utilizing current laser diodes are increasing by the requirement to maintain the diode output power and wavelength within a relatively narrow range over the full milspec temperature range. A new, temperature-insensitive diode is needed to reduce the cost and weight of cooling the diodes.

Phase I: Phase I should result in a theoretical assessment of threshold current density, output spectrum, and slope efficiency vs. temperature for the new structure. Proposed fabrication techniques and material growth methods should be for mass-production of low-cost diode arrays. A sample device, showing the feasibility of the fabrication and growth process, should be built, tested, and then delivered to the government.

Phase II: In phase II, several arrays will be built, tested, and delivered to the government. The testing will include output power and spectral output vs. input power and operating temperature.

Potential Commercial Market: The development of temperature insensitive diodes will have a great impact on the size and weight of military systems that use solid state lasers. This includes rangefinders, designators, laser radar, laser communications, and EO countermeasures.

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-091TITLE: Non-Destructive Optical Evaluation of Thin Layer Semiconductor Heterostructures

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop and demonstrate optical techniques applicable to the non-destructive analysis of thin layer (<200A) semiconductor heterostrucutres. Goals are to non-destructively obtain layer thickness, thickness uniformity, alloy composition, composition uniformity, dopant concentration, and concentration uniformity of the thin layers.

DESCRIPTION: General. Develop concepts for non-destructively providing information about semiconductor thin layer heterostructures composed of GaAs and InP based compounds. These structures are used to fabricate novel devices such as the high electron mobility transistor (HEMT), heterojunction bipolar transistor (HBT), and quantum well laser (QWL) which are critical components in the next generation electronic and opto-electronic systems. The device parameters are extremely sensitive to the properties of the thin layers. Being able to accurately determine these properties will enable one to optimize the device parameters.

Phase I: Should result in an analysis of an approach to non-destructively measure the critical parameters of the thin layers in a semiconductor heterostructure using optical methods. Proof of concept demonstrations of the technique is a requirement and may take the form of theoretical calculations. However, translation of the demonstrated approach must reasonably show to be applicable to an actual measurement system. Selection of a prototype will be made and approaches will be determined which satisfy objectives that are representative of device structures critical to next generation Army systems.

Phase II: A prototype measurement system will be assembled and demonstrated. The system will include optical emission and detection apparatus as well as the software necessary to interpret the data. Documentation should be made by demonstrating capabilities using device structures of interest to the Army.

Potential Commercial Market: Development of a system to non-destructively measure the properties of thin semiconductor layers would be of great benefit to the MIMIC Program which involves the use of HEMTs and HBTs in their integrated circuits for application to next generation high-speed electronic Army systems as well as high speed systems in the private sector. QWLs are evolving into critical elements in fiber optic communication systems that will be used in next generation Army systems as well as system in the private sector.

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-093TITLE: Novel Josephson Junctions for Intrinsic Voltage Standards

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the possibility of utilizing novel superconducting materials (other than those currently in use) in Josephson Junction voltage arrays as primary voltage standards, thoroughly detailing the advantages (e.g. less stringent cryogenic requirements) and disadvantages (e.g. flux trapping) of such an array. The ultimate goal is to design and build a Primary Voltage Standard using relatively inexpensive and mobile closed cycle cryogenic systems.

DESCRIPTION: General - Current primary voltage standards utilizing Niobium-Lead Josephson junction technology are mainly confined to laboratories due to their lack of mobility and need for liquid helium. New ideas for primary voltage standards utilizing Josephson junction arrays made out of novel superconductors are needed in order to lower the cryogenic requirements (to a two- or possibly one-stage closed cycle refrigeration system) and to increase the simplicity/mobility of the system.

Phase I: The Phase I efforts should be a detailed analysis of the use of several different, novel superconductors (both the traditional low temperature alloys and the newer, high temperature superconductor ceramics) for the fabrication of an array of Josephson junctions to be used in a primary voltage standard. The study should include cryogenic requirements, flux trapping difficulties, properties of their Josephson junctions, ease of manufacturability and the difficulties in fabricating a large array of junctions with uniform properties.

Phase II: In Phase II, prototype arrays using the best superconductor candidates as determined in Phase I will be fabricated. The various arrays will be evaluated under actual operating conditions and refined, as necessary, to yield the best characteristics. The array demonstrating the lowest cost, best voltage stability and accuracy and optimum

performance parameters will be incorporated into a self-contained, portable primary voltage standard. This system should be capable of mobile field use, that is, it should be easily transportable in an Army calibration van and not require exceptional cooling and/or power requirements.

Potential Commercial Market: Several potential applications include calibration and maintenance functions, not only for high accuracy military needs, but also for the numerous commercial vendors of high precision, voltage standards. The significance of this effort is demonstrated by the fact that the voltage standard system of which this would be the main component, is a recommended STO (Enhanced Forward Area Calibration).

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-096TITLE: DC to RF Laser Diode Characterization System

CATEGORY: Advanced Development

OBJECTIVE: Design and produce a DC-RF semiconductor diode laser test fixture that allows simple, unbonded and unmounted device characterization. Envisaged tests to be performed include both light vs. current(LI), and spectral analysis and small signal bandwidth measurements. Fixture will provide both facet optical access and have provisions for surface emission. Projected frequency range of interest is initially up to 10GHz.

DESCRIPTION: Two keys areas, RF optical links and optical signal processing, require the development of fast efficient optical sources and modulators. Routine screening of fabricated laser diodes for bandwidth currently requires specialized bonding and packaging arrangements which are time consuming and delicate to perform. A simple test fixture, using high speed probes and optical fiber access could allow testing of cleaved devices without the necessity to package individual devices. Combining the small signal analysis with simple LI and spectral testing would provide a compact test system for complete and efficient characterization of processed samples. In the case of edge emitting devices optical access to both facets or ends of the fixture would allow flexibility for modulator testing. Eventual development to be able to measure simple integrated lasers, surface emitting devices and very high frequency devices (>20GHz) is envisaged. Eventual development into a stand alone test station is anticipated.

Phase I: Develop a prototype fixture to measure 0.8-1.00 um wavelength edge emitting lasers and modulators. Fixture will be readily fitted to both DC, pulsed and RF sources. High speed detector and appropriate biasing circuits will be included in the fixture. Ability to readily load and align different devices is essential. Assessment and testing of the fixture, possibly at ARL, will be undertaken to ensure accurate and reproducible measurements. No external electronics is expected to No external electronics is expected to be incorporated at this stage.

Phase II: Develop a complete characterization system designed around the components developed in phase I. This will include software control and possible inclusion of dedicated electronics (assumed to be off-the-shelf commercial units- no specific electronic circuit or unit design and construction is anticipated here) such that the unit becomes a stand alone high frequency test station. Additionally, the frequency range of operation should be extended to beyond 20GHz and the wavelength range extended to encompass 1.3 and 1.5um operation. A prototype unit will be delivered to ARL.

Potential Commercial Market: Potential applications for high-speed laser diodes and optoelectronic integrated circuits include phased array radar and digital optical signal processing. The latter includes digital optical interconnect for high speed processor applications. The test fixture and system envisaged will enable faster QA and QC to be carried out upon fabricated devices, thereby simplifying the device development cycle. It is anticipated that such a measurement system will be useful in other areas where semiconductor lasers are employed, such as optical fiber communications and possibly solid state laser pumping.

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-185TITLE: Microelectronic Display (MIDIS) Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop state-of-the-art generic microelectronic display (MIDIS) technology, mountable on printed circuit boards (PCB) via microcircuit package, to record, store, and display fault detection/isolation data and other information.

DESCRIPTION: Advances in technology and diagnostic software permit more accurate built-in-test (BIT) at the PCB and to the component level. However, there is no effective and efficient way of sensing faults and fault location, storing the information and displaying failure and other related system data to maintenance personnel, especially once the failed PCB has been removed from its end item. The MIDIS would provide a direct view, readable nonvolatile indicator for identification/isolation for failed PCBs and components, and display other relevant system data. Other applications may include prognostic monitor (e.g., green, yellow, red), event recorder (e.g., identification of redundant circuit usage/failure) and inventory/logistics system status indicator. Display devices should be lower, minimum weight/size, reliable, reusable, resettable and designed with human factor considerations.

Phase I: Address concepts/designs/breadboards for this display technology implementation. Conduct investigations, technical analysis and trade-offs on microcontroller/memory requirements, display technologies and strategies, power, operator effectiveness versus design concepts and hardware costs, human factors, and effective architecture for hardware/software implementation. Consideration should also be given to different types of information to be displayed and a potential family of devices.

Phase II: Prototype/fabricate MIDIS components having undergone successful test and evaluation and demonstrate on potential MIDIS applications.

Potential Commercial Market: MIDIS display technology would allow lower skill level personnel to effect maintenance remove & replace corrective actions in all types of communications-electronics or automotive equipments without having to use sophisticated and expensive test equipment. In the commercial marketplace, this may foster a resurgence in "do-it-yourself" repair of consumer electronic items and automotive repair.

A-3SENSORS AND INFORMATION PROCESSING (I.E. COMMUNICATIONS)

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-186TITLE: Very High Frequency (VHF) Helix Antenna

CATEGORY: Exploratory Development

OBJECTIVE: Build an exploratory development model of a short, broadband, electronically step-tuned/structured altered, high performance, VHF shunt-fed, helical monopole.

DESCRIPTION: Military combat vehicles require communication antennas that are both efficient and of small size. In the past, 10 foot monopole and sleeve dipole whips have been used for tactical VHF communications. These narrowband structures have been used from 30 MHz to 88 MHz through the use of broadband matching networks resulting in both poor efficiencies and easily recognized visual signatures. Recent developments in pin diode technology combined with step-tuned structure altering antenna designs offer both increased efficiency and lower silhouette. Essentially, a small, high Q, narrowband helix antenna can be step-tuned across a wide frequency range with very little loss. The purpose of this SBIR is to build and demonstrate this concept.

Phase I: Phase I of the program will be concerned with fabricating the antenna and pin diode structure. Measurements of gain, Voltage Standing Wave Frequency (VSWR), and intermodulation distortion will be made throughout the frequency range.

Phase II: The contractor will build the electronic switches and interface necessary to operate the phase I antenna with a SINCGARS radio.

Potential Commercial Market: Successful demonstration of a low silhouette high performance tactical VHF antenna for SINCGARS radios would provide the U.S. Army, Marines, and other ground forces with a much improved alternate to the present whip antennas. Demonstration of the unique design concept will undoubtedly give rise to new ideas and alternate antennas for many other frequency ranges and applications both commercial and military.

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-323TITLE: Double Focus Unity Magnification Vision System

CATEGORY: Exploratory Development

OBJECTIVE: To design a vision system which focuses the incident light to a small spot within a laser power limiting material and then focuses it again in either the same laser power limiting material or in a second laser power limiting material before allowing the light to exit to the viewer. This system is intended for use in combat vehicles. The system will provide protection against eye-damaging lasers which operate at wavelengths throughout the visible portion of the spectrum.

DESCRIPTION: Because of the expected appearance of multiple-wavelength and wavelength-agile lasers on the modern battlefield, emerging combat vehicles will require laser protection for all wavelengths throughout the visible spectrum. Research is currently underway to develop a protection mechanism which has a high visible transmittance for low input energies, but a very low transmittance to high input energies. Current technologies under investigation do not have the dynamic range necessary to meet the requirements of the Army's unity magnification vision systems. Also, most of the technologies currently under investigation require a focal plane in order to activate the low transmittance characteristic needed to attenuate high input energies. A unity magnification vision system with only one focal plane would be impractical, since the viewed image would be inverted. Although an erecting prism could be used to re-invert the image for viewing, it is unlikely that this approach would provide acceptable power limiting performance. Two focal planes would most likely be required in a usable unity magnification vision system. Current Army unity magnification vision systems do not have a focal plane at all. The present challenge is designing an optical system which has two focal planes and which improves on the limiting characteristics of the laser power limiting materials. One plausible approach may be to design the system such that the two focal planes are within two separate laser power limiting materials arranged in series. In addition, it is hypothesized that a lower optical switching threshold may be achieved in a system that focuses the incident energy to two spots which are coincident or very close to each other within the same laser power limiting material. Both approaches should be investigated, along with others which the contractor may conceive. The optical system should be designed such that it can be tested with several different laser power limiting materials. The refractive index of most of these materials falls between 1.3 and 1.6. The field of view required under this effort is + 40 degrees (80 degrees total). Overall physical constraints are: height < 16", width < 10", thickness < 4". Emphasis should be placed on high visible transmittance at low energies and a low number of elements.

Phase I: The contractor shall propose optical designs which meet the objectives as outlined above for a double focus unity magnification vision system. The design must not use any ultra-violet curing adhesives (since these degrade over time) and must address lifetime limitations of the system (if any), to reduce the need for replacement of the item after initial implementation. The government will evaluate the proposed design to determine its potential for integration with laser protection concepts and for its use in combat vehicles. The deliverables from Phase I shall include design drawings, a ray trace of the designs provided on disk utilizing a common ray tracing program (provided on disk with the program) and a final report.

Phase II: The contractor shall fabricate the vision system and perform a complete optical analysis of its performance parameters and aberrations. Complete optical and mechanical drawings of the fabricated system shall also be delivered with the vision system along with a final report.

Potential Commercial Market: This device would be ideal for viewing experiments within a test chamber which mat abruptly explode or otherwise emit a large amount of visible energy unexpectedly. In the event of such an occurrence, this vision system would prevent the hazardous high energy light from damaging the viewer's eyes.

OSCR: It is requested that the design not utilize ultraviolet curing adhesives, since these degrade over time, and that the lifetime limitations of the system be addressed in order to eliminate the need for replacement of the item after initial deployment. The current vision devices are replaced every few years. It is the aim within this effort to eliminate replacement costs altogether.

TECHNOLOGY CLUSTER: A-2
TOPIC: A93-354TITLE: Downsized Color Reproduction System

CATEGORY: Exploratory Development

OBJECTIVE: To develop a compact, easily transported color reproduction system capable of producing small quantities of a broad selection of maps, terrain graphics, and other special product images in a demand printing mode at the site of the customer (user).

DESCRIPTION: The Quick Response Multicolor Printer (QRMP), an ongoing development, is being designed to support troops at Division, Corps, and Echelons above Corps HQ in the reproduction of maps and terrain graphics of many types. Once this shelter mounted system is fielded, it will provide some "nearby" demand printing for the user, but the need to have a reproduction system operate with lower echelons of troops in the field will not be satisfied. This SBIR has a goal of identifying suitable hardware and software systems that when housed in a small Army shelter, vehicle, or equivalent, and transported to the field. It shall provide the required demand printing. It will be necessary to identify appropriate scanners, image processing systems, copiers, printers, and software that can be packaged in a small space and at the same time print full color products. The reproduction system must be contained and transported in a suitable shelter and/or vehicle which will protect it from damage caused by the environment or by vibration and shock caused by moving the system across rough terrain.

Phase I: Investigate and identify components and systems that have the potential to meet the requirements of a Downsized Color Reproduction System. Develop a specification for the components and system and demonstrate functionality to establish feasibility.

Phase II: Develop a working model of the system and integrate it into the selected shelter/vehicle. Conduct engineering level tests to prove functionality and environmental durability and provide reports.

Potential Commercial Market: A compact/downsized color reproduction system has high potential for the construction and/or oil-siting industry for quick turnaround products on-site, in the field.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-039TITLE: Low Cost Laser Radar (LADAR) Technology for Smart Submunition Target Sensing

CATEGORY: Exploratory Development

OBJECTIVE: To design and demonstrate that a low cost ladar system can be completely packaged into a given volume constraint and enter into production at a maximum cost goal. The desired cost, volume, and form factor will be provided. The ladar must autonomously detect, locate, and classify various ground targets in clutter from a SADARM like platform configuration.

DESCRIPTION: Technology Base work conducted at ARDEC with preliminary design LADAR testbeds has clearly indicated the feasibility that LADAR offers a new, high performance, lost cost candidate for improved target sensing of armored vehicle type targets. Testbed devices and a captive flight test system is already in place. The following objectives remain to be demonstrated; tailor and package a specific design to the given application, conduct additional captive flight testing in increasingly adverse terrain conditions, develop and improve the target detecting and aiming algorithms, build an end product prototype demonstration package suitable for demonstration in a weaponized platform, produce documentable production cost engineering to meet end item cost goals.

Phase I: Submit credible design with analytical model predicting performance.

Phase II: Fabricate package, conduct tower testing, conduct captive flight testing, demonstrate improved Pd and Pfa with advanced algorithms, prepare final drop test demonstration.

Potential Commercial Market: LADAR profiling and sensing technology has enormous implication for commercial applications. Because short range LADAR offers extremely high resolution at a low cost, LADAR sensors will have application in the commercial automotive industry. LADAR sensors can be built into standard automobiles to provide automated collision avoidance systems with tremendous implications for automotive safety on a national scale. Combined with other technologies, it can be used for automated position location and navigation, as well as for autonomously driven vehicles. Further applications will be for low cost altimetry in aircraft, automated cartography, aircraft collision avoidance, and high precision automated aircraft landing systems in airports.

OPERATIONS AND SUPPORTABILITY COST REDUCTIONS (OSCR): Future smart munitions based on conventional radar and IR sensors employ extremely high tech, high cost solutions for target sensing with attendant high OSC. On the other hand, LADAR sensing systems are extremely simply, and utilize off the shelf optical front end components for the most part. Because of the simplicity of the hardware, costs of maintenance and training are expected to be significantly less due to its low complexity. Furthermore, because of the high resolution capability of LADAR, the system is inherently capable of recognizing a wide variety of new targets by merely retraining the target recognition algorithms. Future LADAR systems can be readaptable and retrainable to spontaneous combat, target, countermeasure and clutter conditions with extremely short notice. This meets the emerging requirements of the Army that future systems shall be field adaptable to new conditions, especially countermeasure surprise. Field adaptability means quick modification without redevelopement costs and long term cycles.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-044TITLE: Passive Aero-Acoustic Sensor Self Interference Cancellation

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate practical and effective local acoustic noise cancellation/reduction for acoustic sensor systems mounted on ground vehicle/weapon platforms.

DESCRIPTION: General: Weapon platform and own-vehicle interference tend to degrade passive aero-acoustic sensor performance (i.e. the ability of the sensor system to detect, track, classify, identify, and locate targets). ANC (Automatic Noise Cancellation) techniques such as the classic Widrow algorithm, have been considered for cancellation of such interference, but these techniques in elementary form have not offered the degree of cancellation needed when the weapon platform or own-vehicle is "stationary/operating"; the problem becomes much more difficult when the acoustic sensor system must detect and locate distant threat ground combat vehicle and helicopter targets while operating on a moving ground vehicle ("sense on-the-move"). Innovative practical and effective acoustic noise

cancellation/ reduction techniques will be developed. Research should address both stationary/operating and "sense on-the-move" cases. Initially, work should address the simpler case where the acoustic sensor system is mounted on a stationary ground vehicle with engine on, and the weapon platform fire control systems are operating. Examples of approaches to the problem might include (1) ANC with multiple reference sensors and innovative signal processing algorithms, (2) enhance the correlation between interference sources at the signal and reference sensors (model the interference transfer function), and (3) adaptive spatial beamforming and null-steering in the direction of the interfering sources. Also of interest are development of more robust acoustic sensor signal processing and algorithmic techniques which enhance the ability of the sensor itself (exclusive of any external reference sensors, ANC processing, etc.) to resist performance degradation in noisy environments. This research directly supports Army mission areas: Air-Defense, EMW (such as smart-mines); Close-Combat (Armor self defense, etc.); Fire Support (inc. AFAS, FARV, Fire Support Modernization Plan, Artillery location/counterbattery); IEW.

Phase I: Assess the amount of noise cancellation required for typical weapon platforms to achieve the required acoustic sensor system performance (e.g. target detection, classification, etc.). Define and develop an effective, robust, and practical baseline system for acoustic noise/interference reduction/cancellation for the "stationary/operating" case. Use existing recorded data, and/or conduct measurements of noise field of one or more candidate Army vehicle/weapons platforms. Conduct a computer simulation and/or a laboratory/field test to assess potential performance and technical feasibility of this baseline design concept. Develop system design for canceling/reducing "on-the-move" vehicle noise.

Phase II: Construct experimental noise cancellation/reduction system hardware with appropriate signal processing algorithms using the techniques developed in Phase I. Demonstrate feasibility for effective acoustic sensor system performance for both stationary/ operating and "on-the-move" vehicle operation. Conduct laboratory and or field tests - preferably with the experimental system mounted on an Army ground vehicle/weapon platform.

Potential Commercial Market: A variation of this noise cancellation technology can be used to reduce interior noise levels of automobiles and trucks, and lower noise levels in passenger compartments of commercial aircraft. This technology could also be used to cancel noise in office environments, factory machinery noise, etc.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-047TITLE: Multipath Interference at Millimeter Wave Frequencies

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to develop and demonstrate techniques to minimize the effects of multipath interference on millimeter radars and trackers operating in low angle tracking scenarios.

DESCRIPTION: The U.S. Army has been experimenting with the use of Millimeter Wave (MMW) technology to track and guide tank and artillery projectiles. However, experimental beacon tracking systems have been rendered ineffective due to multipath interference. This interference, which is caused by the simulations reception of the direct wave from the source and the waves reflected from the ground, causes tracking inaccuracies. The effect is most pronounced for low trajectories. Until the problem is solved, the use of millimeter waves for tracking and guidance will be limited only to high angle trajectories. This effort will focus on abating multipath interference due to low angle tracking at millimeter wave (at 35 GHZ and higher) over all terrain surfaces.

Phase I: This phase consists of laboratory demonstration of multipath reduction techniques and selecting one which best enhances low angle tracking.

Phase II: This phase consists of a field demonstration of the technique that was selected at the end of Phase I.

Potential Commercial Market: The technology developed under this project can be used to minimize low angle tracking errors due to multipath interference. Aircraft tracking radar performance could be enhanced with the use of this technology, particularly all commercial and recreational aircraft tracking radar. For instance, a commercial aircraft on a final approach to a runway can be monitored and guided by air traffic controllers accurately and without any human interpolation of the aircraft position information.

OSCR: Successfully developed technology will enhance low angle tracking and guidance accuracies and therefore, increasing lethality of all gun fired projectiles. With this capability, newly developed tracker and guidance systems will accurately deliver projectiles to the target. This will reduce multiple fire of projectiles to destroy a target, hence, incurring a significant cost savings.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-049TITLE: Characterization of Atmospheric Turbulent Effects for Acoustic Transducer Windscreen Design

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate the effectiveness of prototype noise cancelling/reducing windscreen for implementation on smart mine/ground based acoustic sensor system applications.

DESCRIPTION: Background: Acoustic sensing/processing technology offers distinct advantages in battlefield target detection, classification/identification, localization. These sensors operate on non-line-of-sight targets, and are virtually non-detectible because of their passive (non-emitting) operating mode. Improvements in the computational power and speed of microprocessors/DSP chipsets have led to the realization of sophisticated target acoustic emission exploitation capabilities in relatively small, low power consuming packages. Strategically significant targets, such as helicopters and ground vehicles, are characterized for the most part by their low frequency (10-200 Hz) acoustic emissions. This feature makes them particularly well suited to long-range detection in that these disturbances suffer less propagation loss due to ground absorption/impedance effects. Unfortunately, noise produced by local wind turbulents has a characteristic 1/f frequency distribution, which has the effect of masking the most prominent target signature features. Innovative wind noise cancelling/reducing techniques will be developed for implementation on smart mine/ground based acoustic sensor system applications. The research should be geared toward reducing the effects of wind noise on an acoustic sensor located at or near ground level (<.5m AGL). It is desired that the sensor system perform with no degradation in a wind at speeds up to 25 mph. Examples of approaches to the problem might include but are not limited (1) Adaptive noise cancellation using a reference sensor (pressure transducer, microphone, hot-wire anemometer) and innovative signal processing algorithms, or (2) development of improved windscreen geometry or material. This research directly supports Army mission areas: Air-Defense; EMW (such as smart mines); Close Combat (Armor Self Defense); Fire Support (inc. AFAS, FARV, Fire Support Modernization Plan, Artillery Location/Counterbattery).

Phase I: Analysis and design of wind noise attenuation technique/device. Use existing data or conduct field measurements of wind induced acoustic noise. Conduct a computer simulation or laboratory/field test to assess the potential performance and technical feasibility of the design concept.

Phase II: Construct experimental noise reduction/cancellation hardware and/or software. Demonstrate and validate, preferably using a Wide Area Mine mockup, the effectiveness of the device/technique at wind speeds up to 25 mph.

Potential Commercial Market: Useful for commercial applications where wind or other random/non-periodic low frequency noise interferes with the measurement of low frequency signals of interest. Would be valuable in a noise/vibration measurement/analysis/reduction device, or a security/ surveillance/ interdiction system which employs acoustic sensors. Additionally, an improved windscreen would have applicability in consumer electronics (camcorders, etc.), and in the music recording industry.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-077TITLE: Token Ring Protocols for Packet Radio

CATEGORY: Basic Research

OBJECTIVE: To adapt token ring protocol techniques to single-hop packet radio networks.

DESCRIPTION: The performance of protocols presently used in battlefield packet radio networks is degraded by delaysin radio, terminal and modem equipment. These delays are often so severe that they obviate the benefits of carrier sensing algorithms. Resolving collisions and retransmitting packets result in excessive delays in message delivery, especially under the severest conditions of combat. In addition, slotted Aloha suffers from unacceptably low throughput. On local area networks (LANs) token ring protocols provide a means of avoiding problems associated with packet collisions, but such protocols have not yet been adapted to radio channels. We propose to use silence as the

token (permission to transmit). Each user is assigned an arbitrary position in a virtual ring. After a station completes a packet transmission, only the next station in the ring has permission to transmit (i.e., has the token). If that station does not transmit, the following station will wait a prescribed amount of time (which accounts for propagation and equipment delays, uncertainties in knowing the time, etc) after which it will "have the token".

Phase I: Perform design and analysis of a packet radio protocol which mirrors the operation of token ring protocols used in modern LANs. Consider the following: accuracy and resolution with which a node can know the time; the size (in units of time) of the token; effects of timing errors; effects of nodes dropping out of the net or attempting net entry.

Phase II: Conduct experimental demonstration of the token ring packet radio protocol with a minimum of four nodes. Collect sufficient data to validate Phase I analysis and to confirm the effects of errors, network configuration changes, and knowledge of time.

Potential Commercial Market: This communications approach has real commercial potential in developing countries which because of weak infrastructure will require distributed, mobile, multimedia communications. Potential application is reasonable in future communications systems involving "smart" buildings and personal communication devices.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-087TITLE: Vibration-Insensitive Dielectric Resonator Oscillators and New Ceramic Materials for Microwave Oscillator Applications

CATEGORY: Exploratory Development

OBJECTIVE: Option 1- To minimize the sensitivity of microwave dielectric resonator oscillator (DRO) phase noise to vibration. Initial goal is to achieve a vibration sensitivity level of 10^{-10} /g/axis. In addition, the oscillator must be small and lightweight, suitable for missile and other airborne applications. Option 2 - To develop new ceramic compositions leading to improved performance in DRO microwave applications.

DESCRIPTION: Dielectric resonator oscillators have been shown to be highly stable and very low phase noise microwave frequency sources. On the other hand, very little is known about the DRO's vibration sensitivity, which is very important for many system applications. Because the environment of the dielectric resonator plays such an important role in establishing the oscillator's operating frequency, the mechanical design of the oscillator and its robustness are critical. Option 1 will investigate vibration immune resonant structure for several different operating frequencies. Option 2 of the program is independent of the option 1 and will investigate the possibility of producing new ceramic dielectric resonator materials that improve upon the performance of current materials. This however, should not necessarily exclude non-ceramics. Of prime importance are microwave Q and frequency stability under temperature, static stresses, and dynamic acceleration. A high dielectric permittivity is also highly desirable.

Phase I: Option 1- Identify oscillator's components, finalize oscillator design and establish what factors are most important in order to reduce the DRO's overall vibration sensitivity. Option 2- It is anticipated that the oscillator noise measurement will be made at ARL. The contractor should provide samples of DRO dielectric resonators sized for various microwave frequency bands, i.e. L-band through K-band. Various compositions, to include doping for temperature compensation purposes, shall be explored. Various processing regiments shall also be explored.

Phase II: Option 1- Fabricate and test vibration insensitive DROs. Frequency vs temperature, phase noise and vibration tests will be performed on the oscillators. Option 2- Optimize the material compositions and the processing procedures to develop very high Q, environmentally hardened dielectric resonators for the entire frequency spectrum from L-band to K-band.

Potential Commercial Market: All radar systems require low phase noise microwave frequency sources. The phase noise translates to detection of smaller cross-section targets, and/or detection at longer ranges. Environmental hardening will permit achievement of ultra-stable frequencies in compact environments.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-088TITLE: Synthesis of Materials for Uncooled IR Detectors

CATEGORY: Basic Research

OBJECTIVE: Develop new methods of synthesizing and growing multicompound materials, such as $BaSrTiO_3$, and other ferroelectrics, perovskites or pyroelectrics for use as infrared sensing materials to be used in uncooled focal plane arrays (FPA).

DESCRIPTION: General - The current uncooled detector technology uses ferroelectric compounds which are complex mixtures of perovskites such as barium strontium titanate. The detector elements are fabricated from aggregates of the materials not from single crystals or from crystalline thin films. It is quite likely that if the materials technology were to advance to the point that the elements or perhaps the whole focal plane array (FPA) were to be fabricated from a single well oriented crystal, the performance and uniformity of the FPA would be greatly improved.

Phase I: Phase I should develop methods of synthesis and crystal growth which will yield improved quality materials and perhaps either single crystals or crystalline thin films. At the end of this phase some form of demonstrable result such as material samples, as well as, a process should be presented.

Phase II: The technology of the growth process should be developed into a pilot process suitable for scale up into an industrial fabrication line. Methods of growth should be evaluated and techniques for detector fabrication should be considered.

Potential Commercial Market: It is expected that this project if successful would significantly improve the detection sensitivity of uncooled focal plane arrays. In addition, a successful program could also lead to new fabrication techniques, for the arrays and to new fabrication economies. Additionally, improvements in this materials technology would also impact other related technologies in high temperature superconductors and perhaps also ferroelectric memories.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-089TITLE: Novel High Frequency Optical Modulators

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop and demonstrate new and novel techniques for optical external modulators capable of modulating very high optical powers up to the millimeter wave frequency range.

DESCRIPTION: Recent advancements in high speed photonics have led the way for a distribution network for microwave signals in newly developed phased array satellite systems. These systems require a high power optical signal modulated in the millimeter wave frequency range which is distributed to multiple transmit/receive modules. Conventional optical modulation schemes involve bulk properties such as attenuation, and electro-optic effects. These are limited in their maximum power capabilities, narrow bandwidths, and suffer from high insertion loss. The need for the distribution of microwave/millimeter wave signals requires modulators based on novel mechanisms such as boundary effects which can overcome the aforementioned deficiencies.

Phase I: Under Phase I, the technology to implement modulators based on novel mechanisms such as boundary effects must be identified. The modulator should be capable of accepting greater than 250 mW of optical power at the input and a dynamic range of 10 dB. Performance issues should address millimeter wave operation, microwave input power requirements, input and output optical coupling using fiber and packaging. Development should also include supporting microwave circuitry for impedance matching and driver circuits.

Phase II: Under Phase II, the final designs will be processed, tested, and packaged. A fully functional test facility should be developed and delivered. This test facility should include high-power laser, photodetectors, attenuators and associated test equipment necessary to perform a demonstration of the modulator's operation.

Potential Commercial Market: Applications include phased array systems for SATCOM-on-the-move and ground-based radar, and distribution networks for commercial satellite (CATV).

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-094TITLE: Millimeter Wave Sensor Technology for Identification of Friend or Foe (IFF)

CATEGORY: Advanced Development

OBJECTIVE: Identify, study, develop and demonstrate use of novel millimeter wave sensor component/module technology to detect battlefield targets for use in identification friend or foe (IFF).

DESCRIPTION: Advanced concepts for low-cost, compact, sensors are needed for rapid and positive identification of friendly forces. Millimeter wave circuit techniques that are transparent to obscurants and avoid false identification of targets which might employ similar technology, are to be explored. Monolithic/hybrid millimeter wave techniques which permit circuit fabrication on a single carrier, thereby eliminating interconnecting lines, reducing size, fabrication and assembly costs while improving performance, should be given a high priority.

Phase I: Study and analyze techniques and concepts of integrated electronics technology incorporating monolithic and hybrid devices, circuits and modules which would search, detect, and identify battleground targets. A simple proof-of-concept demonstration of the functionality of the experimental device, such as an active circulator, novel antenna array beam scanning not requiring phase shifters and RF distribution networks, planar multimode antenna aperture, and multidimensional imaging. The selection of the preferred design approach of a component/device will be based on satisfying the objectives that are representative of the Army's tactical situations.

Phase II: Design, construct, test, and demonstrate the performance of the sensor utilizing the state-of-the-art components/devices analyzed and experimentally verified under Phase I. The end product should be a functional module, including a final engineering report, which would be suitable for field testing by the Army.

Potential Commercial Market: Millimeter wave components, devices, and modules are needed for various DoD systems under development, such as ADKEM, MTAS, Active Tank Defense, Passive Imaging. Phased array antenna beam scanning and active circulator would be the potential spinoffs for commercial use.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-097TITLE: Miniature Atomic Clock Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate innovative designs for miniature atomic frequency-standards/clocks. The new atomic clock technology is to provide a higher stability, smaller volume, lower power dis- sipation, and is to cost less than the smallest currently available atomic clocks, i.e., the rubidium cell frequency standards.

DESCRIPTION: General - The state-of-the art of small atomic frequency standards is represented by the small rubidium standards, which are on the order of 1 liter in volume, require about 20 watts to operate at -40° C, and which provide a long-term accuracy of 1 part per billion.Cesium beam frequency standards can provide much higher accuracy, are used in strategic DoD systems, however, their much larger size and much higher cost (=$50K ea.) preclude their use in tactical systems. Advances in laser diode, MMIC and other technologies suggest new approaches to atomic clock design that can significantly reduce the size and cost, while improving the stability.

Phase I: Phase I will explore new approaches to miniature atomic clock design, demonstrate proof-of-concept, and predict through analysis the attainable size, power requirement, lifetime, and environmental sensitivities of the new design.

Phase II: Phase II will develop a prototype of the miniature clock in which the atomic resonator package (the "physics package"), but not necessarily all the associated electronics, shall be miniaturized. The prototype shall be tested for accuracy and stability, especially with respect to sensitivity to military environmental extremes.

Potential Commercial Market: Miniature atomic clocks would impact three major DoD S&T thrusts: global surveillance and communications, precision strike, and technology for affordability. A sufficiently small and low cost atomic clock would find large-scale military applications in C3, bistatic and multistatic radar, EW and navigation systems. Commercial applications would include cellular telephone and other telecommunication base stations, satellite communication systems, and navigation systems.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-100TITLE: Ferroelectric Smart Microsensor

CATEGORY: Exploratory Development

OBJECTIVE: Design a miniature device capable of both sensing an environmental change and actuating a response utilizing a ferroelectric film which is compatible with integrated circuits and can be micromachined.

DESCRIPTION: General: Develop new concepts and improve material properties for smart sensors which can both sense a change in either temperature, pressure, or acceleration, and actuate a response to maintain/ compensate device performance stability despite changes in the surrounding environment.

Phase I: Phase I would study various ferroelectric materials to determine the most promising candidate to achieve high sensitivity, be relatively easy to fabricate with the flexibility to alter the material properties by changing the chemical composition. This phase would include a device design study with a simple proof-of-principle fabrication and demonstration.

Phase II: In this phase the material processing steps would be finalized to achieve uniformity, reproducibility, and the ability to easily tailor the material for altering the sensor response. A full prototype microsensor would be fabricated and tested to demonstrate its ability to sense an environmental change and actuate a proportional response to stabilize device performance.

Potential Commercial Market: Army sensor systems are dependent on having stable frequency sources to maintain high sensitivity and accuracy in their sensing ability. The stability of these sources is adversely affected by environmental changes. This project would develop new devices which could adjust to these changes by actuating a response to counter the change and maintain a stable performance.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-101TITLE: Novel Active High Temperature Superconducting Devices

CATEGORY: Exploratory Development

OBJECTIVE: Design, fabricate and test novel High Temperature Superconducting (HTSC) active devices for use in microwave, analog-based subsystems such as mixers, amplifiers, oscillators and buffers. The principal frequency bands of interest are the X and Ka bands. The ultimate goal is to design an integrated HTSC circuit on a single wafer incorporating all the subcomponents needed for, as an example, an RF front end (RF amp, mixer, LO, IF amp, detector).

DESCRIPTION: General - The present state of HTSC devices is, for the most part, concentrated in passive components. New ideas for active HTSC devices (e.g. fluxonic, flux flow transistors, etc) demonstrating gain and/or rectifying action are needed to facilitate the construction of integrated front ends. The HTSC materials can be any of the recently discovered ones such as the Bismuth-, Yttrium- or Thallium-based ceramics. Because of their expected end use in fielded systems, the only constraint on the operating temperature is that they function properly at temperatures easily attainable by closed-cycle, single-stage refrigerators (i.e. 40° Kelvin).

Phase I: The Phase I effort should include a thorough study of the current state of the art in active HTSC devices, the advantages and disadvantages of each, and their potential for use in active systems. Also, the fabrication and testing of one or more of these active devices should be demonstrated under a range of frequency, temperature and power conditions.

Phase II: The Phase II effort will incorporate the novel HTSC devices into a functional HTSC RF subsystem. In order to demonstrate the usefulness of active HTSC devices, it is anticipated that this RF subsystem will utilize HTSC-based active devices for low-noise amplification and for mixing. HTSC passive devices will also be incorporated into the subsystem. The complete package will include a compact refrigerator of appropriate capacity.

Potential Commercial Market: The potential applications for active HTSC devices include a broad range of radar systems including smart munitions, airborne radar and ground-based perimeter defense.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-122TITLE: Diffractive Optical Elements for Laser Diodes

CATEGORY: Exploratory Development

OBJECTIVE: There exists a great potential for applications of diffractive optical elements in commercial and military markets. However, for optical processing applications involving laser diodes, two major problems exist. One is the severe chromatic aberration associated with diffractive optical elements and the second problem is the wavelength instability of laser diodes. Design algorithms and fabrication techniques are needed for diffractive optical elements that can tolerate variation in laser diode wavelength without suffering significant loss in performance. To reach Phase III, the objective is to develop a design methodology and corresponding fabrication techniques that produce low cost diffractive optical elements suitable for optical processing architectures that incorporate laser diodes.

DESCRIPTION: General: Design algorithms and fabrication techniques are needed for diffractive optical elements in optical processing systems. These elements must have low f-numbers and high diffraction efficiency. Further, they must be able to cope with the wavelength instability in laser diodes. These algorithms must consider the severe chromatic aberration associated with diffractive optical elements, a characteristic that makes them difficult to use with laser diodes.

Phase I: Development of design algorithms and fabrication techniques for diffractive optical elements specific to optical processing. Phase I will include software development, simulation and identification of fabrication techniques suitable for the proposed designs.

Phase II: Advanced development, fabrication, and characterization. Upon successful completion of Phase I, Phase II would include advanced design, fabrication of prototypes, and characterization of performance.

Potential Commercial Market: Technology developed under this SBIR could serve a variety of commercial applications. These include compact disc players, optical disc drives, diode laser printers, and other systems that require optics for laser diode sources.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-123TITLE: Fast Computation of Iterative Maximum Likelihood Estimator for Continuous Wave (CW) Tone Extraction

CATEGORY: Exploratory Development

OBJECTIVE: Design and build synergistic hardware and algorithms (a box) to extract interference signal that are nearly CW Tones at real-time rates. "Real time rate" means 64K point records (12-bit fixed point) at a rate of 500 per second. "K" is understood to be 1024.

DESCRIPTION: The Army Research Lab is conducting research on ultra wide bandwidth (UWB)radar systems where interference is a problem. The digitized radar echo consists of a stream of 64K point records such that the sustained rate is on the order of 500 records per second. The radar echo is noise-like. Interfering signals, however, are relatively slowly modulated sine waves (slow compared to the radar echo). Preliminary work has shown that an iterative maximum likelihood algorithm does a good job of estimation the interfering sine waves. Once estimated, these sine waves are digitally subtracted from the received records to generate "cleaned" records. The maximum likelihood algorithm was evaluated based on its minimal reduction of the radar signal energy, its generation of minimal sidelobes, and its large reduction of the interfering signals. ARL needs cost effective computer architectures matched to algorithms to allow real time interference extraction.

Phase I: Design various computer architectures and algorithms. Simulate the performance and characterize the performance versus size, cost, weight and scaleability to extend the performance. Make recommendations based on the tradeoffs.

Phase II: Build a prototype and demonstrate the performance.

Potential Commercial Market: Potential for the active muffler industry, real-time active cancellation of changing acoustical or seismic noise. Real-time process control requiring super-resolution.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-124TITLE: Artificial-Intelligence-Enhanced Signal and Information Processing

CATEGORY: Basic Research

OBJECTIVE: This topic solicits research in advanced signal and information processing algorithms as well as hardware architectures which will support critical Army program areas such as fusion stations, ground stations, advanced-sensor-based robotics, and automatic target recognition.

DESCRIPTION: ARL/S3I has a strong continuing interest in real-time signal-and information-processing research as applied to single-sensor, multisensor, and multisensor integration (fusion) station processing. Information processing includes those operations normally performed after signal processing, thus relating to higher levels of abstraction and lower "bandwidth" (measured in instructions per second) than those addressed by signal processing. Examples of information-processing tasks include multisensor correlation, fusion, target tracking, situation assessment, target value analysis, etc. Information processing encompasses approaches that are both algorithmic and symbolic (based on artificial intelligence (AI)). Applicable research topics should relate to high-speed signal and information processing (particularly with AI- based enhancement) for such systems as acoustic, radar, and eletro-optics sensors in single and multiple (homogeneous as swell as heterogeneous) sensor configurations. This topic includes advanced processing architectures as well as advanced algorithms.

Phase I: Signal and/or Information processing research yielding innovative algorithms or advanced processing architectures which are then simulated or otherwise shown to have potential in real-time processing applications.

Phase II: Research resulting in the real-time implementation of Phase I algorithms and/or processing architectures which will show direct relevance to an objective interest area such as fusion stations, ground stations, advanced-sensor-based robotics, and automatic target recognition.

Potential Commercial Market: The technologies related to this topic, Artificial Intelligence Enhanced Signal and Information Processing, correspond strongly with a number of commercial or dual use applications such as aircraft tracking and control for commercial airfields or intruder detection and tracking on private locations. The target recognition area relates to identification of individuals and objects for security and robotic parts placement. This also relates strongly to the intelligent highway program that the Department of Transportation is sponsoring.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-125TITLE: Low Cost, Highly Stable Oscillator Systems

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort will be to advance the state of technology to develop small, inexpensive, rugged oscillators which can be calibrated to obviate the need for highly stable (i.e. expensive) oscillators. This would directly support the precision strike thrust S&T thrust in the area of precision guided artillery projectiles and other low cost ammunition systems.

DESCRIPTION: Systems often require ultra accurate frequency reference or timebases. Tactical systems can not afford the cost of high grade frequency sources, nor the time required for temperature stabilization of a frequency source, since they are often powered at launch. One example would be a Global Positioning System (GPS) receiver, which requires a precise time reference, mounted on a rocket. The performance of a low cost oscillator may be acceptable if it can be calibrated at or immediately after launch. This topic area is looking for innovative solutions to calibrating an unstable oscillator. A GPS receiver would be an adequate system to base the study on, in that once the receiver has acquired the GPS signal, the precise frequency of the satellite is available, but the acquisition cannot take place without an accurate frequency reference. Both tethered (pre launch calibration) and unconnected (powered at or after launch) systems should be considered. A Phase I effort resulting in algorithms and a system study could lead to a Phase II effort consisting of a test of actual prototype hardware.

Phase I: An investigation shall be conducted into small, inexpensive oscillator technologies which can be used in place of highly accurate oscillators and report on potential candidate systems.

Phase II: Continue detailed studies into small, inexpensive oscillator technologies which can be used in place of highly accurate oscillators, etc. and demonstrate candidate systems.

Potential Commercial Market: The systems developed under this effort would be applicable in products that have a short use lifetime yet require a high quality oscillator, such as expendable GPS receivers for weather balloons, radiosondes or sono-bouys.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-126TITLE: Charge Coupled Device (CCD) Evaluation using the Modulation Transfer Function (MTF)
CATEGORY: Basic Research

OBJECTIVE: Develop an automated minimal error MTF test system for 1-D and 2-D CCD arrays

DESCRIPTION: Develop a system and procedure to evaluate CCD arrays by measuring the modulation transfer function. The operation should be automated to the extent that no manual handling of the array output data is necessary. Instrumentation and software capable of gathering the data, performing the required spatial domain processing, and displaying the results are required. The hardware and method chosen should minimize the effects of any optical aberration and phase dependence between the optical source and the array. The MTF should be measured over a frequency of zero to Nyquist and be separable from the arrays fixed pattern noise. Array sizes are up to 1x1024 for 1-D and up to 1500x1500 for 2-D. The CCDs should be tested at wavelengths from visible to 830 nm.

Phase I: The Phase I effort will include a feasibility study, discussion of possible solutions, and selection of a testing system which minimizes component error. Following the selection process a prototype will be built and characterized.

Phase II: The phase II effort will be the refinement of the above prototype into a deliverable test system.

Potential Commercial Market: Manufacturers of equipment containing CCD arrays may be interested in using this evaluation to characterize the arrays.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-127TITLE: Two-dimensional Individually-addressable Laser Diode Arrays

CATEGORY: Basic Research

OBJECTIVE: The ability to randomly address individual elements of a two-dimensional laser diode array is required in incoherent optical processors where the laser diode array is used in the object plane of the processor. To be competitive with digital image processing schemes, high resolution arrays with 1024 x 1024 elements are necessary. A matrix-addressed array would require 2048 connections to the outside world. Such a large number of connections is impracticable. In addition, the matrix-addressing scheme is limited in its ability to access sets of elements. Clearly, more flexible addressing schemes must be explored. A two-dimensional individually-addressable laser diode array would find potential applications in incoherent optical processors, optical morphology, displays, and free-space optical interconnections. To reach Phase III, the objective is to develop a two-dimensional laser diode array whose elements can be individually addressed. Possible addressing schemes include but are not limited to integration of the laser diodes with on-chip shift register and multiplexer circuitry or optical-addressing via acousto-optic scanners or spatial light modulator devices. The device should show scalability to 1024 x 1024 elements, have an optical intensity modulation with 24 dB of dynamic range, and have the capability for operation at kHz frame rates. Consideration should also be given to integrated packaging with microlenslet arrays for flexibility in formation of the output beam characteristics.

DESCRIPTION: Incoherent optical processors require object plane arrays with the temporal coherence available from laser diodes. A two-dimensional laser diode array must have elements which are individually-addressable for the display of random input images.

Phase I: System design and development. Phase I will include the identification and design of the addressing scheme for a two-dimensional laser diode array. The design must include selection of the laser diode configuration and its method of integration with the addressing network. The performance characteristics of the device also must be addressed in Phase I.

Phase II: Advanced development and testing. Develop and demonstrate a prototype device with at least 64 x 64 elements. Deliver prototypes for testing at ARL.

Potential Commercial Market: Two-dimensional individually-addressable laser diode arrays span a broad range of potential commercial applications which include high resolution miniature displays, solid state barcode scanners, optical communications, and assembly-line quality control. The compact lightweight nature of the device should form a rugged package capable of surviving the harsh environments of the commercial market place.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-128TITLE: Wideband Frequency Selective Limiter

CATEGORY: Basic Research

OBJECTIVE: Develop a wideband frequency selective limiter for ESM applications.

DESCRIPTION: Develop a frequency selective limiter capable of attenuating overpowering narrowband interferers (bandwidth less than 100 kHz) over a 1 GHz passband. While interferers are greatly attenuated (60 dB), all other desired signals pass through with negligible effects. It is desired that multiple interferers can be attenuated without prior knowledge of their location in the spectrum. This device should also exhibit a 60 dB spurious free dynamic range, minimum insertion loss (less than 10 dB), and minimum ripple (less than 1 dB). Other desired features are small size, weight and power consumption.

Phase I: A Phase I effort should consist of a technology study to determine the feasibility of a frequency selective limiter with the above characteristics. With such technology limitations, what best effort can be achieved? Two prototypes of the selected design should be assembled with measured data and delivered.

Phase II: A Phase II effort should concentrate on extending the frequency selectivity bandwidth and dynamic range not achieved in Phase I. Improving insertion loss and ripple, and minimizing size, weight, and power requirements is desired.

Potential Commercial Market: The requirements for commercial application is to use wider modulation bandwidths and less transmit power in their radar and communication equipment. This is driven by cost savings of less transmit power. This also causes the potential of narrowband co-located transmitters to interfere with wideband equipment. The requirement for wideband frequency selective limiters is to suppress narrowband interferers without distorting the entire modulation bandwidth. Additional benefits would come from a device that exhibited a small size, light weight, low cost in production, and interference rejection without apriori information.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-129TITLE: Foveal Vision Algorithms

CATEGORY: Basic Research

OBJECTIVE: Develop algorithmic techniques for ATR using foveal vision analysis on second generation FLIR imagery in order to reduce computational load and increase performance.

DESCRIPTION: Foveal vision incorporates multi resolution analysis of an image using low resolution wide field of view searching with narrow field of view, high resolution target recognition simultaneously.

Phase I: The contractor will present an analysis of different foveal patterns examined for suitability for various military scenarios, including but not limited to ground to ground, air to air and ground to air. The contractor will also keep in mind that any foveal system should use current detector technology, preferably second generation IR focal planes. The contractor should also address the method of saccade generation needed to direct such a foveal system such as; physical movement of the detector or an electronic saccade moving the high resolution region on the detector chip.

Phase II: The contractor will develop and deliver for testing the algorithmic techniques to demonstrate one or more foveal ATR systems chosen by the government from the Phase I study. Potential Commercial Market: Foveal algorithmic techniques could be applied to any imaging system to speed identification of objects of interest and reduce computational load (i.e. autonomous robots, industrial vision, aided surveillance, etc.)

Potential Commercial Market: Foveal algorithmic techniques could be applied to any imaging system to speed identification of objects of interest and reduce computational load (i.e. autonomous robots, industrial vision, aided surveillance, etc.)

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-130TITLE: Neural Based Automatic Target Recognition (ATR)

CATEGORY: Basic Research

OBJECTIVE: Develop neural network based ATR modules to improve performance and/or speed of the ATR process.

DESCRIPTION: Neural networks are capable of a number of functions important for ATR development including classification, pattern matching, pattern completion and noise removal. These functions are often faster, more robust, or more accurate than the algorithmic methods used in common ATR's under development.

Phase I: The contractor will demonstrate and deliver for testing the neural components of an ATR using second generation Forward Looking Infrared (FLIR) imagery, alone or in a Multi-sensor suite, such as but not limited to FLIR-MM wave radar or FLIR-laser radar.

Phase II: The contractor will develop and demonstrate and deliver for testing a complete ATR system using the neural components developed in Phase I, either in a conventional ATR or a completely neural based ATR using the FLIR or multi-sensor information used in Phase I.

Potential Commercial Market: Techniques and alogirthms developed could aid the Medical Imaging Community. Also potential applications exist in machine and robotic vision (i.e. part history and identification) and aircraft and automotive environment sensing.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-131TITLE: Two-dimensional Optical Signal Processing Architecture and Components for Planar Optics

CATEGORY: Exploratory Development

OBJECTIVE: The development of two-dimensional (2-D) optical signal processing architectures in a planar optics format would greatly improve the manufacturability and robustness of the processor. Here, "planar optics" refers to the arrangement of the optical components in a single plane which communicate by transmission and reflection in a transparent substrate. Examples of candidate signal processing architectures include image processing, 2-D correlation and convolution, and synthetic aperture radar processing. To reach Phase III, the objective is to develop the components and integration methodology for the fabrication of a generic planar optical two-dimensional signal processor. Primary consideration should be given to ease of manufacturability. Reduction of processing steps in the fabrication and compatibility of the individual components is essential. Additionally, to be competitive with 2-D digital electronic processors, the pupil plane element should show scalability to 1000 x 1000 pixels and kHz frame rates

DESCRIPTION: Coherent bulk optic 2-D signal processors are limited in manufacturability and robustness by the critical alignment necessary for the optical comments. A planar optics geometry has the potential for utilizing the mature planar processing techniques currently available from the semiconductor industry. Epitaxial lift-off and flip-chip bonding are two potential techniques for integrating 2-D active optical elements such as laser diode arrays, spatial light modulators (SLMs), and CCD detector arrays onto a common substrate.

Phase I: System design and development. Phase I will include the identification and design of a generic signal processing architecture for concept demonstration. The flexibility of the generic system hinges on the selection of the component elements such as the SLM and diffractive lenses as well as on the integration technique(s). These issues in addition to performance characteristics of the generic system must be addressed in Phase I.

Phase II: Advanced development and testing. Develop and demonstrate multiple element integration towards complete system integration. Deliver prototypes for testing at ARL.

Potential Commercial Market: The driving motivation behind "planar optics" is the manufacturability of robust two-dimensional signal processing systems. Low cost, robust optical pattern recognition systems will find commercial applications in assembly line quality control and machine vision for industry automation.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-132TITLE: Gun-rugged Accelerometers and Vibratory Gyroscopes

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort will be to advance the state of technology to allow low cost guidance systems for artillery projectiles to be developed. This would directly support the precision strike S&T thrust.

DESCRIPTION: If it were possible to build accelerometers with sufficient accuracy, resolution and range, then both the large forces (>16,000 Gs) experienced by an artillery projectile during gun launch and the much smaller forces experienced during flight could be measured. By combining these data with the gun coordinates and orientation, the projectile's trajectory would then be fully determined. In addition, the existence of such accelerometers would make inexpensive inertial reference units possible for guided projectile applications. Because the research done to create such ideal accelerometers has shown little progress, it seems unlikely that the necessary technology will emerge in the near future. However, an alternative approach may be possible, one which takes advantage of the Global Positioning System (GPS). To be specific, it may be possible to protect a sensitive low-dynamic-range accelerometer during the gun-launch interval using caging methods or temporary restraining structures such as electrically-fusible links. Although launch acceleration would not be measured, the initial attitude could be accurately inferred and subsequent changes in attitude would be used for GPS receiver aiding. It should be noted that the basic scheme is not new. Various Global Positioning System (GPS) location-mapping devices are now available as options in certain luxury automobiles. Some employ micro-machined accelerometers or inexpensive, rate-integrating vibratory oscillators (vibratory gyroscopes) to estimate vehicle motions during intermittent periods when GPS satellite signals become blocked by structures or terrain. As the first step in an innovative research effort, it is suggested that existing devices be investigated to ascertain gun-ruggedness.

Phase I: Perform analyses and evaluations to determine the accelerometer and gyroscope technologies best suited to produce low-cost devices which will operated after gun launch (17000 G) acceleration.

Phase II: Continue detailed studies into small, inexpensive accelerometers, gyroscopes, etc. and demonstrate hardware suitable for the gun-launch environment.

Potential Commercial Market: The potential commercial market for micromechanical inertial measurement units has been estimated at 20 million units per year. applications in the automobile industry include airbags, breaking, leveling, true skid detection, and augmentation to vehicular GPS navigation systems. Additional commercial application can be found in products such as camcorders, general aviation, medical electronics, and perhaps one of the largest areas of all, children's toys. (Source: Poth, T. Elwell J. "Progress on Micromechanical Inertial Guidance System", 21st JSDE for Guidance Navigation and Control.)

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-133TITLE: Miniature Charged Coupled Device (CCD) Driver-Controller

CATEGORY: Basic Research

OBJECTIVE: To package a high density CCD driver-controller exhibiting small size, high signal isolation and good thermal dispersion properties.

DESCRIPTION: Develop a method for miniaturization and packaging of analog and digital hardware used to control and drive 1024 by 1024 CCD arrays. System must provide a high degree of isolation between high speed, high voltage CCD drive clocks (10-15 MHz) and multiple low noise high impedance analog signals. System must also be capable of buffering these analog CCD outputs for coax transmission. The system must provide a sufficient method of heat dissipation in a high density package.

Phase I: Examine existing CCD control-drive systems. Do a technology study of alternative methods for size reduction and determine what degree of reduction is possible and what the trade offs are.

Phase II: Design, build and characterize a prototype unit for application insertion. A performance appraisal will be based on improvements to an existing controller-drive system.

Potential Commercial Market: High speed, high resolution CCD cameras, and imagers.

TECHNOLOGY CLUSTER: A-3

TOPIC: A93-134TITLE: High Frame Rate, Snap Shot Infrared Imaging Focal Plane Array

CATEGORY: Exploratory Development

OBJECTIVE: To develop, test, and fabricate a high frame rate infrared (ir) focal plane array (FPA).

DESCRIPTION: A high frame rate long wavelength ir imaging FPA that acquires images in a snap shot mode. The FPA should acquire images such that all pixels are irradiated and integrated simultaneously for the same time interval. The pixels should then be read out simultaneously while the FPA is electronically shuttered. Current long wavelength ir FPA technology uses architecture which reads out pixels serially through a common read-out register. With this type of technology, some pixels continue to be irradiated while others are read out; thus smearing the image of a rapidly moving object.

Phase I: During this phase the effort should propose one or more read out architecture designs for an 8-12 micron FPA micro chip containing a minimum of 128x128 (256x256 desired) square pixels with a simultaneous pixel read out at 1,000 Hz frame rate. The FPA should have a D* of 3x10 *10 cm, a minimum dynamic range of 8 bits (12 bits desired), a responsivity uniformity of 5% for 1/4 the array's area about the center of the array, and a responsivity uniformity of 10% for 1/2 the array's area about the center of the array. The FPA micro chip should include external synchronization and external computer control of the start, stop, and reset functions.

Phase II: In this phase the effort should include the design of, fabrication of, and detailed test plan for demonstrating a prototype 8-12 micron FPA with the specification called out in phase I. Detailed test plan and supporting calculations should address these specifications.

Potential Commercial Market: The potential is very high. A camera with this FPA can be used in the medical field to study and analyze neuron activity in response to stimuli. A camera with this FPA can also be used by industry (especially automotive, aviation, and ship building) to analyze high speed motion of motorized components, turbine blade heat build up, thermal propagation and shock waves, laser annealing and damage, and integrated circuit (IC) inspections. In the chemical field, the FPA can be used to analyze violent chemical reactions.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-135TITLE: UWB Antennas

CATEGORY: Exploratory Development

OBJECTIVE: Determine the feasibility of an efficient, Ultra Wide Band (UWB), high input drive signal antenna, and the most practical technique to characterize this UWB antenna.

DESCRIPTION: Presently, there are various off the shelf antennas which meet some of the requirements in the UWB community. In recent years, the need to develop an efficient antenna with a bandwidth to cover from 50 to 1000 MHz and to handle input signals of more than 10 to 20 kv has arisen. This effort should focus on the design and development of an antenna with the above mentioned characteristics, and also restricted in size by the physical dimensions that will still allow the antenna to have such a broad bandwidth. Other critical characteristics for this type of antenna are its beam width and input impedance. The beam width parameter should be within the range of plus and minus 15 degrees and plus and minus 40 degrees, and the input impedance approximately 50 ohms.

Phase I: During Phase I, the effort should propose one or more designs for an antenna which can satisfy the above mentioned characteristics. This proposal should also include a formal plan on how to perform the antenna characterization.

Phase II: During Phase II, the effort should include the final design and fabrication of the antenna, and the conduct of the antenna characterization to include the data analyzed and processed defining all parameters of interest.

Potential Commercial Market: These antennas have the following potential commercial applications: 1. Provide U.S. companies an added capability for bidding on mine-clearing operations in areas such as the middle east. 2. Performance of EMC/EMI testing of final products in near to real-time on assembly lines. 3. As an aid to the mining industry for ground recognition in case of accidents, where additional information is needed when searching for survivors. 4. With proper filtering as part of general purpose communication systems.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-147TITLE: Machine Health Monitoring with Multi-Domain Smart Sensors

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate highly reliable diagnostic system which eliminates unwarranted component replacements.

DESCRIPTION: The removal and replacement of good components based on poor diagnostics is a major contributor to high operation and support costs. Many diagnostic systems are built around the monitoring of a single parameter. This type of system is prone to false alarms and consequent removal/replacement of good parts. New and emerging technology can be combined to greatly increase the reliability of a diagnostic system and avoid the false alarm problem.

Phase I: Selection of machine or sub-system to be monitored, parameters identified, algorithms defined, conceptual model developed, validation plan prepared.

Phase II: Fabricate and demonstrate system for chosen application.

Potential Commercial Market: Aircraft sub-systems, shipboard machinery, plant equipment.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-148TITLE: In Situ Fatigue Life Monitor

CATEGORY: Exploratory Development

OBJECTIVE: To design and demonstrate an integrated solid state device to measure component strain and calculate (rainflow cycle counting and Miner's cumulative damage algorithms) and display fatigue life expenditure. The application of this technology would increase the useful life of fatigue critical components, thereby reducing replacement costs.

DESCRIPTION: The Army has recently funded efforts toward development of solid state strain sensors and of integrated fatigue life calculation/display systems. A highly desirable extension of these efforts would be a completely integrated solid state device for measuring operational strains and calculating/displaying fatigue life expenditure. A totally self contained unit, including power, is desirable. Current technology should allow for a production unit about the size of a quarter.

Phase I: The initial effort will involve demonstration of strain measuring and logic capabilities of the selected solid state technology as well as preliminary design of an integrated system.

Phase II: This effort will involve detailed design, fabrication, and laboratory demonstration of a brassboard system.

Potential Commercial Market: The useful life of any limited fatigue life commercial aircraft part could be extended by monitoring actual fatigue strains. The potential commercial market for this technology is large.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-180TITLE: Low Cost Electric/Electronic Governor for Small (5-20hp) Diesel Engines

CATEGORY: Exploratory Development

OBJECTIVE: Develop a low cost electric/electronic governor for small (5-20hp) diesel engines used on generator sets.

DESCRIPTION: The Army is currently replacing its extensive inventory of small (1 1/2-10 kW) gasoline engine driven generator sets with diesel engine driven sets in order to remove gasoline from the battlefield and comply with the one fuel forward policy. Though all small diesel engines have a mechanical governor, it is sometimes necessary to replace these with a more precise governor. There are electric governors available, but they are designed for larger engines and are expensive when compared to the cost of a small diesel engine. A low cost electric/electronic governon needs to be developed that will meet the Army's small generator set requirements.

Phase I: Preliminary design and breadboard testing of the electric/electronic governor.

Phase II: Detail design, fabrication and testing of the electric/electronic governor. Application to an appropriate generator set to validate the design concept. This effort addresses S&T Thrusts in advanced land combat and the Star 21 focal values for electric drive technology.

Potential Commercial Market: Potential to replace mechanical governors on small diesel engines.

OSCR: #4 New technologies which reduce generator/battery size, improve the efficiency of the power generation/storage system, and/or provide alternate power sources to reduce logistics burdens will be considered under this topic.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-182TITLE: Soldier's Radio: Innovative Communications and Networking Technologies for the Individual Warrior

CATEGORY: Advanced Development

OBJECTIVE: To provide the Soldier/Warrior with a personal communications and robust networking capability by leveraging advances in the Personal Communications Services (PCS) field and developing military-unique technologies.

DESCRIPTION: Requirements for The Enhanced Integrated Soldier System (TEISS) call voice and data communications for the individual soldier and a robust network for the squad and platoon by FY2000. This is also a key element of DoD Science & Technology Thrust-8: "Sharpening the Warrior's Edge." The Soldier's Radio electronics will likely be on a card embedded or inserted in the Soldier's Computer and will utilize the computer's CPU, RAM, Mass Memory, display, and power source. While the precise frequency band has not been determined, it is expected to be above 900 MHz. Key technologies for this contract will include: security, power conservation techniques, network topology/hierarchy, protocols, voice/data contention, adaptive power, range extension in varying terrain, data relaying for range extension, adaptively modifying network base on dwindling power sources, and interfacing/interroperability/internetworking with other radios/networks. Offerors should assess which technologies and techniques can be leveraged and which will require unique focus under this contract. Offerors should contact DTIC for information on "Soldier's Radio". Offerors, or their team members, must show the capability to transition this work into both DoD and commercial products.

Phase I: Assess current technology and coordinate with related DoD programs. Work with DoD users to refine requirements. Develop comprehensive concepts for technologies to fulfill requirements. Submit Phase II proposal. Define Phase III plan for marketing Phase II results to DoD and commercial markets. Secure Phase III funding prospects.

Phase II: Develop proposed technologies and conduct a system level proof-of-principle demonstration utilizing developed, leveraged, or surrogate hardware/software and/or simulation. Propose Phase III follow-on development. Lay groundwork for Phase III development and DoD/commercial marketing.

Potential Commercial Market: This system has the potential for fulfilling the anticipated commercial demand for robust networking capabilities for PCS devices utilized by teams of mobile individuals.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-183TITLE: Soldier Audio Orientation and Integrated Command, Control and Communications System
CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate lower echelon knowledge technology to enhance soldier awareness and performance in a battlefield environment.

DESCRIPTION: The feasibility of conducting "hands free" command and control for lower echelon operations has been demonstrated recently in laboratory prototype tests. Similarly, advanced prototype communications soldier-machine interface devices have been demonstrated to continue to function in noisy and confined environments. Further technology development is required to integrate the communications with the command and control input and output devices to evaluate the effect of diminished audio cues when working in a hostile battlefield environment. Using

lower echelon knowledge, command and control, and communications technology demonstrate the means for restoral of normal soldier interfaces to enhance typical mission functions to include: tactical situation assessment, communications, command and control, planning, status and location reporting, reconnaissance, well-being, and training.

Phase I: Formulate and define conceptual integrated designs that accommodate simultaneous and combined functionality, including hardware implementation and software prototyping, to demonstrate enhanced soldier performance when using linked knowledge and acoustic resources.

Phase II: Develop and prototype a field demonstrable integrated system that has optimized the lower echelon command and control, communications, and situation awareness interfaces for "hands free" operations on-the-move in a hostile battlefield and contaminated environment.

Potential Commercial Market: The primary market for this technology development is the military. Civilian market opportunities exist for operations in hazardous environments where protective suits may be employed.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-184TITLE: Soldier's Computer Concepts in Maintenance and Logistic Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop applications which utilize Soldier's Computer concepts and technologies for use in maintenance and logistics support operations.

DESCRIPTION: The Soldier's Computer program being developed at CECOM will provide soldiers with a state of the art integrated communications and information processing capability consisting of a shirt pocket or belt mounted computer, miniaturized head mounted display, voice recognition input/output (I/O) control system, and communications radio subsystems. Many new logistic applications of this technology are envisioned for field and depot use. This technology can be adapted for shipping, transportation & packaging applications, training applications, stockroom parts/supply applications, large scale indoor/outdoor warehousing & inventory & materiel tracking/location/identification applications, and others.

Phase I: Conduct a feasibility study to identify and examine various candidate applications for utilization of the Soldier's Computer concepts and technologies. The study should examine available hardware/software products, system architectures, system costs, technical and technological risks, human factors, and environmental considerations. The study should propose one or more candidate applications for further development and detailed evaluation.

Phase II: Design, develop, and fabricate a prototype demonstration system that can be used to conduct test and evaluation activities and demonstrate system feasibility, utility, and worthiness for the candidate application.

Potential Commercial Market: This technology can support both military and commercial needs. The private sector must provide similar support services for products it sells in the commercial marketplace. Consequently, any applications successfully developed for military application will have similar or identical application in the commercial sector.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-187TITLE: Advanced Video Compression Techniques

CATEGORY: Advanced Development

OBJECTIVE: Evaluate recent advances in video compression technology for transmission of both near full-motion and still color images of varying resolution in two distinct environments: circuit/packet switched telecommunications and PC Local Area Networks (LANs).

DESCRIPTION: There is a growing need to provide video and still imagery to both commanders and front-line troops on the battlefield. This is a thrust of Battlefield Information Systems -2015 (BIS-2015). In order to provide such imagery over limited bandwidth, new and improved lossless and lossy compression techniques for imagery need to be explored, developed and exploited. Further exploration on both intra-frame and inter-frame compression techniques for

live video need to be examined. New techniques, such as wavelets and fractals need to be refined into usable software/hardware to meet the Army's needs.

Phase I: Survey existing video and imagery compression techniques with a key emphasis on maximum compression possible with limited loss. The approach and feasibility of a transcoding technique to standards such as National Imagery Transmission Format (NITF), Motion Picture Experts Group (MPEG), Joint Photographic Experts Group (JPEG), or P*64 from any state-of-the-art technique should also be clearly defined.

Phase II: Implement one or more of the recommended techniques from Phase I, including the transcoding device in prototype hardware/software to interface with existing or developing systems such as the Soldier's Computer, Mobile Subscriber Equipment, or SINCGARS radio. Demonstrate this working prototype with simple scenarios at Ft. Monmouth upon completion of the project. The prototype system, along with all hardware/software will become the property of the Government upon contract completion. Rights to pre-existing algorithms and software will remain with the originator, with the government retaining a user license for the prototype system.

Potential Commercial Market: The area of video compression, both for video teleconferencing, multimedia conferences, and PC distribution is rapidly expanding. This product has unlimited potential in the commercial world and can be utilized by any large telecommunications carrier or PC hardware/software house.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-188TITLE: Spread Spectrum Technology for Communications on the Move

CATEGORY: Advanced Development

OBJECTIVE: The objective of the Phase I effort is to investigate the feasibility of developing a spread spectrum mobile radio communications system (including suitable antenna design) capable of transmitting and receiving digital voice, data, and video in a multi-user environment to support line-of-sight (LOS) and non-LOS communications on the move.

DESCRIPTION: The use of Spread Spectrum technology will allow radio communications on the move between multiple users at the same time. Considerations shall be given to minimizing multipath, mutual interference between users and spectrum allocation, while maximizing distance between users. Consideration shall also be given to efficient baseband modulation and error correction coding techniques to minimize emission bandwidth and Signal-to-Noise-Ratio (SNR) requirements for a given Bit-Error-Rate (BER). Maximum use of commercially available equipment shall be considered.

Phase I: Investigate the feasibility of developing a spread spectrum mobile radio communications system (including antenna design) capable of transmitting and receiving digital voice, data, and video in a multi-user environment to support line-of-sight (LOS) and non-LOS communications on the move.

Phase II: Phase II effort will continue ongoing research and development efforts of the Phase I program including hardware development.

Potential Commercial Market: Potential commercial market use of this technology is in multi-user wireless mobile communications.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-190TITLE: Interoperable Power Adapter and Charger (IPAC) Technology

CATEGORY: Advanced Development

OBJECTIVE: Analyze, develop and evaluate advanced electric power conditioning and battery charger technology interoperable with U.S. Army manportable command, control, communications, computer, and intelligence (C4I) equipment; rechargeable energy storage devices; and commercial and military electric power sources.

DESCRIPTION: Electric power generation and storage is a principal operating and support (O&S) life cycle cost driver of sophisticated military equipment. Primary battery types are routinely assigned as principal electric power sources for U.S. Army manportable C4I equipment due to mission critical operational, performance, and environmental requirements. Equipment utilization and maintenance procedures and primary battery supply

acquisition, storage, transportation and disposal practices significantly contribute to increased cost per unit energy and decreased energy capacity of primary battery types despite technical advancements in electrochemical primary cell chemistries and battery designs. A lightweight, manportable device is needed which is interoperable with a variety of commercial and military electric power sources (i.e., generator sets, vehicle power, auxiliary power units, etc.) U.S. Army manportable C4I equipment, and rechargeable energy storage devices in a tactical field environment. The IPAC device will implement advanced electric power conditioning components, microelectronic devices, and secondary battery charging techniques to provide quality electric power to manportable C4I equipment and to increase the efficiency and prolong the service life of secondary batteries. The IPAC design will provide an uninterrupted power supply capability for manportable C4I equipment, where required. The IPAC device will be reliable and survivable, and feature a modular design and user interface for easy operation and maintenance in hostile military environments.

Phase I: Conduct investigation, analyses, synthesis, and technical tests to identify and allocate functional requirements. Document initial research, preliminary design, and development plans for Phase II.

Phase II: Develop, test, and evaluate engineering development model to demonstrate feasibility of IPAC design. Update design and document Phase II effort and plans for commercialization.

Potential Commercial Market: The IPAC technology will support both military and commercial needs in the manportable C4I and telecommunications equipment marketplace.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-191TITLE: Parallel Processing Effort

CATEGORY: Exploratory Development

OBJECTIVE: To survey and develop software support tools in the field of parallel processing.

DESCRIPTION: As imbedded processor applications become more and more complex the need for greater processor speed is becoming critical. The increases in throughput of single processors has not kept pace with the computational demands of the applications and functions. This situation is expected to worsen as fabrication and construction techniques reach their theoretical limits. The most attractive solution to the throughput shortfall is to employ multiple processors performing parallel computations. This solution creates another problem. How is a complex application divided into individual tasks in a manner which maximizes temporal independences?

Phase I: The contractor shall identify the functions necessary to support the government's requirements in the field of parallel processing. To satisfy those requirements the contractor shall survey the field of commercially-off-the-shelf (COTS) and developmental products which support parallel processing. Of interest to the government are software development products and operating systems which facilitate the development of parallel processing software, the supporting of existing single processor software to parallel processor platforms and the execution of parallel processing software. Issues such as processor throughput optimization through static and dynamic load balancing, degree of automation and availability are of particular importance and should be highlighted in the survey. If the survey fails to identify parallel processing products which are sufficiently mature for practical employment, the contractor shall identify those agencies which are considered preeminent in the field of parallel processing research and provide recommendations to the government as to the best development course to follow, along with estimated costs. All recommendations must be amply supported by documented current work in the field of parallel processing. As Phase II will involve development on the part of the contractor to a minimum of one half the expenditure, contractor must document it's own qualifications to perform development work to generate the products required. The documentation must include past work in the field.

Phase II: The contractor shall initiate the Government approved development course and produce the required parallel processing products and capabilities identified as a result of Phase I.

Potential Commercial Market: This work could result in a very marketable product as the trend in the computer industry is tending toward multi-processor platforms but the software development tools are not keeping pace with the hardware.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-192TITLE: Soldier Identification (SID)

CATEGORY: Exploratory Development

OBJECTIVE: Develop, test and demonstrate the capabilities to identify individual soldiers through the use of cooperative and/or non-cooperative techniques.

DESCRIPTION: The increasing use of weapons capable to engage targets at ranges beyond aided and unaided visual capabilities as well as the advent of the non linear battlefield has heightened the need for SID capabilities. This effort is aimed at developing and demonstrating one or more techniques to identify at least the allegiance of individual soldiers. As a reaction to fratricide issue from Operation Desert Storm this effort will emphasize the identification of friendly forces. Given that friendly individual soldiers are to be identified, it is expected for cooperative techniques to have the highest payoff. Cooperative techniques are those that require an interaction between the interrogator and the responder. This interaction: could be either automatic or manual were the interrogated soldier is alerted to initiate a response; could consist of an exchange of energy transmission at different wavelengths (e.g., RF, optical, acoustic) and; must provide for a small, lightweight manportable responder system. The system should also provide covert and secure operation. Covert operation reduces the probability of intercept (non-exploitable) and secure operation reduces the potential for compromises.

Phase I: Demonstrate the feasibility of the solution by analysis, simulation or laboratory testing. Feasibility will be established using specific measures of effectiveness to be defined during the kickoff meeting. Those measures will be based on specific Government requirements. If deficiencies are identified, alternatives will be proposed based on a trade off analysis.

Phase II: Design, develop, prototype and demonstrate the SID system as per the proposed configuration of Phase I. The demonstration will take into account operational issues to include but not limited to covert and secure operation, size and weight of the responder and host systems for the interrogator.

Potential Commercial Market: A derivative of the SID system could be used for civilian applications where detection and identification of items and personnel from 100 meters or so is required. Some of the envisioned applications include: inventory, motor vehicle identification and intelligent intrusion detection systems. Under the inventory application, part numbers of items could be quickly and automatically recorded without handling the items and even if the items are packaged for shipment and assembled into a system.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-193TITLE: Millimeter Wave (MMW) Radar Measurement of Ice Formation on Aircraft Wings

CATEGORY: Exploratory Development

OBJECTIVE: Analyze the feasibility of using a radar to measure the amount of ice accumulated on an aircraft wing.

Phase I: Conduct an analysis of the applicability of MMW radar's capability to measure the formation of ice on aircraft wings and rotors. Investigate High Range Resolution requirements to map the aircraft wing. Define the radar parameters necessary to measure the boundary layers between ice, slush and the metal wing. Define the impact of atmospherics on the measurement of ice on the wings. Identify the performance range of a MMW radar in conducting the measurement in various levels of snow, sleet, or freezing rain.

Phase II: Utilizing the Radar Division's MMW radar target measurement system, collect and analyze data on ice measurement using radar. Provide a detailed report and system performance specification.

Potential Commercial Market: Airport de-icing efforts. Ice detection.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-194TITLE: Radar and Communications Intercept and Analysis System

CATEGORY: Exploratory Development

OBJECTIVE: To develop an RF Intercept System capable of analyzing, depicting and graphical representation of jamming techniques in simulated and actual environments during real time scenarios. The frequency band of interest is 500 MHZ through 40 GHZ and will be capable of pulse characterization.

DESCRIPTION: A need currently exists to develop a system or systems which allow both communication and radar jamming effectiveness to be evaluated during run time of a system. The ability to utilize this same equipment for live testing is desirable.

Phase I: During this phase, the offeror will analyze the specific requirements to IEWD and their applicability to the simulated and real environments being used in the Systems Integration/techniques development laboratory. As a result of this analysis, the offeror will generate a complete design and integration plan. The offeror is requested to examine commercially available systems and subsystems in order to minimize purchase, maintenance and operational costs. The offeror will delineate and provide hardware recommendations which will meet the spirit of the "objective" and "description" portions above. In addition, they will specify all hardware and highlight the attributes of all recommended hardware subsystems, systems and pieceparts. In addition, the preliminary innovation integration scheme(s) to be used in achieving this effort will be identified.

Phase II: The offeror will procure/fabricate/design the necessary hardware to meet the general requirements set forth here and the specific requirements as delineated by the contract Statement of Work (SOW). The offeror will integrate and test the delivered system(s) according to a test plan approved by the government. The offeror will train government personnel as necessary to enable self-sufficient operation of the equipment by government personnel.

Potential Commercial Market: Applications may include commercial Radar and Communications Analysis (Terrestrial/Space Comm and Commercial Radar analysis, FAA, NASA, etc.). Potential customers may include FAA, NASA, DEA, and FBI. This system may be a viable candidate for superconducting material usage/integration.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-195TITLE: Radar Target Simulators

CATEGORY: Exploratory Development

OBJECTIVE: Develop design concepts for radar target simulators. Simulator would be applicable to radar cross section measurements in support of low observable technologies.

DESCRIPTION: Radar target simulators are needed which will provide small size units which will draw small amounts of prime power and simulate radar targets with varying velocity (Doppler frequencies), amplitude (radar cross section), and range (pulse delay). These simulators are meant for field use in calibrating radars, and will be designed to operate off 12 volt vehicle battery power. The radars operational frequencies will range from 1 to 95 GHz. Target velocities will range from 1 m/sec to 200 m/sec, radar cross section will be capable of being varied over a 50 db range, and range will be capable of being varied for 1km to 50km. The simulators would be designed to be observed from airborne as well as ground based radars. GENERAL: Radars, particularly instrumentation radars, are required to provide accurate target amplitude and positional information. When performing radar field calibration, it is often very expensive and time consuming to position varying cross section calibrated targets at a variety of ranges. Simulators would significantly reduce the measurement problem, as well as provide improvements when doing multipath measurements.

Phase I: Create the design for the radar target simulators over the requirements stated above.

Phase II: Develop and fabricate models for selected frequencies for demonstration and test.

Potential Commercial Market: This SBIR would have commercial application in the Federal Aviation Agency Research & Development for commercial aircraft radar design.

TECHNOLOGY CLUSTER: A-3

TOPIC: A93-196TITLE: Advanced Deception Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To develop advanced Deception Capabilities to complement existing technologies and systems.

DESCRIPTION: Low intensity conflict being more of a probability places convert and low observable technologies/techniques in the fore front.

Phase I: To devise, develop and plan a program to initiate Advanced Deception Techniques, complementing those currently available. These techniques/devices will utilize state of the art electronics and will provide cost effectiveness to the government. The offeror will provide Rough Order of Magnitude (ROMs) for those techniques of which hardware will be built.

Phase II: Hardware development and test laboratory and field test against surrogate threats.

Potential Commercial Market: Although this topic may not be directly applicable to one commercial market, the inherent technology required will enhance state of the art in several areas: packaging, electronic density, precision delay devices, RF power.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-197TITLE: Synthetic Aperture Radar (SAR) Countermeasure (CM)

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-199TITLE: Large Well Capacity Input Circuit

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate a Readout Integrated Circuit (ROIC) Input Circuit having well capacity = 1.0E8 carriers/400 um^2

DESCRIPTION: Mercury Cadmium Telluride (HCT) has a high quantum efficiency that cannot presently be taken advantage of in STARING applications. This is due to the limited well capacity of the integrating capacitor in the ROIC input circuit. The impact is that the 30 frame per second HCT staring Focal Plane Arrays (FPAs) have sensitivity little better than Platinum Silicide (PtSi) Staring FPAs. Input circuits with well capacities an order of magnitude grater than PtSi in similar sized unit cells would provide significant sensitivity margin over PtSi that could be traded for smaller optics, etc. The technology used here would also permit capacitors with small physical size in SCANNING unit cells and leave room for other functions.

Phase I: During this phase of the program a study/investigation will be made to determine material, processing techniques and capacitor architectures that could lead to an increase in the capacitor's well capacity. Other storage circuits which could possibly replace the capacitor will also be investigated. Concepts to be implemented in Phase II will be identified.

Phase II: During this phase of the program, concepts identified in Phase I will be implemented. The effort would be performed using small, inexpensive test devices and SPICE modeling. The well capacity of each test device will be measured. Failures as well as successes will be explained. The design, fabrication procedure and performance of the circuit will be presented to Infrared Focal Plane array (IRFPA) suppliers with the anticipation that IRFPA suppliers will incorporate the circuit into their ROICs/FPAs which require large well capacity.

Potential Commercial Market: This is intended for high performance, high dynamic range military IR system applications. However, with the commercialization of a subset of these, this circuitry may apply to various public sectors, e.g., environmental, meteorological, agricultural areas.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-200TITLE: Superlinear Readout Integrated Circuit (ROIC)

CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate a ROIC having linearity sufficient to achieve Standardized Advanced Dewar Assembly I (SADA I) and Standardized Advanced Dewar Assembly II (SADA II) post correction uniformity.

DESCRIPTION: A ROIC with sufficient linearity to achieve the 2-point post correction uniformity required by SADA I AND SADA II has not been developed. Present silicon models are insufficient to directly design to the required level of approximately .02% non-linearity.

Phase I: During this phase of the program, a ROIC circuit between the detector input node and the ROIC output driver would be designed with .02% nonlinearity. The effort would be performed using small, inexpensive test devices and SPICE modeling. A number of iterations would be conducted until the proper circuit design was defined.

Phase II: During Phase II, the final circuit design of Phase I would be fabricated and tested for linearity, dynamic range, noise, gain, and frequency response. The design, fabrication procedure and performance of the circuit will be presented to Infrared Focal Plane Array (IRFPA) suppliers with the anticipation that IRFPA suppliers will incorporate the circuit into their ROICs/FPAs which require approximately .02% nonlinearity.

Potential Commercial Market: This is intended for high performance, high dynamic range military IR system applications. However, with the commercialization of a subset of these, this circuitry may apply to various public sectors, e.g., environmental, meteorological, agricultural areas.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-201TITLE: Zero Droop Readout Integrated Circuit (ROIC) Thermal Reference Substraction (TRS)
CATEGORY: Exploratory Development

OBJECTIVE: Demonstrate an On-Readout Integrated Circuit (ROIC) Thermal Reference Analog Memory Element with Drift/Droop Rate Slower Than .01% of Full Signal Per Hour.

DESCRIPTION: The present Standardized Advanced Dewar Assembly (SADA) pre-correction offset fixed pattern noise is 250 mv p-p. This uses some of the system A/D dynamic range, but, more importantly, increases residual (uncorrectable) A/D convertor fixed pattern noise and hence scene fixed pattern noise. Focal Plane Array (FPA) Thermal Reference Substraction (TRS) circuitry that reduced the pre-correction offset fixed pattern noise by about 2 orders of magnitude has been implemented, however, system users do not desire to use it because of possible droop and the fact that the set level changes from frame to frame too fast for system gain and offset correction to fix.

Phase I: During this phase of the program, an on-ROIC TRS circuit with infinite droop time ("infinite hold subtraction circuit") will be designed. The design will be such that the offset level could be set once at system turn-on and not further changed. The effort would be performed using small, inexpensive test devices and SPICE modeling. A number of iterations would be conducted until the proper circuit design was defined.

Phase II: During Phase II, the final circuit design of Phase I would be fabricated and tested for offset correction and droop time. The design, fabrication procedure and performance of the circuit will be presented to Infrared Focal Plane Array (IRFPA) suppliers with the anticipation that IRFPA suppliers will incorporate the circuit into their ROICS/FPAs that require offset fixed pattern noise correction.

Potential Commercial Market: This is intended for high performance, high dynamic range military IR system applications. However, with the commercialization of a subset of these, this circuitry may apply to various public sectors, e.g., environmental, meteorological, agricultural areas.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-202TITLE: Technology for Transition from Ada 83 to Ada 9X

CATEGORY: Exploratory Development

OBJECTIVE: Determine approaches, techniques, and appropriate support tools that will facilitate the transition to Ada 9X on mission-critical software systems currently written in Ada 83.

DESCRIPTION: The Ada language revision, Ada 9X, will result in increased capabilities for Army mission-critical systems previously developed in Ada 83. These will include, for example, facilities for real-time programming such as data synchronization with protected types, support for programming-in-the-large through hierarchical library units, and support for object-oriented programming concepts. There will be advantages to transitioning software to Ada 9X with its increased capabilities if it can be done in an automated way that doesn't jeopardize the robustness and integrity of the original system. This SBIR will address the issues associated with providing effective methods and processes for transitioning Ada 83 mission-critical software to Ada 9X. This may include but not be limited to: redesign aids, translation techniques, reengineering approaches, inclusion of performance considerations, and testing. Having effective transition approaches to use Ada 9X, a standard language built on software engineering principles, will aid in lowering software maintenance and support costs.

Phase I: Formulate an approach and appropriate support to expedite the transition of Ada 83 mission-critical software systems to Ada 9X.

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

Potential Commercial Market: More commercial applications are using Ada for their large software projects. Having effective ways to transition to Ada 9X will allow them to incorporate the advantages and features of Ada 9X and ensure a greater market for Ada in the future.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-203TITLE: Management Metrics Decision System

CATEGORY: Exploratory Development

OBJECTIVE: Develop a management metrics decision system to assist in making programmatic and technical decisions concerning management metrics program implementations on software projects.

DESCRIPTION: There is critical need to furnish high-level insight of software lifecycle management and technical processes and products, in order to give managers control over project direction. Insight comes from smart use of software management metrics. Managers need assistance in making decisions concerning; whether or not metrics will be helpful; what measures; and what resources, are required; what corrective actions are available and reasonable to apply; and, which corrective actions represent acceptable risk. The decision system should include an informational subsystem, to answer questions on metrics program implementations, that is based on input provided to a menu-driven query subsystem which addresses system technical approach and programmatic priorities. This subsystem will help a manager decide on a metrics program and its specifics, and provide information on the most useful measures. The decision system will also be used for sensitivity studies, to do trade-off analyses of resource requirements. For on-going metrics programs, it would help decide alternative courses of corrective action based on metric reports and correlations. Flexibility is needed to accommodate existing metric sets, and how each addresses primary manager concerns. Use of management metrics is now widely accepted as an effective means of providing managers control of their projects based on their priorities, risks and constraints. Metrics support the concept of "building quality in", and thus will lead to significant cost savings in the area of maintenance and support of deployed systems. The proposed management metrics decision system will be a major contributor to building quality systems and reducing operational support costs.

Phase I: Demonstrate proof-of-concept and feasibility. Develop a plan of approach. Address risk and technical alternatives.

Phase II: Develop prototype of the system and provide a demonstration of its capabilities. Develop technology transfer mechanisms such as informal seminars and, hands-on tutoring including management games scenarios.

Potential Commercial Market: This type of automated technology is of prime interest to acquisition organizations charged with the development of large, complex defense industry software systems, and therefore, is of prime interest to private sector defense contractors.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-204TITLE: Ada 9X Graphical Design Support

CATEGORY: Exploratory Development

OBJECTIVE: Determine methods and appropriate automated graphical support that will facilitate the design of mission-critical software applications, in particular real-time, using Ada 9X as the implementation language.

DESCRIPTION: The Ada language revision, Ada 9X, will result in increased capabilities for the development of Army mission-critical systems. These will include, for example, facilities for real-time programming such as data synchronization with protected types, support for programming-in-the-large, and support for object-oriented programming concepts. Methods that currently exist for supporting the design of software using Ada 83 will have to be extended and adapted to incorporate all of the features proposed for Ada 9X. To enhance the communication required between management and the design team, and to increase productivity, the methods must allow the visualization of the design, and have automated support. Having effective approaches for developing mission critical applications using Ada 9X, a standard language built on software engineering principles, will aid in lowering software maintenance and support costs. This SBIR will address the issues associated with providing graphical support for the design of Ada 9X mission-critical software. This may include but not be limited to: the selection of a method that uses graphical representations that correspond to the entire proposed Ada 9X language revision and an approach for addressing application performance considerations.

Phase I: Select a method and define graphical support needed for the creation of mission-critical software systems using Ada 9X. All features in the 9X version of the language must be addressed.

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

Potential Commercial Market: The number of commercial companies using Ada for their large software projects is increasing. Using an effective graphical design method that incorporates the advantages and features of Ada 9X and has automated support, will allow them to use Ada for a wider range of applications, ensuring a greater market for Ada in the future.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-205TITLE: Intelligent Multi-Mode Tactical Communications Interface

CATEGORY: Engineering Development

OBJECTIVE: To develop an intelligent communications processor interface for continuous assessment and selection of the best available communications ports.

DESCRIPTION: Army tactical communications systems currently have multiple medias available for the transport of data communications. The focus for this effort is to develop a user friendly solution that will allow simultaneous connectivity to all available communications media with continuous fully automated assessment and selection of the best mode to be used at any given time. Developed product ideally would be modular for inclusion in standard data terminals and not unnecessarily degrade other operations and functions.

Phase I: Define parameters and algorithms for software design and determine preliminary hardware approach.

Phase II: Develop and refine technical requirements and build functional prototype, demonstrate product in the Army CECOM Comm Design Center with MSE.

Potential Commercial Market: Tailoring of specific interfaces on both the terminal and communications media interfaces of the device would enable wide applications in commercial as well as both strategic and tactical military applications.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-206TITLE: Solar Power Array/Satellite Communications Antenna

CATEGORY: Exploratory Development

OBJECTIVE: To combine a solar power array with a satellite communications antenna.

DESCRIPTION: Satellite communication is a necessity for teams that are deployed away from their parent organizations. Such teams must be self-sufficient and cannot rely on resupply of batteries. A solar power system capable of operating the radios during the day and recharging batteries for night operations will increase the teams self-sufficiency and reduce operating costs. Combining the system with the radio's antenna eliminates the need to carry a separate antenna. The combined antenna and solar power array must fold to a small size and be lightweight. The antenna must be compatible with commercial and military Ultra High Frequency (UHF) radios currently used by the U.S. Military.

Phase I: This phase of the program will survey current UHF satellite communications systems and radios, government agencies and potential commercial users for requirements, conduct trade off studies and develop a preliminary design for the array/antenna. The deliverables from this phase shall include a functional specification for the array/antenna, design report and survey and trade off study results.

Phase II: Complete the design, fabricate and demonstrate fully capable solar power array/antennas. The contractor shall explore the adaptation of the array/antenna technology to other frequencies and systems. The deliverables from this phase shall include four array/antennas, commercial design drawings, a technical report on the performance of the array/antennas and report on the adaptation of the array/antenna to other frequencies/systems.

Potential Commercial Market: A combined antenna and solar power array may be used with commercial satellite communication systems and adapting it to other frequencies and radio systems. The solar power array/antenna may be used to power unattended radio systems used for weather stations geological surveys, etc.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-207TITLE: Versa Module Euro Standard (VMEbus) (ANSI/IEEE-1014-1987) Compliant Radio Frequency (RF) Down Convertor

CATEGORY: Advanced Development

OBJECTIVE: To construct a high performance VMEbus compliance RF down convertor operational over a frequency range of DC to 1.8 Ghz.

DESCRIPTION: VMEbus signal processing systems are supporting a growing emphasis on common module architectures. A VMEbus RF down convertor is a natural compliment to the wide range of high performance signal processing boards available for the VMEbus. An excellent selection of Microwave Monolithic Integrated Circuit (MMIC) devices, a simple Intermediate Frequency (IF) plan and well understood noise mitigation practices allows this design to be developed with only a moderate amount of risk. The IF strip will contain a sub-octave preselector, digital attenuator and two signal paths: direct current (DC) to 10 Mhz to 1800 Mhz. The DC to 10 Mhz path will be preselected, amplified and directly digitized using a 25.6 Mhz sampling analog to digital convertor (ADC). The 10-1800 Mhz path will be upconverted to a first IF of approximately 3700 Mhz. The second local oscillator (LO) will down convert to a common IF of 70 Mhz, and the third LO will baseband to RF to a 6.4 Mhz center frequency with a 10 Mhz wide bandwidth. This module is expected to utilize one 6U VMEbus slot. The 10 Mhz analog baseband output will be supplied through the front panel. Commercially available components will be used throughout. The local oscillators will be supplied by a second VMEbus card. Target performance will be tuning speeds of less than 100 usec with very low close-in and wideband phase noise. This module is expected to utilize one 6U VMEbus slot. Phase coherence among LOs would make the down convertor suitable for direction finding. Local oscillators will be supplied through front panel connectors. All control functions will be programmed via VMEbus. Full Institute of Electrical and Electronic Engineers (IEEE) P.1014 compatibility will be required. Proper attention to design details will ensure the VMEbus noise problems are successfully minimized.

Phase I: The contractor will investigate the IF plan and choose the RF components (connectors antenuators, switches, mixers, amplifiers and filters) to implement the design. Careful attention will be given to noise abatement and RF shielding. The LO module will also be designed. The IF strip will be simulated using spur and noise figure analysis. A final report with schematics, parts lists, and simulation results will detail the Phase I effort.

Phase II: The contractor will construct the down convertor designed during Phase I. This will include layout, parts procurement, test and debug. Deliverables will include working convertor, all design information for convertor construction and all modeling and simulation results.

Potential Commercial Market: There is a large market within the intelligence community for small, standardized signal processing modules. This RF module would benefit the Army's Ground Based CommonSensor,

Guardrail, Trojan and other signal intercept programs. In addition this design would immediately become part of a companies standard product line. By developing a high performance RF downconvertor for the VMEbus, signal processing applications throughout DoD have a vehicle for total integration of a standard, commercially available architecture.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-209TITLE: Frequency Scan Optimization

CATEGORY: Basic Research

OBJECTIVE: Schedule a list of prioritized channels to maximize the numbers of high-interest signals detected per scan.

DESCRIPTION: Given a list of labeled frequency bands, a table which prioritized each band, the duration of a signal expected to appear in a band, and a table which indicates over what broad time interval a signal is normally active, develop a schedule to search the spectrum which maximizes the number of signals of high interest detected during any particular scan. The schedule consists of an ordered list of pairs, where each pair is a frequency band with an associated dwell time. Accommodations should be made to add new bands or delete old bands at arbitrary times. This problem is classic, but remains unsolved and very relevant. Army applications including scheduling scans for the TROJAN system. Potential offerors should be advised that the problem cannot be addressed simply as an exercise in expected value as defined in classical probability theory, since the scheduling problem is NP-hard, in the same class as the knapsack problem, bin packing, and the traveling salesman problem. Approximate solutions are acceptable, but unless accompanied by convincing proofs that estimates converge within a neighborhood of admissibility, will be greeted with skepticism.

Phase I: Development of scheduling technique and accompanying proof of convergence within bounds of admissible result. Limited implementation with ten sets of signal data generated by the offeror, each containing one hundred simulated signals of varying frequency, duration, bandwidth, priority and daily temporal mode.

Phase II: Upon government acceptance of Phase I results, offeror may proceed with full-scale implementation on a library of signals, generated by the offeror and accepted by the government as representative.

Potential Commercial Market: Communications industry, cellular and cordless phones, citizens band radio, surveillance, counternarcotics, rescue, electronic countermeasures.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-210TITLE: Advanced Hardware for Intelligence Electronic Warfare (IEW0) Common Architectures
CATEGORY: Exploratory Development

OBJECTIVE: Reduction of Operations and Support (O&S) Costs through the use of common digital hardware throughout an IEW System.

DESCRIPTION: Current Communications ESM/ECM systems are essentially totally digital hardware. However the systems are composed of multiple types of different digital technology: specialized signal processors; general purpose computers; fast personal computers; signal analysis workstations; and application specific integrated circuits. These components (as line replaceable items or circuit card assemblies) must be stocked as spares and configuration managed separately. Operational and Support (O&S) costs are driven by the numbers of different items that must be maintained in the inventory. The highly parallel architecture as now used allows consideration of a system composed of common digital processing components for almost all functions. Although the common digital processor may be more expensive than any one component now used, the large number, even in low density equipment field applications, of the same component can reduce production costs and O&S costs. The common processor must account for the high data processing speeds needed for high dynamic range, 4k to 16k point Fast Fourier Transforms (FFT), signal acquisition/analysis in milliseconds in dense environments and real time multiple signal ECM response. This may be accomplished with common processors through the use of innovative algorithms, special application chips host common, lower performance, processors or a combination of approaches.

Phase I: This will be trade-offs of various candidate architectures, simulations of the response of these architectures for performance and estimates of resulting O&S cost reductions to be achieved. Key issues are ways to handle both low and high speed functions, input and output translations, data bus and signal path optimization and producibility/costs per processor/function. Driving point functions and their sensitivity must be identified. A final technical report will describe in detail the results.

Phase II: A single real time operating breadboard thread of the selected architecture and components will be assembled to verify performance and better refine O&S cost reduction estimates. The deliverables would be the architectural design of a system based on the breadboard and a final technical report.

Potential Commercial Market: In this phase it is anticipated a sponsor would fund an advanced technology test bed demonstration of a complete ESM/ECM system. In addition this concept has application to radio transceivers of all types, including satellite communications and radio data handling networks.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-211TITLE: Data Communications Support for C4I for the Warrior

CATEGORY: Engineering Development

OBJECTIVE: To develop software and/or hardware products to enable commercial personal computer networking on existing Army tactical data systems.

DESCRIPTION: Current Army concepts call for a seamless C3 architecture linking tactical and strategic data communications resources. Computer assets provide the remaining element for the total C4I concept. Modifications to existing commercial networking products (supporting Dod protocols) will result in global C4I capabilities via existing Army tactical and strategic networks. The current approach is to develop or enhance commercial networking software and hardware technologies compatible with the Army tactical interface specifications (based on DoD protocols) for standard commercial automation platforms (personal computers).

Phase I: This is the concept validation phase. Alternative products and approaches should be investigated. The only required deliverable in Phase I is a report documenting the results of the investigations and analyses and describing the selected candidate products.

Phase II: This is the prototyping phase. A prototype of the proposed product will be developed and demonstrated to ensure interoperability with tactical systems at CECOM.

Potential Commercial Market: Lack of products that provide this functionality is a current void in computer communications products. Data networks targeted to support these technologies exist and are stable. Computer communications products for the strategic echelons exist to provide the base for the enhancements outlined in this effort.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-260TITLE: Wavelet Characterization of Clutter for Enhanced Detection and Identification of Low Flying Target

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the possibility of characterizing various clutter environments for infrared (IR) or radio frequency (RF) sensors or both in real time and produce appropriate matched filters or signal processing algorithms for detection and/or identification of low flying targets.

DESCRIPTION: The U.S. Army Missile Command has been pursuing technology base programs on sensors for future Air Defense applications. The type of weapon system envisioned is a remotely launched missile which is guided through midcourse inertially with periodic updates from a fire control sensor. In the terminal mode the missile will be diving toward an estimated collision point while trying to acquire the target in an unknown clutter background. To enhance detection and identification, the clutter environment might be characterized using wavelet transforms. The resulting wavelet transform coefficients could then be used in real time algorithms to define the present clutter and use that information to detect and/or identify low flying targets. This technique might be utilized in the missile seeker for detection or in the ground based fire control sensor for both detection and identification purposes.

Phase I: The contractor shall investigate the use of wavelets or wavelet packets specifically designed to characterize clutter environments for either RF or IR sensors or both. This investigation may involve only the missile seeker case or the ground based sensor case or both. The use of actual clutter data is highly desirable in this part of the task. The goal is to demonstrate the capability (given appropriate computational resources) to characterize any one of several types of clutter environment in real time and to outline the approach which will be used to perform detection and/or identification.

Phase II: The contractor shall utilize the wavelet transform technique determined in Phase I as a starting point. The goal of this phase of the task is to demonstrate an algorithm which may operate in real time to produce either a matched filter or suitable signal processing for detection or identification of low flying targets in clutter. The contractor shall demonstrate the technique in real time using an appropriate test bed and real targets.

Potential Commercial Market: The results of this research is applicable to air traffic control, medical screening, security and surveillance, robotics and especially to earth sciences and mine detection.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-269TITLE: Transmitter-Receiver Isolation for Continuous Wave (CW) Radar Antenna

CATEGORY: Exploratory Development

OBJECTIVE: To develop a means of isolation between the transmit and receive antennas of a CW (continuous wave) radar that provides 110 dB or greater isolation for vertically polarized radiation.

DESCRIPTION: In order to achieve maximum detection range, sufficient isolation between the transmit and receive antennas of CW radars must be achieved. Septum designs provide one alternative to achieve an isolation level of no less than 110 dB for vertically polarized, stacked antennas with a one foot separation are sought. The designs should perform over the C, X, and Ku frequency bands to maximize their potential applications for various types of radars and missile seekers

Phase I: Provide detailed analysis of potential septum designs.

Phase II: Fabricate, test, and iterate designs of most promising septums.

Potential Commercial Market: This technology has commercial market potential for industrial use in telecommunications and for government use in radar systems.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-272TITLE: Real Time Lossless Data Compression Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To develop real time, lossless or near lossless, data compression techniques for high data rate sensors such as EO, IIR, MMW seekers, and fiber optic guidance system.

DESCRIPTION: Many presently fielded weapon systems as well as systems on the drawing boards, must transmit and store large volumes of digital data generated by EO (electro-optical), IIR (imaging infrared), and MMW (millimeter wave) sensors. The storage devices and data link equipment is large and cumbersome due to the volume of data that must be processed. Real time data compression offers the advantage of smaller storage devices and data link systems by reducing the volume of data without reducing the amount of information contained in the data. Innovative ideas are sought for the design and implementation of real time lossless or near lossless (less than 10 to the -3 BER) data compression techniques. The design should include techniques that operate at real time speeds (real time in this case, is that the compression technique works quickly enough that no noticeable time delay occurs if the sensor data is being viewed by an operator on a monitor while providing for a maximum retention of information in a minimum of compressed data. Proposals should contain detailed description of the technique as well as a description of its implementation. Emphasis will be placed on the techniques which are lossless or near lossless (less than 10 to -3 BER), and have the best information to compressed data ratios for digital data from EO, IIR, and MMW sensors.

Phase I: Provide detailed analysis of the proposed design including experimental evaluation plan.

Phase II: Develop hardware and perform laboratory demonstrations to verify the technical approach.

Potential Commercial Market: Millimeter wave electromagnetic energy penetrates some of the severest atmospheric conditions known and still provides a sufficient signal margin to produce images. Commercial markets can benefit from the use of this technology in several areas, however, one of the most important would be landing commercial aircraft in dense fog. The ability to image the runway would allow the pilot to safely land the aircraft. The difficulty arises in the storage of the data required to accomplish the image processing task. Real time data compression offers a solution to this storage problem.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-273TITLE: Millimeter Wave Conformal Antenna

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-274TITLE: Wide Bandwidth End-Fire Slotline Ring Antenna

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-278TITLE: Low Noise Frequency Agile Exciter

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-300TITLE: Visible Sensors

CATEGORY: Basic Research

OBJECTIVE: Innovative approaches and designs to improve visible sensor performance for ASAT application.

DESCRIPTION: This program is intended to promote advances in visible sensor design and related technologies for Kinetic Energy Anti-Satellite Program application. A sensor and its associated systems will provide to the kill vehicle the means to update position by stellar alignment as well as to detect, acquire, and track target satellites against a variety of backgrounds. The current ASAT design employs a staring visible seeker. Technical challenges include off-axis

light rejection, platform stability (jitter tolerance), long term storage reliability, cooling requirements. New and innovative approaches to these requirements using advanced concepts are sought. In addition to novel sensing concepts, sensor-related device technology is also needed in areas such as advanced focal plane arrays, improved device efficiency, improved optic baffle designs, platform damping, and image intensification methods.

Phase I: A phase I effort will provide proof of concept by means of preliminary design, simulation, and/or laboratory experimentation.

Phase II: A phase II effort will include detailed design, fabrication, and evaluation of a working, but not necessarily optimized, breadboard or brassboard model. Phase II proposals will also include an assessment of commercial markets for the devices to be developed during this phase of the project.

Potential Commercial Market: New or improved visible sensor designs will be readily applicable to commercial use in areas such as video cameras, robotics vision, visible navigational aids, product inspection.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-301TITLE: Anti-Satellite Kinetic Energy Weapons

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-302TITLE: Use of Tactical Lasers in Mine Detection and Counter-Mine Operations

CATEGORY: Advanced Development

OBJECTIVE: The objective of this development is to (1) explore possible methodologies using advanced tactical laser or laser concepts to remotely sense tactical minefields or other threat weapons and weapons systems on the battlefield, and (2) explore the potential capabilities of tactical lasers to neutralize and/or eliminate the detected minefields and weapon systems.

DESCRIPTION: Recent developments in laser technology have provided the potential to field relatively powerful tactical laser systems. Traditionally, lasers have been looked at as possible battlefield sensors, as well as, weapons to blind threat sensors and possibly destroy "soft" targets. This project would research specific methodologies that could possibly be employed to use lasers as remote sensors to locate and possibly destroy or neutralize tactical minefields.

Phase I: Research possible methodologies/techniques using lasers and laser technology to remotely sense tactical minefields. Research possible methodologies/mechanisms by which lasers can either destroy or neutralize tactical mines. Conduct preliminary design of laboratory and field experiments, using lasers available at HELSTF, to verify/validate research results.

Phase II: Refine the design of possible laboratory and field experiments to be conducted at HELSTF. Assist in the conduct of these experiments. Develop conceptual laser systems using methodologies validated by the research and experimental process.

Potential Commercial Market: Phase II proposals should also include a commercial applications for using laser technology for remote sensing.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-305TITLE: Hydroacoustic Impact Location System for the East Reef Area of the Kwajalein Atoll (KA)

CATEGORY: Basic Research

OBJECTIVE: The objective of this topic is to determine if there are practical alternatives to air-dropped sonobuoys/deep-ocean transponders for detecting reentry vehicle (RV) impact locations in the East Reef Area of the KA using hydroacoustic sensors.

DESCRIPTION: There is a current need for a highly reliable, low cost sensor system to score RV impacts in the ocean area in proximity to the East Reef of the KA. The use of P3/Orion-deployed sonobuoys is expensive. Alternative

hydroacoustic methods should be examined. Possibilities which might be considered include bottom mounted hydrophones and sonobuoys with GPS translators which are either bottom-moored, ship-deployed, or deployed by small planes. The area of interest extends to about 25 kilometers off the reef and reaches depths of about 3500 meters.

Phase I: Generation and analysis of alternatives. Selection of one option.

Phase II: Design of sensor system.

Potential Commercial Market: Phase II proposals should also include an assessment of the commercial applications and markets for use of hydroacoustic sensors in harbors and shipping lanes.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-307TITLE: Prediction of Rocket Exhaust Plume Microwave Attenuation for Kwajalein Atoll (KA) Launches

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-310TITLE: Automated Reduction of Kwajalein Missile Range (KMR) Optical Metric Data

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-311TITLE: Economic Value of Weather Support for Range Operations

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-312TITLE: Optical Sight Line Characterization

CATEGORY: Exploratory Development

OBJECTIVE: Optical measurements play a much greater role in range support, especially in strategic defense systems tests. Atmospheric effects can significantly degrade the fidelity of optical sensors. The goal of this research is to identify the best and most efficient way to characterize the atmosphere to remove these atmospheric effects from optical data.

DESCRIPTION: This program will focus on developments in passive or active technologies, systems and sub-systems which may be utilized in ground based and airborne applications. LIDARS and radars are the principal technologies of interest.

Phase I: Provide determination of feasibility by means of research, preliminary design, simulations and/or laboratory experimentation.

Phase II: Build upon the feasibility of Phase I results to provide demonstration through design, fabrication, and testing of a breadboard/brassboard model.

Phase III: Hardware will be developed specific to the ground based site or airborne application.

Potential Commercial Market: Phase II proposals should also include an assessment of the commercial applications and markets for methods of removing atmospheric effects from optical data.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-313TITLE: The Use of Infrared Technology for Tracking and Scoring

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-314TITLE: Use of Satellite-Based Radiometry in CLEARSKY for Support of Range Operations

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-3

TOPIC: A93-315TITLE: Advanced Audio Cue Generation and Projection for Distributed Interactive Simulation (DIS) Platforms

CATEGORY: Exploratory Development

OBJECTIVE: To develop an innovative audio special effects generation system capable of producing realistic 3-dimensional "battlefield" sound cues for DIS platforms.

DESCRIPTION: DIS synthetic battlespace environments such as the Army's Battlefield Distributed Simulation-Developmental(BDS-D) and Close Combat Tactical Trainer (CCTT) stand to benefit greatly from the creation of an advanced audio cue generation and projection system. Such a system should be capable of generating and projecting realistic complex representations of "battlefield" sound cues which include the Doppler effects of projectiles and other sound producing battlefield objects. These synthetically generated and projected "battle" sounds and cues should be perceived by the DIS training participants with the correct apparent sound intensity (within the published safety limitations) and spatial orientation.

Phase I: Develop cost effective DIS compatible concepts/designs for an advanced audio cue generation system.

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

Potential Commercial Market: Entertainment to include networked virtual environments and video arcades.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-316TITLE: Force/Tactile Feedback for Virtual Reality Environments

CATEGORY: Exploratory Development

OBJECTIVE: To develop realistic force/tactile feedback for Virtual Reality(VR) power gloves such that "the grasping and touching" of virtual objects will result in realistic tactile cues.

DESCRIPTION: In a virtual cockpit environment the pilot may be required to interact with virtual controls such as the control stick and other control instrumentation. To make these interactions realistic the pilot should experience appropriate tactile cues through the hands and fingers. This capability might be achieved through the design and integration of force/tactile feedback technology into the VR power gloves.

Phase I: Explore alternative concepts and develop a design and cost estimate for integrating force/tactile feedback into VR power gloves.

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

Potential Commercial Market: Home video games and arcade games.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-326TITLE: Preview Sensor Development

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a preview sensor for application in preview active suspension systems for combat vehicles.

DESCRIPTION: A sensor system that is capable of sensing cross-country terrain obstacles at a range of 5 - 30 feet in front of a combat vehicle is being solicited. The signal would be incorporated into an active suspension controller and provide feedback required to adjust suspension characteristics, braking or steering maneuvers. The sensor shall be able to distinguish solid obstacles (i.e., a rock versus a bush). The sensor shall be capable of sensing when an obstacle height is greater than the wheel travel of the vehicle. The sensor signature shall not be easily detected.

Phase I: The contractor will research promising sensor technologies and develop a concept for use in active suspension control. The design concept shall be proven from a feasibility standpoint. A final report will detail the Phase I effort.

Phase II: The contractor will continue to research, plan, and develop a computer controlled breadboard prototype of the sensing system. Laboratory bench testing shall be accomplished to prove the functionality of this concept. Concept shall be demonstrated on a combat vehicle based on further direction from TACOM engineers. The deliverables from this phase will include design drawings, software, technical report, and prototype system.

Potential Commercial Market: The preview sensing technology could benefit the automotive industry as well as the off-road vehicle market. Interest in the research years, both in the automotive industry and the military. Active suspension systems offer improved ride and handling, while increasing vehicle stability and safety.

OSCR: Previewing upcoming obstacles will allow the suspension to adapt to the terrain and reduce shock loadings to vehicle components both externally and internally. Reduced shock loadings correlates into improved reliability which leads to reduced O&S costs.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-334TITLE: Battlefield Acoustics Model

CATEGORY: Exploratory Development

OBJECTIVE: Develop a model that can simulate on acoustic battlefield environment. The model can be applied to airports, highways, and other complex environments.

DESCRIPTION: The project extends the single source vs. single receiver atmospheric acoustics problem to one where at least six sources can be tracked by a sensor system. At least four of the sources should be moving in user selected routes that can vary fro distances from 100 to 5,000 meters from the receiver. The receiver can be a simple or multi-faceted array. The model will vary environmental parameters such as atmosphere, terrain, wind direction, background noise and be able to predict probability of detection contour values based on baseline source-target configurations.

Phase I: Determine the feasibility of extending any of the existing government owned atmospheric models to realistic battlefield environments. This will involve enlarging targets to up to six sources where vehicle movement can be varied by the model user. Targets will be heavy, medium, light ground combat vehicles, wheeled vehicles, and auxiliary power units. Targets can be extended to those encousted near airports and industrial highways.

Phase II: Develop the model further by improving the analysis tools and internal databases required to perform the simulation. The model will be written in the Unix operating system using the C language. The model will be validated by a government test and provided to the government at the end of Phase II.

Potential Commercial Market: Commercial companies interested in complex noise surveillance located at airports and highways.

OPERATING & SUPPORT COSTS: The army is spending substantial funds to lower the acoustic self noise signature of ground combat vehicles. This model will analyze these low signature vehicles and apply the results to realistic battlefield acoustic conditions. Commercial companies are also interested i complex noise source environments. THis model would serve as a basis for coordination between government and private industry.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-344TITLE: Rapid Measurement of Artillery Tube Elevation and Azimuth

CATEGORY: Engineering Development

OBJECTIVE: Development of a method/system capable of measuring Tube Elevation and Azimuth without interference with the ability to rapidly change Elevation and Azimuth. System needs to make precision measurements within a small fraction of a second. System measurements should be reasonably independent of the Artillery System internal measurement systems.

DESCRIPTION: The Advanced Field Artillery System (AFAS) will be capable of rapid emplacement, rapid fire, and of adjusting firing angles from round to round. AFAS will be semi-autonomous once a fire mission is started. A system external to AFAS is needed to verify the QE/Azimuth angles. To reduce/eliminate interference with test, the system must perform measurements as AFAS fires a round. Although it may be possible to perform some of this measurement by external measurement of internal artillery systems such as encoder angles, the preferred system would be independent of internal systems.

Phase I: Conceptual design of the measurement system, to include mathematical analysis of the probable accuracies of implementations of the concept. Also requires preliminary technical analysis of the ability to maintain accuracy under the shock and temperatures involved during firing. Some laboratory "proof of principle" demonstrations of critical components may be necessary where new technology is involved.

Phase II: Design, fabrication and test of field-capable prototypes enabling field demonstrations of the QE/Azimuth measurement system.

Potential Commercial Market: New, precision measurement technology would offer wide opportunity for all types of measurement applications, especially where non-interference in high shock environments is required.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-346TITLE: Vehicle Position Location System

CATEGORY: Engineering Development

OBJECTIVE: Develop a prototype vehicle position location system for evaluation of system accuracy, reliability and operational ease.

DESCRIPTION: A vehicle position location system is required in support of a variety of tests including vehicular mobility and stability, tank turret stabilization system performance, and amphibious performance. The system must be able to track military vehicles on test courses moving at speeds up to 100 kmph at ranges of 30 to 1500 meters. The system must output three dimensional vehicle position location data in real-time at an update rate of 20 Hz with an accuracy of +/-0.01%. It is envisioned that the system will utilize optical and/or radio-frequency (RF) components; however, these components must not pose a safety hazard to either personnel or environment in the vicinity of the system. (Additional detail available at DTIC)
Phase I: Conduct a feasibility study to determine what type of components will most likely be utilized in the position location system (optical, RF, etc.). Provide design concept and technical information to support the concept.

Phase II: Initiate prototyping of a vehicle position location system for evaluation of system accuracy, reliability and operational ease.

Potential Commercial Market: Desired technology would produce significant upgrade in vehicle test capabilities utilized by both government and commercial vehicle developers.

TECHNOLOGY CLUSTER: A-3
TOPIC: A93-350TITLE: Applications of Radar Imaging to High-Altitude Measurements

CATEGORY: Exploratory Development

OBJECTIVE: Adapt radar imaging technology to test center measurement requirements such as attitude of missiles and aircraft, miss distance between interceptor and target, detection of deployed objects, and determination of extent of damage to targets, all at high altitudes or long ranges.

DESCRIPTION: The U.S. Army White Sands Missile Range has developed measurement and processing techniques for extracting more and better information from coherent radar signals. Improved measurements include trajectory parameters, motion about the center of mass (e.g. spin and coning) and characteristics of events (e.g. time of occurrence and duration). Recent advances in radar imaging suggest it is now possible to adapt imaging technology to obtain even more information in the test center environment. Of particular interest are measurements of attitude of missiles and aircraft, measurements of miss distances of high-altitude missile and target engagements, detection of deployed objects, and determination of extent of damage (i.e, damage/kill assessment). In general, the requirement is to make measurements at high altitudes or long ranges where optical data are not available and where current instrumentation radars are incapable of making the measurements to the desired accuracy (e.g. miss distance to +/- 1 ft) or making the measurements at all (e.g. damage assessment).

Phase I: Research is required to determine the extent to which radar imaging technology is applicable to those measurements, to characterize the problems to be solved (e.g. resolution of individual scattering centers, elimination of acceleration smearing, stabilization of shifting phase centers, and identification and correction of multiple-bounce returns), and to specify the upgrades needed for the WSMR instrumentation radars and data processing facilities.

Phase II: Develop a prototype processor to make the radar images and extract the desired measurements. Some human intervention may be needed in the measurement process, but the prototype system should be as autonomous as possible, particularly in the arduous task of deriving the radar image from the coherent video data. Although the system will be designed for making measurements at long ranges, it should also work at the shorter ranges employed in many of the tests conducted at WSMR.

Potential Commercial Market: Development of this technology could expand radar applications for numerous commercial uses.

A-4HIGH PERFORMANCE COMPUTING AND SIMULATION
(I.E. MODELING DISPLAYS, AI, VIRTUAL REALITY)

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-037TITLE: Fire Control Battlemanagement and Decision Support System Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate advanced software engineering and expert system decision aids technology for direct, indirect fire and smart mine field control. Develop embedded training for using the expert system decision aids for direct/indirect fire and smart mine field control applications.

DESCRIPTION: The feasibility of developing high performance expert system decision aids for direct and indirect fire systems and smart mine applications has been demonstrated recently based on laboratory prototype tests. Further technology development is required, however, to address specific algorithmic issues associated with real time planning/replanning, sensor/information fusion, terrain analysis, as well as issues of knowledge engineering, man/machine interface, rapid prototyping and simulation environments for evaluating decision aids. Expert system decision aids which address one or more of the following requirements are of specific interest: (a) Identification Friend or Foe (IFF); (b) Fire Control (acquisition/tracking); (c) tactical planning/order preparation; (d) tactical situation assessment; (e) status/reports; (f) self defense of weapon platform; (g) sustainment; (h) command and control (C2); (i) fire direction; (j) communication; (k) reconnaissance, selection and occupation of position; and (l) embedded training.

Phase I: Develop methodology for design and implementation of distributed expert system decision aids for direct/indirect fire and/or smart mine field control applications. Formulate and define conceptual designs for specific expert system modules including hardware implementation and software prototyping environment. Develop detailed functional specifications.

Phase II: Develop a full-up laboratory technology demonstration prototype decision support system with appropriate displays, simulation driven, development environment and run-time environment. Develop component-based software architecture and tool environment which will support reuse and reengineering of software components thereby reducing overall software development and maintenance cost of embedded decision support systems. Optimize hardware/software, algorithm and interface design based on laboratory test results and provide complete documentation of hardware/software, analysis and test results.

Potential Commercial Market: Developed technology has potential for commercial wargame products. In addition, required algorithm development in real time planning/replanning, sensor fusion, and terrain analysis can be used in commercial development of decision aids. Embedded training algorithms can be used on a wide variety of commercial software package offerings.

OSCR: Developed component based software architecture and tool environment will support reuse and reengineering of software components, thereby reducing overall software development and maintenance cost of embedded decision support system. Embedded training will reduce training cost on using expert system decision aids for control applications.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-042TITLE: Position Location, Navigation and Fire Control Map Interface Unit

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate an Operator Interface Unit for position location, navigation and Fire Control Systems based on the use of the current paper military map as the data base.

DESCRIPTION: A requirement exists for an operator interface unit for position/navigation (POS/NAV) and fire control equipment which is based on the use of the paper military map. The portable Global Positioning System (GPS) receiver, envisioned as the primary position and navigation device for military vehicles, will use a small alpha numeric operator interface. Position coordinates are read on a display and the grid coordinates of waypoints, etc., are entered via a keypad. The operator must manually make the association with his military map to locate his position or determine the grid coordinates of targets or waypoints. Each of these operations requires additional steps which are

potential sources of operator error. Due to the importance of timely and accurate navigation for the successful conduct of highly mobile military operations and for the prevention of fratricide, a method is required whereby the POS/NAV system operator on a military ground vehicle can interface with the navigation system, principally the GPS receiver, using his most familiar and readily available navigation device, the military map. A unit is desired which would be a component of the ground vehicle POS/NAV system, uses the current military map as its basis and allows the operator to locate his position, locate other positions, and perform other IO tasks directly from the map. Examples of functions to be performed are: locate present coordinates of any position indicated on the map, enter grid coordinates of a waypoint indicated on the map into the POS/NAV system; enter a series of waypoints defining an intended route of travel; recall a waypoint and indicate its location on the map for verification; indicate the range and azimuth to a designated location on the map from the vehicle's present position. The unit should accommodate military maps of various scales and be easily oriented. The size of the unit should allow convenient use inside a M1A1 tank or a Bradley Fighting Vehicle.

Phase I: Develop the design concept of the operator map interface unit including the systems interface to position location, navigation and fire control systems. Implement a conceptual broad board type system which operates in conjunction with standard military maps and uses existing military position location and navigation units of measure, coordinate systems operator interface procedures. Below for optional input, output and functional menus and functions to facilitate concept evaluation testing. Develop a preliminary functional system specification based on user inputs and test results.

Phase II: Produce several full-up modular-type units for application to different potential Army platforms and systems based on the Phase I preliminary specification. Support user testing and evaluation of the units. Optimize the design based on results of the user testing and evaluation. Develop finalized functional specifications.

Potential Commercial Market: The potential for commercialization is high. The use of such a map interface unit with a GPS position location system can be applied to a number of vehicle navigation situations. GPS navigation is being proposed for urban and inter-urban transportation vehicles, emergency vehicles, law enforcement vehicles, environmental management vehicles and even private use vehicles. It would have future use in survey and engineering applications for field data gathering and analysis.

OSCR: Unit has great OSCR potential. It would provide a very low cost interface unit to allow a much improved method for operators to interface with a POS/NAV system, GPS or otherwise based. It minimizes the use of high cost electronic display technology substituting a small alpha/numeric display and a conventional military map.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-048TITLE: Neural Network Based Speech Identification/Transcription Module

CATEGORY: Exploratory Development

OBJECTIVE: Develop a neural network based voice recognition system that can identify and extract the speech of a single person from a signal containing other speakers and random noises, and then produce a transcription of the recognized words. Utilizing system completed in Phase II, expand the voice recognition system to include a full language based processing module to permit continuous real-time transcription of any grammar free statement containing any English work, from a chosen speaker in a harsh, high noise environment.

DESCRIPTION: Progress is slowly being made in the area of speech recognition, but as yet no system can work well in a noisy environment. This problem is compounded when the background noise is random or contains other voices. A voice recognition system capable of locking on to a speaker's voice would enable the system to be operated in a noisy environment and without a special microphone or headset which is currently required to acoustically separate the speaker from the environment. Artificial neural networks are currently being examined to solve this problem and appear to hold the greatest potential, but considerable amounts of conventional signal preprocessing may still be required. Technical issues of interest include noise reduction, speaker identification, language identification and language transcription.

Phase I: Develop methodology and approaches for enabling a neural network to learn and identify a designated speaker's voice in a signal containing other voices and random noises. Determine requirements for any signal preprocessing needed by the net, and provide system design specifications.

Phase II: Develop neural network based voice recognition hardware/software and development environment for interface with laboratory test bed environment. Develop test scenarios to demonstrate the recognition systems ability to learn and identify a designated users voice and transcribe what is said disregarding any random noises and other voices present in the signal. Provide fully integrated prototype module with documentation, source code and development environment and evaluate in laboratory test.

Potential Commercial Market: The results of this contract will conclude in the development of a product/system that will recognize and transcribe speech in a harsh, noise environment. Since current recognizers are designed to be used in a friendly, office environment this system will stand alone in its ability to transcribe commands and comments spoken on noisy factory floors, at construction sites, as well as in our battlefield and weapon crew station environments.

OSCR: Cost reductions will be realized due to the nature of voice control. It is natural, flexible and very high level and will therefore, reduce training time, increase crew efficiency and response time, as well as reduce total crew size.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-063TITLE: Molecular Holographic Sensor

CATEGORY: Advanced Development

OBJECTIVE: Develop a prototype high resolution interference holographic Non Destructive Testing imaging system employing the organic light sensitive bacteriorhodopsin as the sensor medium.

DESCRIPTION: Hologram interferometry is used for studying the dimensional deformation of parts. A few possible examples are detection of wall anomalies in projectiles and cartridge cases, measuring the shape of cylinder bores, detection of residual stress and material fatigue, vibrational analysis of turbine blades, detection of disbonds in composites, and poor adhesion in epoxy laminates. Current methods employ holographic film as the sensor medium. Film is not realtime in that it must go through a development process. Also film is not erasable and reusable. Film does not interface well to digital encoding. These attributes severely limit possible real-time automated application of the technology. Bacteriorhodopsin has emerged as one of the most likely organic candidates for a molecular medium light sensor. The spectral transmissivity properties are appropriate for interferometry. Its image retention property is such to make it useful for real-time hologram interferometry, i.e., two images can be taken sequentially with no pause in time and the resulting interference pattern immediately seen and digitized. Images are formed immediately without a development process. Images can be erased in milliseconds and material immediately used to acquire a new image. Resolution is more than adequate for holography. Even though bacteriorhodopsin is an organic molecule, it is stable over many years. This solicitation is for the research and development of a new high resolution real-time interference holographic imaging Non-Destructive Testing (NDT) system. The system should use bacteriorhodopsin as the medium for the hologram. The system should have adequate speed, resolution, and range for real-time interference holography. The system should include a computer interface for digitally capturing the hologram. The system should be appropriate to use for NDT of munition items.

Phase I: The contractor shall investigate and prove the feasibility of making a high resolution real-time interference holographic NDT system as described above. The contractor shall find potential sources of venture capital for developing the "SBIR Phase III" market. The contractor shall design a prototype system to be build in Phase II. The proposal must show that the contractor has considerable prior experience with bacteriorhodopsin.

Phase II: The contractor shall build and deliver a prototype high resolution interference holographic NDT system with characteristics described above, test it, document its operational characteristics, validate its worth, and design a version rugged enough for use in a manufacturer's production facility.

Potential Commercial Market: A real-time erasable holographic medi does not currently exist. This project involves the development of such a media and its application to non-destructive inspection. Film, the current holographic media, has very limited real-time applications in automated NDI and even in pure holographic applications. An erasable holographic media will greatly expand possible applications.

OSCR: This office has clear evidence that automated NDI is more consistent and accurate than manual methods. This office will use the results of this project for inspection of munition items during or following the manufacture process. The result will be greater confidence in the quality, reliability, and safety of munition items before they are placed in the

stockpile. Increased quality, reliability, and safety will lead to decreased logistic costs (fewer items will be required to achieve the same ultimate effect). A measurable effect should be a reduction in quantity of newly manufactured munition items that are suspended. The technique could be used under proper condition for inspection of already suspended items for such conditions as residual stress, cracks, fissures, and voids.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-078TITLE: Simulation Interfacing Techniques

CATEGORY: Exploratory Development

OBJECTIVE: The military has a large number of simulations, most of which cannot talk to each other. In order to achieve widespread use of distributed simulations, we need to look at ways to allow simulations to interact both horizontally and vertically.

DESCRIPTION: An example of such interaction is provided. The Corps Battle Simulation (CBS) must interoperate with the Air Warfare Simulation (AWSIM) on a horizontal basis. Some progress has been made using the DARPA-sponsored Aggregate Level Simulation Protocol (ALSP). Also, in the interactive distributed simulation arena, SIMNET and BDS-D objects need to exchange data. Again the DIS 1.0 standard is the first step in the process. However, linking CBS with BDS-D requires a level of vertical linkage not yet addressed. Further, large-scale linkage of many simulations/simulators may overwhelm the current approaches and available bandwidth. The Army urgently needs to address technical approaches to solving these interconnection issues. What are the appropriate technical approaches to these problems? Are current techniques sufficient? Do they need modification? Can vertical integration be done through protocols? What are good candidates? Are selected approaches scalable? What is the horizontal complexity, the vertical complexity, the combined complexity?

Phase I: Examine possible solutions to these interoperation needs. Provide the theoretical basis for solving this problem. Prepare a report addressing simulation interfacing needs.

Phase II: If appropriate solutions are found, demonstrate at least one solution by linking current selected simulations/simulators.

Potential Commercial Market: An interoperability standard/protocol will enable industry to offer enhanced simulations or new innovative simulations/simulators that will be compatible with a large number of others. This supports the military's move to open systems and standards.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-079TITLE: Simulation Technology: Virtual Factory and Process Simulation

CATEGORY: Basic Research

OBJECTIVE: To develop new language constructs in support of "virtual" factory and process simulation.

DESCRIPTION: Through the use of the compiler-compiler technology, one can write "little languages" tailored to take high-level descriptions of engineering processes and convert these specifications into traditional target languages like C, C++, and FORTRAN. For example, to simulate a nonlinear control scheme, a language could be developed tailored to the terminology of feedback control. Similarly this idea could be extended for robotics, manufacturing technology, and process synthesis. Numerical algorithms could be described using mathematical objects which ultimately get targeted to efficient procedural languages for execution. Language recognition tools which make these projects easy to implement are needed to support the DOD/DA simulation initiatives. Object-orientation is strongly encouraged.

Phase I: Develop a suite of tools to aid rapid prototyping of process simulation. Demonstrate the approach with several examples using at least two different target languages.

Phase II: Extend the methodology to include graphical metaphors for language specification. The demonstration should model a full-scale industrial process with several hundred components. Optimization of process parameters or inverse modeling are examples of advanced applications expected for a phase II effort.

Potential Commercial Market: Optimization of manufacturing procedures or process design interests US heavy industry and the DOD. Most processes are tuned experimentally at great cost. Software tools which expedite the computer simulation of engineering problems are in great demand.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-086TITLE: Optics for Head Mounted Displays

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop and demonstrate reflective optic, binary optic, and/or holographic optic techniques potentially applicable to head mounted displays. Goals are for compact, high performance, inexpensive, light-weight, manufacturable optics to provide a (potentially transparent) display with an image projected at infinity.

DESCRIPTION: General - New concepts for providing visual information directly to the individual soldier including thermal images, video, maps, drawings, and text messages are limited by the lack of miniature displays that are acceptable in terms of cost, performance, reliability, size, weight and power consumption. This program should concentrate on alternative optic mechanisms for producing a miniature virtual image display.

Phase I: Phase 1 should result in an analysis of one or more approaches to miniature imaging system technology and identifying specific techniques with potential application to specific video generating devices. Simple proof-of-concept demonstrations of these techniques is a requirement and may take the form of static exhibits. However, translation of the demonstrated approach must be reasonably shown to be applicable to high resolution displays. Selection of prototypes will be made and approaches will be determined which satisfy objectives that are representative of Army tactical situations.

Phase II: In Phase II, a prototype display device suitable for head mounting will be demonstrated. The approach will be evaluated for further refinement and incorporation in user specific demonstrations. The end products should be capable of demonstration with video camera and computer inputs. Approaches should be documented as to relevance to Army needs and how these techniques might be applied to Army systems.

Potential Commercial Market: Identified applications include the thermal weapons sight, Soldier's Integrated Protective Ensemble (SIPE), maintenance and logistics applications, and telepresence displays for robotics applications.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-092TITLE: Interaction with 3-D "Virtual" Environments

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop and demonstrate hardware and/or techniques potentially applicable to providing interaction between human and machine for "virtual reality" and telepresence applications. Goals are for inexpensive, easy access, natural (instinctive) action means (hardware/software) for an operator to effectively interact with a "virtual" environment.

DESCRIPTION: General - New concepts which can provide faster, more natural response of the scene to operator inputs; better and faster tracking of operator movement; improved linking of audio to visual information; enhanced depth perception; and improved methods of sharing common head-mounted displays (where hygiene, size and vision accommodation are concerns). This program should concentrate on approaches which could ultimately be used by a single soldier on the battlefield.

Phase I: Phase I should result in an analysis of one or more approaches to improving interaction and identification of specific techniques with the potential to improve performance in virtual reality, cyberspace, or telepresence applications. Simple proof-of-concept demonstration of these techniques is a requirement and may take the form of static displays. However, translation of the demonstrated approach must be reasonably shown to be applicable to military requirements. Selection of prototypes will be made and approaches will be determined which satisfy objectives that are representatives of Army tactical and training situations.

Phase II: In Phase II, a prototype approach including hardware and software will be demonstrated. The approach will be evaluated for further refinement and development of or incorporation into a user- specific demonstration. The end products should be capable of demonstration with MSDOS or UNIX based computers with EtherNet, standard RS-232, and RGB or EGA/VGA video connections. Approaches should be documented as to relevance to Army needs and how these techniques might be applied to Army systems.

Potential Commercial Market: Identified applications include combat and maintenance simulators, mission planning stations, medical training, diagnosis and surgery, and telepresence displays for robotics applications.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-103TITLE: Fire Support Suppression Effects in Battlefield Simulation

CATEGORY: Exploratory Development

OBJECTIVE: To improve combat simulation models to account for the effect of nonlethal fire support.

DESCRIPTION: Fire support on the battlefield can destroy the ability of the enemy to act. As a result of fires, enemy personnel may be killed and their vehicles or weapons made inoperable, or personnel may be wounded--physically or psychologically--and their vehicles or weapons may sustain some degree of damage. In either case, the ability of the enemy to attack or defend is decreased. The extent to which suppression versus kills hinders the response of the enemy, has not been adequately quantified to be incorporated into fire support simulation. Typically, the use of fire support in simulations results in either a kill or no kill. When no kill is assessed, there are no other suppressive effects imposed on the enemy due to the delivery of fires. Suppressive effects caused by such things as (a) personal injury, (b) psychological stress, (c) equipment damage, (d) visual obscuration of the battlefield, or (e) navigational problems due to restricted visibility or cratering of the surrounding terrain need to be addressed in future simulation models. This weakness, inherent in the current simulation models, decreases the external validity of the simulation for fire support. Thus, in order to increase the utility of fire support simulation in MANPRINT-related studies, variables affecting fire support suppression must be identified and their singular and synergistic effects quantified.

Phase I: The purpose of Phase I will be to determine the feasibility of quantifying the nonlethal effect of fire support on personnel and equipment. This will include identifying the nonlethal effects of fire support on the battlefield and proposing a method for quantifying their impact on battlefield performance.

Phase II: The purpose of Phase II will be to select critical variables, from those identified in Phase I, and quantify their impact on battlefield performance. The resulting algorithms will be incorporated into the Target Acquisition Fire Support Model (TAFSM) maintained at the U. S. Army Field Artillery School (USAFAS), and a proposal to update the Janus simulations will be prepared for consideration by Janus software proponents, TRAC-White Sands Missile Range. Improvements to the Janus simulation software will allow the Army Research Laboratory to use the Janus simulation to examine weapon system performance during acquisition and product improvement phases.

Potential Commercial Market: Models and simulations for training and weapon system acquisition or enhancement are used extensively by both government agencies and private industry. The impact of fire support suppression on battlefield performance is not portrayed adequately in the currently available models and simulations. Thus, any improvements would be incorporated into existing models and simulations and used in the development of new systems.

OSCR: One of the goals of MANPRINT is to reduce the operating and support costs associated with a system. This is accomplished through influencing design in order to reduce training requirements, reduce personnel skill requirements, and reduce the number of operator and maintenance personnel required. The products produced by the Human Research and Engineering Directorate (HRED) do not directly impact the Generic Cost Drivers; they are more directly impacted by hardware and software developers. The SBIR efforts initiated by the HRED are aimed at enhancing human performance and expanding the data base related to human capabilities and limitations. It is when these human performance characteristics are applied to a specific hardware or software acquisition program that the reductions in operating and support costs can be realized.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-105TITLE: Development of Performance and Effectiveness Measures to Support Evaluations of Unmanned Ground Vehicles (UGV) Technologies and Operations

CATEGORY: Basic Research

OBJECTIVE: Develop test set-ups, methods of measure, data gathering, analytical tools, and methods of statistical analysis to study the important performance and effectiveness measures unique or particularly related to UGV technologies and operations.

DESCRIPTION: This effort would center on identifying and developing solutions to major difficulties in conducting experiments on human factors issues associated with remote driving and mission execution for UGV operations. The contractor will understand and incorporate current military UGV operational battlefield requirements and real-world terrain issues into performance and measurement criteria developed. The contractor will develop test design plans based on this criteria and will be required to identify the UGV operational issues resolvable by human factors studies and develop test course design ideas and test and analysis methods. The contractor will identify a range of studies and controlled test set-up procedures required to complete the studies developed, and demonstrate how these studies answer critical UGV technology issues. Study efforts will be directed to answer specific questions about augmentation techniques for a variety of UGV operations issues such as evaluating latency in video images and control over RF links, multiple cameras vs. single camera operational benefits, stereo vs. mono vision, and color vs. black and white displays. This list will be expanded under this effort.

Phase I: Identify the UGV battlefield operational issues and current UGV supporting technologies. Through a literature search of UGV testing completed to date, develop principal categories of measures required, identify the means of information capture and analysis. Propose specific approaches for development of the required capability to meet this Phase I objective in a Phase II effort.

Phase II: The measures, data gathering and analytical tools, and confidence measures will be developed, delivered and demonstrated for a specific UGV evaluation.

Potential Commercial Market: Opportunities exist within the UGV program in both industry and Government in the conduct of studies and evaluations of UGV technology effectiveness.

OSCR: One of the goals of MANPRINT is to reduce the operating and support costs associated with a system. This is accomplished through influencing design in order to reduce training requirements, reduce personnel skill requirements, and reduce the number of operator and maintenance personnel required. The products produced by the Human Research and Engineering Directorate (HRED) do not directly impact the Generic Cost Drivers; they are more directly impacted by hardware and software developers. The SBIR efforts initiated by the HRED are aimed at enhancing human performance and expanding the data base related to human capabilities and limitations. It is when these human performance characteristics are applied to a specific hardware or software acquisition program that the reductions in operating and support costs can be realized.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-146TITLE: Quick-look Geometry and Vulnerability Description for Armed and Attack Helicopters
CATEGORY: Exploratory Development

OBJECTIVE: To be able to make "quick-look" estimates of vulnerability/survivability of armed and attack helicopters to various weapons systems.

DESCRIPTION: In order to get an early idea of effectiveness of a particular weapon system against a helicopter, or conversely to determine the survivability of a specific helicopter when attacked, it would be very useful to have an easy means of making "quick-look" assessments before performing in-depth analysis. The "quick-look" methodology requires a generic vulnerability/survivability database and also an easily modifiable geometry description. It must include a user-friendly graphics package, which would allow you to construct the helicopter on the screen of a PC and allow you to manipulate the database simply. The goal would be that given an attack helicopter and a weapons system, one could manipulate the existing vulnerability/survivability database and the geometry description to describe them and then come up with performance estimates. It should be emphasized that this tool would only be used to supply very preliminary performance estimates, but the detail would be sufficient to supply a reasonable idea of how to proceed with a more detailed analysis.

Phase I: Concept, approach and methodology should be demonstrated. A sample helicopter and vulnerability database should be constructed and a sample interaction demonstrated. The "user-friendliness" of the model and the graphics capability must be demonstrated.

Phase II: After demonstrating the feasibility of the "quick-look" techniques in phase I, the methodology should be extended to both foreign and U.S. helicopters and weapons systems. The ability to model several classes of armed and attack helicopters should be achieved and the database should contain descriptions of a variety of U.S. and foreign weapons systems.

Potential Commercial Market: This technology and approach could be extended to vehicles and structures. As a preliminary design and decision tool it would be valuable if shared with or transferred to defense contractors. This supports the concept of smart design engineering and simulation before entering into expensive prototyping and testing.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-155TITLE: Graphical User Interface for Finite-Element Based Comprehensive Rotorcraft Analysis Software

CATEGORY: Exploratory Development

OBJECTIVE: The development of a user friendly, graphics-based interface for comprehensive rotorcraft analysis software.

DESCRIPTION: In recent years, there has been significant progress in developing computational methods for comprehensive rotorcraft analysis. These methods have been introduced into computer codes, which permit the rotorcraft industry to perform increasingly complex and realistic analyses of complex rotorcraft aerodynamics and structural dynamics phenomena. Unfortunately, using these new codes is often quite cumbersome because of the need to supply the large quantities of data needed to define the major components of the rotorcraft model (i.e., structural model, aerodynamic model, control system model), and to guide the complex solution algorithms. The Second Generation Comprehensive Helicopter Analysis System (2GCHAS) is a large, multidisciplinary, computer software system designed to analyze the performance, stability and control, aeroelastic stability, loads and vibrations, aerodynamics, and acoustics characteristics of rotorcraft. Developed by the Army to provide a significant increase in rotorcraft analysis capability, 2GCHAS provides state-of-the-art capability in modeling and analysis. 2GCHAS uses finite element methodology to analyze structural dynamics, and will be adding Computational Fluid Dynamics (CFD) capabilities for enhanced aerodynamic analysis. In 2GCHAS, the use of menu-driven selection, coupled with formatted data entry screens and help files, offers some on-line guidance to the user, but the menu hierarchies can be confusing to the user. The personal computers and workstations that have recently appeared incorporate novel, graphics-based user interface concepts that, when applied to comprehensive rotorcraft codes, could dramatically enhance user interfaces with these codes. The novel concepts include multiple-window environments, pull-down menus, mouse-driven selection of software options, and the use of interactive color graphics to display user input data as well as analysis results.

Phase I: Perform the conceptual design of a graphical user interface for a finite element-based comprehensive rotorcraft code. Present the design in the form of a draft user's manual that should focus on how the graphical aspects of the user interface will operate. Also present a demonstration of the graphical user interface with a typical comprehensive rotorcraft analysis problem.

Phase II: Implement the graphical interface with the 2GCHAS. The software shall be designed using the Structured Design Methodology, and the final deliverables shall include the software, complete User's Manual, and the design documents mandated by the design methodology.

Potential Commercial Market: Validated comprehensive rotorcraft analysis capability is sorely needed in both military and commercial markets. 2GCHAS provides that capability. This capability could be applied to all new commercial designs and product improvements reducing design and analysis cost and time as well as integrating a wide range of technical areas during design optimization.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-160TITLE: Expert Systems Conflict Resolution

CATEGORY: Exploratory Development

OBJECTIVE: Develop analytic means to categorize conflicts in expert system guidance and suggest concrete methods for potential users to resolve such conflicts.

DESCRIPTION: Military and civil aviation flight decks are seeing an increasing trend toward applying model-based aiding systems to facilitate aircrew performance in a number of domains. Within the military, navigation and route-planning expert systems have been developed for optimizing cover and threat avoidance, while similar systems exist for commercial aircraft diversion logistics and weather avoidance. Fault diagnosis, system maintenance, and fault recovery reconfiguration expert systems are becoming increasingly sophisticated on both civil and military platforms. Information management systems are being prototyped to deal with the profusion of communication and information exchanges made possible by improved transmission and display technologies. Unfortunately, each of these model-based systems is being developed in relative isolation. A significant challenge yet to be addressed is the integration of these model systems in a dynamic environment. Individual model update rates must be coordinated and references to other expert system models must be explored in order to avoid the likely condition of conflicting system advice. A reported incident in relatively low-tech commercial aircraft operations illustrates the problem. While in a multiple aircraft holding pattern, a TCAS (Traffic Collision Avoidance System) issued one of the aircraft in the pattern an executive level alert to dive. A subsequent cascade of dangerous actions resulted from the tightly coupled nature of the operations system. Similar precision and tight operational tolerance is experienced in the flight deck. Methods must be investigated to assure that conflict resolution among highly automated systems is not simply left to the flight crew or the ground operations controller. Information concerning the interaction of joint automated experts should be supplied to the human operators of those systems if they are to have the responsibility for coordinating and deconflicting them. An analysis method is required to determine by what information, time frame, protocols, and procedures is the human operator to deconflict expert guidance. We are entering a system environment in which the current standby "turn it off" is no longer an acceptable option.

Phase I: Complete study of documented guidance conflicts within fielded and near operational expert systems. Categorization, along temporal and logical dimensions, of "typical" conflicts. Describe and abstract principles from "ideal" human intervention in resolving such conflicts. Document findings in a report.

Phase II: Develop working software prototype which guides a novice user through resolving conflicting expert system guidance in an aviation domain example. Develop techniques for depicting and predicting logical conflicts within embedded knowledge of inhomogeneous expert systems. Prototype software tool embodying these techniques.

Potential Commercial Market: While the aviation environment motivated this SBIR topic, the methods for safely handling conflicts in expert system guidance would see widespread application. Truth maintenance and debugging systems for single platform, single domain expert systems are in widespread use today as part of the system's development environment or shell. Tools for accomplishing the stated objectives would find similar commercial viability as the use of multiple, cooperating expert systems proliferates.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-164TITLE: Application of Parallel Processing Technology to Complex Helicopter Analysis

CATEGORY: Exploratory Development

OBJECTIVE: Develop parallelization techniques for complex helicopter analysis systems to expedite processing and output.

DESCRIPTION: Complex helicopter analysis systems are being developed and implemented to provide a significant increase in rotorcraft analysis capability. These large, multidisciplinary software systems are capable of analyzing the performance, stability and control, aeroelastic stability, loads and vibration, aerodynamics, and acoustics characteristics of rotorcraft. The systems use finite element methodology to analyze structural dynamics and will be adding Computational Fluid Dynamics (CFD) capabilities for enhanced aerodynamic analysis. The major limitation on their effectiveness is the slow processing that results from the computational intensity of the modeling and analysis software. Efforts are currently under way to improve the computational efficiency through improving the algorithms and data access methods. Future versions will require additional significant increases in processing speed in order for them to

achieve their full potential as design optimization tools. Parallel processing technology offers a cost effective approach to increasing performance by distributing the computational load over multiple processors. Proposals are sought to investigate the opportunities for parallelization, and to demonstrate the implementation of parallel processing methods to expedite processing of complex analysis models.

Phase I: Identify and evaluate specific opportunities for parallelization of helicopter analysis systems, and estimate performance on selected parallel computer systems.

Phase II: Produce an efficient parallel implementation of a complex helicopter analysis system on an appropriate parallel processing computer system.

Potential Commercial Market: Validated comprehensive rotorcraft analysis capability is sorely needed in both military and commercial markets. These software systems provide that capability. This capability could be applied to all new commercial designs and product improvements reducing design and analysis cost and time as well as integrating a wide range of technical areas during design optimization.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-168TITLE: Methods for Pre-Flight Risk Assessment in Army Aviation

CATEGORY: Exploratory Development

OBJECTIVE: Determine the factors and combinatorial rules to accurately predict mission risk in Army aviation. Several criteria for these factors and rules must be met. They must be: 1) readily available; the pilots must not be delayed trying to determine mission risk, 2) easily and quickly input to a calculational or computational system capable of rapid response, 3) diagnostic; taken together they must accurately predict a region on a risk distribution where this mission would fall, and 4) sensitive; a change in one of the factors should affect the overall risk prediction.

DESCRIPTION: Much of the groundwork is laid for performing preflight risk assessment in Army rotorcraft through the automated systems designed for Emergency Medical Services (EMS) in the civil sector (Shively 1992). Extensions to this approach would be of direct benefit in the Army aviation environment. However, elements which contribute to a quantification of risk in the Army domain can be much different from civil counterparts, such as flying nap-of-the-earth or with night vision goggles. This effort will research and identify those factors in today's Army aviation which contribute to risky missions, and then use these factors to develop a decision aiding system for operational aviators. Some of the required information for such a system may be available through the review of accidents and incidents. However, this is a select database--risky missions often do not result in accidents. Therefore, a study performed at operational units is appropriate for a useful tool. Once adequate data is gathered, modeling the subsequent findings may result in a simple linear regression, if that captures enough of the variance. Otherwise more complex combinatorial rules will also have to be explored. The chosen knowledge and methodology can then be embedded within an automated system and subjected to validation studies. The decision aiding system resulting from this topic will help to determine, objectively and reliably, if the risks of a potential mission are outweighed by its benefits, as well as aid with material allocation, (i.e., two helicopters may reduce the risk to acceptable levels). Such a system can also be used to indicate when a higher authority is needed. For example, under low risk conditions the pilot may have authority to approve the mission, while higher risk sorties may dictate approval by the company commander prior to flight.

Phase I: This phase would consist of: 1) initial data collection, literature review, 2) studies at operational units to investigate factors leading to risky missions, and 3) initial development of the candidate algorithms to combine the factors to predict the risk of missions.

Phase II: This phase would consist of several parts: 1) testing and selection of the most appropriate combinatorial rules, 2) the development of the software and interface that would serve as the pre-flight risk assessment system, and 3) preliminary validation studies.

Potential Commercial Market: The commercial application and interest for this topic is demonstrated by the present work (performed) in the EMS industry). A similar topic was also chosen for a joint research initiative between NASA Ames and a commercial partner. Once a system such as this has been developed, it may logically be extended to other services and environments. Spin-off systems for the Navy, Air Force, or Coast Guard as well as markets in general aviation and air transport may also be of substantial value.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-170TITLE: Intelligent Information Presentation for a Helmet Mounted Display in a Synthetic Environment

CATEGORY: Exploratory Development

OBJECTIVE: To develop an innovative and intelligent information presentation for a Helmet Mounted Display (HMD).

DESCRIPTION: Future methods of providing appropriate and timely information to the rotorcraft pilot via an HMD will require significant improvements to meet mission and pilotage requirements. Categories of information already envisioned for the HMD include flight, weapon, target acquisition, navigation, system, obstacle avoidance, virtual switching and warnings. Research has shown that this would lead to pilot information overload. Advances in intelligent information presentation as well as prioritization and filtering of flight mode information needs to be achieved to obtain an essential high level of performance during low altitude night operations. Manual mode selection of display information in use today was developed in the late 1970s. Manual mode selection does not take advantage of data bus and electronic cockpit monitoring systems that could provide automatic and intelligent information updates. Manual mode switching also increases pilot workload and often results in unnecessary display icons that clutter the pilot's synthetic environment. Current technology does not provide the intelligent information presentation requirements necessary in future aircraft.

Phase I: Using several design principles, identify and evaluate innovative flight and mission information mode switching concepts necessary for Army Aviation. Then, using a baseline which is representative of current technology, select several candidate intelligent information prioritization/filtering techniques to demonstrate the potential increase in pilotage and mission effectiveness.

Phase II: Preliminary evaluations of intelligent information presentation concepts for a HMD will be performed in both ground and in-flight simulation to verify improvement potential. Complete definition of intelligent moding characteristics of the most promising configuration will be verified in flight tests on helicopters with HMD systems.

Potential Commercial Market: Developments in intelligent information presentation have vast potential commercial market applications. Proper information presentations is a critical operational safety and mission performance issue in both commercial helicopter and fixed-wing markets. Technology developments and lessons learned through this effort could be readily applied to address these issues.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-171TITLE: Application of Virtual Reality to Helicopter Target Acquisition, Pilotage and Simulation
CATEGORY: Exploratory Development

OBJECTIVE: Develop an application of virtual reality technology for helicopter target acquisition, pilotage (on board and remote) and simulation.

DESCRIPTION: As the laser and other directed energy threats on the battlefield increase, there will be a need to reduce or eliminate the crew's direct optical link to the outside world. An improved method of providing the crews scene, target, and flight data will be required. Virtual reality technology is revolutionizing the way in which man and machines interface and the way in which data may be presented to operators. acquisition and pilotage (onboard and remote) capability. Furthermore, virtual reality technology may offer a significant operational and support cost savings in the development and use of aircraft simulators, potentially eliminating the need for expensive fixed simulator facilities and offering the capability to provide a computer driven, virtual reality based reconfigurable simulator at each airfield.

Phase I: Develop a limited laboratory demonstration of the application of virtual reality to helicopter target acquisition, pilotage, or simulations. -Assess the state of the art in virtual reality technology. -Define potential applications for virtual reality. -Assess the requirements to demonstrate these concepts. (To include computing power, hardware, software, etc.) -Conduct a limited laboratory demonstration of a selected application. -Define an application for comprehensive demonstration in Phase II.

Phase II: Develop virtual reality application for a specific mission and demonstrate the concept in a ground based system.

Potential Commercial Market: Virtual reality technology will have a significant commercial market from video games to robotics. Development of a pilotage or simulator capability will have commercial application in the aerospace indopace ind

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-172TITLE: Light Weight Small Volume Stereoscopic Visual Sensors for Telepresence on Robotic Rotorcraft Research Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: To allow the ground-based human pilot of a remotely operated rotorcraft research vehicle to project their sensory, motor and cognitive skills to a remote location, thereby giving them the sensation of being present at that location in the cockpit of the flight vehicle. The faithful reproduction of sensory information, and the degree to which the command and control infrastructure is rendered transparent to the operator determines the fidelity of the telepresence experience. However, all of the characteristics mentioned above need to be accomplished by onboard sensors that are severely limited in size and weight.

DESCRIPTION: The proposed effort is to be part of the Free Flight Rotorcraft Vehicle (FFRRV) program being conducted jointly by the US Army and NASA Langley. The FFRRV program is developing the technology to perform dynamic agility, stability, control, and acoustic research using instrumented, free flight, reduced-scale powered rotorcraft models having Mach-scaled wind-tunnel model rotor systems. The free-flight rotorcraft program is in part an outgrowth of the fixed-wing drop model program which has become an essential part of the development of all high-performance military aircraft. The significant difference between the rotary-wing and fixed-wing programs is that the helicopter models must be powered and are therefore subject to all of the dynamic handling quality issues of full-scale helicopters, but amplified by the smaller scale of the research vehicle. Development of a telepresence capability can provide the model helicopter research pilot with considerably enhanced sensory environment, necessary for nap of the earth flight (NOE). Although the telepresence research is to be conducted on helicopter models, the technology is wholly transferable to the fixed-wing activities at Plum Tree, and to the UAV, flight test, and robotic communities at large. Even though there have been a number of studies aimed at providing remotely controlled systems some measure of telepresence capability, the technology is immature and there are few precedents on which to rely for guidance. However, it is widely recognized that stereoscopic vision with a field of view around 180 degrees will be desired. Although high resolution is only needed in a small range around the focal point of the eyes. Moreover, the technique has never before been attempted at this scale for research flight vehicles having the level of performance expected from the Free-Flight Rotorcraft Research Flight Vehicle (FFRRV), and there are several unknowns in solving the telepresence problem. For example, the required tracking rates and damping characteristics for vision systems needed for flight operations are not well defined. These are also severe video sensor system weight and size constraints on unmanned vehicles of this scale. This technology offers not only enhanced research capabilities for model flight research conducted at Langley, but also has exciting implications for full scale flight testing, hazardous environment operations for all forms of automotive vehicles, combat, reconnaissance, and surveillance activities, and robotic applications.

Phase I: The expected results of the phase I SBIR would be the complete design of the stereoscopic video sensors, the control system for the helmet tracking system to steer the sensors, and a telemetry system for the transmission of the stereoscopic video data to the ground station. This design must be sensitive to the volume, and weight restrictions of the free flight research vehicle.

Phase II: Phase II would be the manufacture and test of the complete system incorporated into FFRRV.

Potential Commercial Market: The commercial market for robotic vision devices is vast. In particular, civil ground transportation and manufacturing applications would directly benefit from the technology developed through this effort.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-198TITLE: Modeling of Automatic Target Recognizer Performance

CATEGORY: Exploratory Development

OBJECTIVE: Develop a systems level model which provides accurate predictions of ATR performance.

DESCRIPTION: Current capabilities for modeling system performance of thermal imagers cover sensor design and the human operator. In the case where an automatic processor does all or part of the target acquisition process, the statistics

of past experiments and testing are the only tools available for predicting future performance. A model is required which encompasses both human and processor performance.

Phase I: Outline an original methodology for the understanding and prediction of automatic target recognizer performance. Limited government test data will be made available by the government since some of the material is classified. A security clearance would be advantageous, however, a security clearance is not required for this effort.

Phase II: The methodology outlined in Phase I will be formalized into a mathematical model and computer code. A more extensive validation against test data will be accomplished.

Potential Commercial Market: The model and computer code developed in Phase II can be used by commercial developers of ATR's to measure the efficiency of their current algorithms and guide the development of improved algorithms.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-208TITLE: Contextual Benchmark Features for use within AI Scripts

CATEGORY: Basic Research

OBJECTIVE: Develop a mathematical proof which proves or disproves the existence of contextually sensitive features within scripts, which, if they exist, may be used to ensure the robust and accurate flow of contest between script elements. This technique would become part of a tactical threat assessment system. It's function would be to evaluate the relevancy of a tactical script hypothesis to instantiated battlefield data.

DESCRIPTION: AI-based planners and plan recognition algorithms frequently make use of scripts to establish context and context expectation. Many researchers believe that humans are able to accurately navigate within a script by identifying contextual features within the current context which provide benchmark information to uniquely identify the context. This effort will develop the necessary mathematics to prove or disprove the existence of the hypothesized benchmark features. If such features can be shown to exist, the remainder of this effort will be focused on the development of an algorithm which can automate the benchmark feature selection process, as a function of script, and make use of this information to accurately navigate inter- and intra-script contexts.

Phase I: Development of mathematical proof which will prove or disprove the existence of contextual benchmark feature information as described above.

Phase II: If the existence of such benchmark features can be proved, automate the benchmark feature selection process, as a function or script, and show that this information can be used to accurately navigate inter- and intra-script contexs.

Potential Commercial Market: This technique should find wide applicability in military, space, and industrial usage where robotics is employed.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-221TITLE: High-Speed Transient Waveform Acquisition System

CATEGORY: Exploratory Development

OBJECTIVE: To develop a single-board, high-speed transient waveform acquisition system to acquire and process multiwavelength IR LIDAR data in real time.

DESCRIPTION: Light detection and ranging (LIDAR) systems used in chemical remote sensing applications require very high digitizing rates (50-100 MHz), good dynamic range (10-12 bits), and large amounts of memory for waveform storage (2 Megabytes). Multiwavelength LIDAR systems require that the data acquisition system have a high throughput rate and special triggering modes. These systems also demand the capabilities of on-board modes. Currently available technology is limited to digital oscilloscopes connected to slow interfaces such as GPIB which seriously limit system throughput. A compact programmable single-board approach is desired which can be inserted into a standard high-speed bus such as EISA or VXI.

Phase I: The contractor will study the acquisition and processing requirements in detail and present the most promising solutions. Key issues to be investigated include bus interface, choice of operating system, on-board digital signal processing (DSP), digitizing and dynamic range tradeoffs, market trends on A/D technology, and ease of system

upgradeability as A/D technology matures. An approach will be chosen based on the most desirable solution and a single prototype will be designed. Phase II: The contractor will fully debug and implement two working data acquisition systems designed in Phase I. Special attention will be placed on perfecting and hardening the actual circuit design of the main acquisition board. Issues such as EMI susceptibility and protection will also be studied at this time.

Potential Commercial Market: WIll make available to the waveform acquisition and digital oscilloscope market a high-end single-board digitizing capability not currently available.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-233TITLE: High Explosive Structural Damage Assessment Model Computer Code Enhancement

CATEGORY: Advanced Development

OBJECTIVE: modify, enhance, verify and document the high explosive structural damage assessment model (HEXDAM) to provide a public release code for use in preparing explosives safety site plans.

DESCRIPTION: A major component of the logistics cycle costs for ammunition and explosives is the investment and maintenance costs for the structures and real estate required to store these items. Reduced costs for real estate (explosives safety buffer zones) and protective construction designs can be realized if a verified high explosive structural damage assessment model were available to the local commands for the preparation of explosives safety site plans. The HEXDAM code can be improved to fulfill this requirement. The improved computer code with documentation would be developed as a public release product to be approved by the DDESB for use in preparation of explosives safety site plans.

Phase I: This phase modified the computer model to expand the applicability. Develop an unclassified library of up to 20 typical structure types. Vulnerability parameters are to be derived based on pressure-impulse (P-I) diagrams for structural elements, e.g., walls, slabs, beams, columns. Work is to include developing a methodology for creating composite P-I diagrams and/or vulnerability parameters for each typical building type, based on addition or superposition of P-I diagrams for individual building components. This methodology is to be used to define the structure types in the library. Develop an automated process for defining new structure types, using the methodology developed above.

Phase II: This phase enhances, verifies and documents the computer model. Perform a study to validate the program's prediction of damage using the structures defined above. This study should compare damage levels (percent damage) predicted by the program with damage actually observed in explosive tests or accidents. Develop a guidance document that defines and describes what the predicted damage values for each of the predefined structures actually means in terms of percent physical damage, e.g., broken windows, roof or wall panels blown off, buckled roof beams. Evaluate the existing structure-to-structure shielding algorithms in the program. Determine if the methodology used by the code realistically predicts the effect one structure has in shielding another structure from blast wave effects. Expand the program capabilities from two-dimensional (2-D) to 3-D problem definition and solutions. This would include input and output, color graphics, and overpressure and damage contours, computer and plotted in either two or three dimensions. Add a mouse-driven user interface.

Potential Commercial Market: As a public release, unlimited distribution computer code with documentation this product will be available to the commercial architecture and engineering community for providing technical support for preparation of DoD, Department of Energy, and NASA explosives safety site plans.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-262TITLE: Human Operator Model Baseline Architecture Simulation (HOMBAS)

CATEGORY: Advanced Development

OBJECTIVE: The objective of this effort is to identify a knowledge level architecture in which components of a predictive Human Operator Model (HOM) can be integrated and operate to demonstrate intelligent behavior. The intelligent behavior will be in response to a specific dynamic and environmentally relevant stimulus. Components of the HOM include: human sensor functions (visual, audio, smell, feel, taste), cognitive (cognition, perception, memory, rule based reasoning, mental model reasoning), and motor behaviors (physiological and motor functions). The modular

structured and objected oriented architecture and integrated HOM components will be demonstrated through the use of a computer based simulation to be developed by the contractor.

DESCRIPTION: The majority of Human Performance Models (HPM) are developed to: demonstrate theories of human performance, or to assist in the design of equipment, or help establishing equipment configuration. An example would be a model of human vision to assist in design and layout of a man-machine interface for a specific system. The task here is not the development of a HPM for equipment or system design. The emphasis will be on the development of an architecture and human operator models that demonstrates intelligent human behavior and can serve as an input to existing system simulation models. An example of an HOM applications would include replacing a human in a Person-In-The-Loop Simulation for a specific application and system analysis. The architecture will be modular structured and object oriented to permit the integration of developmental models and existing HOMs that were developed using traditional modeling methods that include: information processes approaches; control theory approaches; task network approaches; and knowledge-based approaches (See reference: Quantitative Modeling of Human Performance in Complex, Dynamic System, Eds. S. Baron, D.S. Kruser, and B.M. Huey, Panel on Human Performance Modeling, Committee on Human Factors, Commission on Behavioral and Social Sciences and Education, Nation Research Council, Nation Academy Press, Washington D.C. 1990, ISBN 0-309-04135-X). The computer based simulation developed to initially demonstrate the architecture and HOM operation will be developed for a 486 (or higher) PC type computer and will use the NASA developed CLIPS Version 5.0 or above for the simulation development environment. Through the use of the HOM in conjunction with person-in-the-loop simulation, Operation and Support Cost Reductions associated with Software Maintenance/Support Costs can be achieved.

Phase I: This phase will include identification, design and prototype development of a knowledge-type architecture for integrating the HOM components. Simplified models of HOM components will be used to demonstrate the modular structured, object oriented architecture. The demonstration will be a PC computer (486 or higher if available) and Clips 5.0 or higher.

Phase II: This phase will produce a matured object oriented, modular structured architecture for integrating and developing HOMs that will demonstrate intelligent behavior. The intelligent behavior will be in response to a specific dynamic and environmentally relevant stimulus or screnario. Components of the HOM will include combination of existing models and developed models as indicated in the objective of the task. The contractor will deliver to the government a demonstration system that includes: the modular structured, object oriented architecture; human operator models; any non-developmental software packages and specially developed software required for system operation; the operating platform necessary for full up demonstration.

Potential Commercial Market: Training system development; Prediction of human responses in a dynamic and stressful environment. The study and evaluation of surrogate member operation in a multi-member team operating environment.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-263TITLE: Computer Aided Software Engineering (CASE) Tool for Software Maintainability Feedback for Software

CATEGORY: Advanced Development

OBJECTIVE: Integrate metrics into a CASE tool such that a parametric definition of software design features drives software under development towards optimal maintainability.

DESCRIPTION: A software development CASE tool is developed which is specifically for object oriented Ada and includes features to automatically adjust the architectural structure of the software based on parameters reflecting maintainability (modifiability). Provisions must be included to tune the model based on data collected from maintenance efforts on the code. This effort supports Operation and Support Cost Reduction generic cost driver, "Software Maintenance/Support Costs" in three aspects: it improves software CASE tools, it enhances the software engineering process, and it utilizes software metrics.

Phase I: Build into a graphics based object oriented Ada CASE tool metrics which can be used to tune software during development.

Phase II: Demonstrate the operability of the tool and enhance it's operation based on commercial or military software projects.

Potential Commercial Market: This technology would allow software developers to design software production lines which measure the product as it is being developed so that, by tuning the process and the product in real time, an optimum software product would be produced.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-265TITLE: Logistics-Sustainment Technical Assessment Simulation

CATEGORY: Exploratory Development

OBJECTIVE: Develop simulations that will permit the assessment of technology innovations and improvements in logistics and sustainment systems ranging from industrial base through combat conditions, that can be hosted on a variety of platforms ranging from PCs to workstations, and fully interfacing with Battlefield Distribution System (BDS) at all levels from individual weapons' systems through Corps.

DESCRIPTION: Modern technology offers great potential improvements in reading and sustaining America's Army. With the advent of the Louisiana Maneuvers, Forward Projection, and tailorable forces, the need for critical analysis and interplay tools/simulations that accurately portray the production, stockpiling, transport, distribution and use of equipment, spares, and supplies is a must. Modern object oriented programming techniques offer great potential for a contemporary, advanced analysis tool and simulation that will facilitate the comprehensive assessment of modern technologies applied to logistics and sustainment at all levels from individual packages/systems through organizational and control methodologies. This capability is fundamentally necessary to provide a cutting edge, high technology logistics instrumentality that is optimally responsive to the demand of tailorable forces and force projection. Additionally, the depth and comprehensiveness of this simulation/tool will afford unprecedented capability to identify O&S cost drivers and analyze technological and organizational alternatives for their reduction (i.e. OSCR).

Phase I: Within the framework of current and future combat simulations, including the interactive BDS, the analytical requirements of the DoD 5000 series and Army regulations, and the capabilities of modern technology applied to logistics, conduct a comprehensive review of existing logistics and sustainment simulations and models. Develop a practical object oriented architecture for a modular logistics simulation and demonstrate proof of principal with a limited problem set.

Phase II: Apply the Phase I architecture at a practical level of implementation ranging from CONUS depot and (aggregated) production base through at least Corps level distribution. Demonstrate interface with an analytical Corps level simulation (e.g., VIC or EAGLE) and with BDS (e.g. CBS).

Potential Commercial Market: The Phase II portion of this effort should develop and incorporate artificial intelligence, virtual reality, and advanced graphics techniques in order to achieve maximum user interface, visualization of the logistics systems, dynamic reaction of the simulation to the logistics situation, and training feedback for logisticians. These fields are on the leading edge of computer science technology and have tremendous potential for any business interested in simulation and improvement of their processes and training of their personnel.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-267TITLE: Man-In-The-Loop Trainer for Non-Line-of-Sight Combined-Arms (NLOS-CA) and The Army Combined Arms Weapon System (TACAWS)

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-271TITLE: Improved Missile Guidance Simulator Target Position Control for Precision-Guided Weapons

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-4

TOPIC: A93-275TITLE: Software Assemble Expert System

CATEGORY: Advanced Development

OBJECTIVE: Development of an expert system to assemble predefined Ada software packages into customized guided missile systems.

DESCRIPTION: The automated software generation expert system would select from predefined sets of generic software for missile systems. Select parametric valves for the parts, and assemble them into a customized missile system software package. This effort supports Operation and Support Cost Reduction by reducing generic cost driver, "Software Maintenance/Support Costs" in two areas: It improves software process model and it enables a powerful reuse concept.

Phase I: Integrate automated software domain analysis with AI expert system techniques to build from Ada software parts repositories, as software system for generating tactical missile code and test cases.

Phase II: Construct and test variations on software for several tactical missiles to fine tune the parameteriztion process.

Potential Commercial Market: This technology would allow commercial and military "software parts houses" to be developed for many different application areas. Simulation, communications and engineering sciences using compute software could have extensive software parts inventories if the technology were available.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-281TITLE: Application of Neural Network & Fuzzy Logic Theory To An Autotracker Design

CATEGORY: Exploratory Development

OBJECTIVE: Increase the robustness efficiency and performance (accuracy, stability, target discrimination and identification, etc.) using neural network and fuzzy logic theory to implement an autotracker design.

DESCRIPTION: The neural network/fuzzy logic implemented autotracker must "learn" to distinguish between the target and 1) background clutter (foliage, trees, bushes, etc.) and 2) countermeasures (flares, etc) & obscurants (dust, smoke, etc.). Once a target is selected, this protypical autotracker must "lock onto" the target, ignoring any other objects which may pass in front, behind, or adjacent to the selected target. The solution approach dictated for this Small Business Innovation Research inherently produces both a development cost reduction and also an Operation and Support Cost Reduction for Software Maintenance/Support Costs. An important by-product of neural network and fuzzy logic methodologies is a decrease in the mathematical scope and complexity and an increase in the prototypical (incremental) design technique's frequency, resulting in a decrease of the time and labor (cost) necessary for the intensive and intricate design/maintenance analysis. Cost reductions will also be realized by: using less expensive sensors and microprocessors; the ability of such an item to "learn to adapt" to it's environmental cues; the ease in modifying the system through changing: either the rules describing the system's operation, using natural language, and/or the graphical representation of the system; and the increased stability, robustness, and efficiency of the system (when compared to conventional and/or man/machine systems). Finally, nonlinear physical systems are extremely difficult to model mathematically and only neural network/fuzzy logic techniques may produce the required solutions for these types of systems.

Phase I: Given the functional description and the algorithms/equations for a generic autotracker, determine which functions and algorithms/equations can be implemented using neural networks and/or fuzzy logic techniques. Compare the neural network/fuzzy logic implemented autotracker design with a conventional autotracker design (for accuracy, stability, performance) by analysis and/or simulation.

Phase II: Establish the requirements and the design for a neural network/fuzzy logic implemented autotracker for a protypical laboratory model which can demonstrate it's design soundness and functional capabilities (robustness, efficiency,and performance).

Potential Commercial Market: There are many commercial and Government "spinoff areas" which could result from the development and implementation of "NEURAL NETWORK & FUZZY LOGIC THEORY TO AN AUTOTRACKER DESIGN". A few of these are:

A. Terminal guidance techniques and methodology which can be applied in any "docking" and/or "maneuvering" situation; e.g., space vehicle docking and maneuvering. The use of advanced technology could make "docing" and/or "maneuvering" more efficient and accurate--no oscillations and/or overshoot.
B. Image enhancement and identification systems.
C. Robotic systems.
D. Unmanned Vehicle Navigation and/or Homing Systems (Land, Air, and Sea).
E. Surveillance and espionage systems.
F. Missile Weapon Systems

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-306TITLE: Fusion of Kwajalein Missile Range (KMR) Optical and Radar Data for Enhanced Deep Space Surveillance

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-308TITLE: Global Positioning System (GPS) Error Modeling for Incorporation into Post-Mission Trajectory Estimation

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to determine an error model for recorded GPS/TPS data which can be used to optimally correct and combine the GPS position and velocity solution with ground based radar and optical data.

DESCRIPTION: More and more frequently, missiles, aircraft and other vehicles are equipped with GPS translators which receive signals from the GPS satellites and retransmit them to a ground station (TPS), where they are processed into a real-time position and velocity solution. Although the processing is done in real-time, some intermediate results are also recorded and are available for post-mission analysis. Since position and velocity information are also available from numerous ground sensors, the best trajectory estimates should be obtained by combining the GPS data with the data from the ground sensors. In order to do this in an optimal manner, it is necessary to have error models for both the GPS and the ground sensor data. Error estimates of the GPS position and velocity are supplied as part of the real-time solution; however, these errors are the result of a complex processing procedure which prevent the user from assessing the validity of the output errors, modifying any of the input components, or determining concomitant information such as time correlation.

Phase I: Investigate the error model used in the current GPS/TPS solution to isolate the basic input error parameters and quantify them. Determine the mathematical models used to propagate these input errors into the final position and velocity errors. Determine which errors can be reduced by post-mission processing and quantify the expected improvement.

Phase II: Develop a practical method by which GPS data and ground sensor data can be combined in a trajectory estimator in a reasonably well balanced manner. This phase of the study should address such issues as: methods of combining the highly correlated GPS solution with the relatively independent radar and optical sensor errors; identification of significant GPS error inputs which can be corrected and/or estimated in a post-mission environment, and the possibility of estimating GPS error parameters via post-mission regression analysis.

Potential Commercial Market: Phase II proposals should also include an assessment of the commercial applications and markets for use of error model for estimating trajectories.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-309TITLE: Film-to Video Conversion

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-317TITLE: Visual Data Base Feature Extrapolation

CATEGORY: Exploratory Development

OBJECTIVE: To develop methods which are applicable to visual simulation data bases for "filling-in" specific building structural features when appropriate photographic data is not available.

DESCRIPTION: From a comprehensive set of photographs of an area of interest a visual data base for visual simulation purposes can be created. There are practical cases where the required photographic data is either not available or incomplete but the training application requires a high fidelity representation of the area of interest. Techniques are needed to generate the "missing" building structural features such as doors and windows in their correct dimensions, and spatial orientation with respect to buildings in the area and region of interest. Such techniques should incorporate an effective means of informing/alerting the trainee that specific elements in the scene are known only in a probabiistic sense with the degree of uncertainty assigned to the objects being conveyed to the trainee in a non-intrusive way.

Phase I: Explore techniques and develop a concept for generating and presenting "missing" visual data.

Phase II: Design and implement the concept from Phase I with the objective of demonstrating feasibility and effectiveness.

Potential Commercial Market: Commercial data bases for visual simulation of real-world objects and features.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-318TITLE: Measurement of Cost Effectiveness as a Result of the Use of Training Devices/Simulators
CATEGORY: Basic Research

OBJECTIVE: To develop a model that will effectively assess the cost effectiveness of training devices/simulators.

DESCRIPTION: There is currently no established method for determining the effectiveness of training devices or determining how it's effectiveness relates to any ultimate cost savings to the Government. It is commonly recognized that training devices and simulators, such as the M1 Tank Driver Trainer and the Tank Gunnery Weapons Simulation System, reduce operational and support costs (eg, fuel, ammunition, and maintenance) for weapons systems and are therefore considered to be cost effective. However, the degree of their cost effectiveness is unclear. A cost effectiveness model is needed which will accurately and consistently determine the cost savings derivable from utilizing training devices/simulators as surrogates for the actual weapon system and/or firing of the weapons systems.

Phase I: Assess modelling approaches and develop a concept for assessing the cost effectiveness of training devices/simulators.

Phase II: Design and implement the concept from Phase I with the objective of demonstrating the accuracy and consistency of the model.

Potential Commercial Market: A robust cost effectiveness model and methodology should be adaptable to non-DoD applications where there is a need to determine the cost effectiveness of training devices and simulators vice the use of actual equipment for training.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-319TITLE: Application of Contemporary Psychological Research to Training Devices and Simulators
CATEGORY: Basic Research

OBJECTIVE: To develop more effective training devices and simulators through the application of contemporary psychological research.

DESCRIPTION: Training devices and simulators are already technically complex equipments that generally achieve their design/system objectives but the potential exist for making them more effective. Effective application of current research results in human cognition and performance which also exploits and complements advances in computer

science and engineering, and instrumentation in the man-machine/training device environment could facilitate the desired improvements. Concepts in adaptive feedback and learning, techniques for augmenting short term memory, and effective methods of organizing and representing information so as to take advantage of "natural" or preferred modes of communication are considered to be especially relevant.

Phase I: Explore techniques and technologies and develop one or more concepts which could enhance the effectiveness of training devices and simulators.

Phase II: Design and implement one or more of the concepts from Phase I with the objective of demonstrating feasibility and effectiveness.

Potential Commercial Market: Public and private education; Computer based self help/study aids.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-320TITLE: Analytical Augmentation of Player Units in a Distributed Interactive Simulation (DIS) Environment

CATEGORY: Basic Research

OBJECTIVE: To provide effective mathematical surrogates for selected player units in the DIS environment.

DESCRIPTION: Future effective use of simulators in the DIS training environment could require large numbers of units of participating player units to be represented to achieve the desired training objectives. Realism is not an issue when all simulators are manned but this approach is considered to be impractical for large scale force-on-force training exercises in the DIS environment. A potential solution is the development of a capability to simulate and adaptively control the behavior of computer generated individual units and the tactically and doctrinally correct aggregations of these units inot hierarchically higher echelons of command. The goal is to develop a modeling methodology/technology that captures (1) relevant individual solider and unit behaviors, such as, communicating and exchanging information, maintaining and communicating and exchanging information, maintaining and changing formation, avoiding obstacles, making effective use of terrain for cover and concealment, and detecting, acquiring and engaging targets; and (2) relevant commander behaviors, at all appropriate command levels, such as the planning and execution of the command and control function (e.g. planning, executing plan, assessing, planning, etc.) in a dynamic and uncertain environment.

Phase I: Explore new techniques and approaches and develop a concept for realistic surrogates.

Phase II: Design and implement the concept from Phase I with the objective of demonstrating the feasibility and effectiveness.

Potential Commercial Market: Entertainment and educational games, learning and design aids.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-321TITLE: Next Generation Dismounted Infantry Interactive Simulation Environment

CATEGORY: Basic Research

OBJECTIVE: To develop a dismounted infantry simulation module for use in a Distributed Interactive Simulation (DIS) environment.

DESCRIPTION: Current DIS training environments permit mechanized units to "fight" on a simulated battlefield. However, a key tactical element, the infantry, is not being adequately addressed in the training exercise. Mechanized units often operate in concert with infantry and must always be alert to the threat posed by enemy infantry. Similarly, individual infantry should get experience in working with mechanized units. Currently, the affects of the infantry on the manned DIS training participants are made through an extension of the semiautomated forces (SAFOR) model. However, this concept by itself does not permit the infantry's direct interactive participation in the training exercise. As an alternative, an infantry interactive module might incorporate SAFOR technology with a virtual reality interface thus ideally permitting the squad or platoon leader to be "totally-emersed" in this environment leading their "troops".

Phase I: Explore approaches and develop concepts for a dismounted infantry module in the DIS environment.

Phase II: Design and implement the concept form Phase I with the objective of demonstrating feasibility and effectiveness.

Potential Commercial Market: Personal entertainment video arcade simulators.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-322TITLE: An Instrumentation and Threat Target Simulation Requirements Generation System

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-325TITLE: Test and Analysis of Ada Language Programs

CATEGORY: Exploratory Development

OBJECTIVE: Develop a forerunner ADA Test/Analysis Tool that uses static and dynamic Software Testing and Analysis (STA) to curtail the spiraling cost of operating and supporting ADA software.

DESCRIPTION: As software complexity increases, current STA methods become inadequate. This leads to inefficient software development and the fielding of unreliable software. As a result, 70% of total life cycle costs for Ada software are spent on debugging software after fielding. New research at area universities has led to test and analysis methods that increase software reliability. These methods are ready for incorporation into a comprehensive STA tool. The development of an Ada specific tool of this type is needed to develop more efficient software thereby increasing reliability and reducing operational and support costs. Phase I: The Phase I effort will consist of a feasibility study to investigate new theories and implementations as prospective components of an Ada specific STA tool. The result will be a detailed specification and a pilot implementation for a reasonable subset of Ada.

Phase II: The Phase II effort will consist of developing a fully functional Ada STA system. The system will be based on the components specified in Phase I. Experimental data gathered from Phase I will be used to revise and update the final system.

Potential Commercial Market: Due to Congressional and self-imposed commercial mandates, Ada implementation in the private sector has grown to make Ada one of the most highly utilized software languages in the United States. As the Ada market has grown, so has the market for Ada development tools. Presently, the large and growing commercial Ada market urgently needs an Ada development tool that reduces operational and support costs by development tool that reduces operational and support costs by improving software efficiency, and increasing reliability.

OSCR: Generic Cost Driver (GCD) #7 - Causes of Software Maintenance/Support Costs.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-329TITLE: Data Base "Mining" through Machine Intelligent Learning Algorithms

CATEGORY: Exploratory Development

OBJECTIVE: Examine and develop non-linear relationships among data elements that may define causes equipment failures and the increase in O&S cost burdens.

DESCRIPTION: Artificial intelligence researchers at government and privately sponsored laboratories have made significant progress in practical machine intelligent systems, capable of supervised and unsupervised learning. Some of these products and the expertise is being marketed commercially by small business start-ups. A practical demonstration and application is to use these techniques to supplement conventional, statistical methods in finding cause and effort relationships in complex processes or machine failures.

Phase I: The contractor will research the state-of-the-art in both, hardware and software, to determine the most promising machine intelligent systems for unsupervised learning of databases. A final report will detail findings

and a strategy to implement "data mining" techniques on large government databases. One Army database of interest is the Fielded Vehicle Equipment Performance Database System (FVEPDS).

Phase II: The contractor will continue the effort started in Phase I by implementing the planned strategy on data bases identified by the government for field testing the most promising machine intelligent, learning methods. The test will be used to explore the performance and applicability of these techniques to find non-linear relationships among data elements that could suggest research projects, or changes in procedures, leading to reduced O&S cost burdens.

Potential Commercial Market: The same techniques could be used commercially to improve efficiencies in operations and reduce business risks. One application might explore the personality profiles of employees with job performance. This could lead to a more satisfied employees working at peak performance. Another application could explore the relationship between bank loand and business risk, finding those business characteristics that lead to a high payoff, low risk investment. A third application might explore the logistic problem of inventory control and optimization by exploring buying patterns and the changing preferences of consumers. A fourth application may be to monitor manufacturing processes and machines to determine factors that lead to out of tolerance conditions before they become critical. This could lead to higher quality product output and production cost savings.

OSCR: The goal will be to isolate high payoff, O & S cost reduction areas.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-348TITLE: Image Processing Using Temporal Cellular Neural Networks

CATEGORY: Exploratory Development

OBJECTIVE: Produce a commercial charge coupled device (CCD) camera based on temporal cellular neural networks.

DESCRIPTION: The U.S. Army White Sands Missile Range has been following advanced in the field of neural networks for application in range instrumentation. Previously, these advanced had been confined to artificial neural networks, i.e.simulations of neural networks on conventional computers. Recently, advances have been made which may make it possible to field actual neural network technology for range instrumentation. Demonstration of this technology would require interfacing existing CCD sensors directly with temporal cellular neural networks and creating a CCD/neural network camera where signals can be processed by the neural network in a parallel and continuous manner.

Phase I: Research will be required to study and develop the design of such a camera. Because of the parallel nature of neural networks, an advanced design of how such a camera is interfaced to conventional processors and/or alternative neural network processors for further processing of the sensor data will have to be incorporated.

Phase II: Phase I design and development will lead to the implementation of a prototype version of the CCD/neural network camera. Testing of the camera will require novel techniques and use of available instrumentation.

Potential Commercial Market: True CCD/neural network cameras offer potential breakthroughs in commercial video technology in several areas: first, the standard NTSC signal would no longer be a time constraint for syncing to the video picture; second, the neural network eliminates the need for digitizing a video picture (a significant time savings); finally, neural networks would allow processing to be accomplished continuously so that pattern recognition algorithms could be processed in a fraction of the time it would take conventional processors.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-349TITLE: Automated Foward Looking Infrared (FLIR) Resolution Measurement Using Fuzzy Logic & Neural Networks

CATEGORY: Exploratory Development

OBJECTIVE: Develop a new automated approach, using neural network technology, to objectively measure the Minimum Resolvable Temperature Difference (MRTD) and maximum resolution of Forward Looking Infrared (FLIR) systems.

DESCRIPTION: Automation of MRTD and maximum resolution measurement offers the advantages of measurement repeatability, reduced cost, and test time reduction. Currently, MRTD is performed in a time consuming, subjective manner, with several trained observers determining the final decision (given unlimited viewing time). Imaging infrared sensors that require this laboratory measurement are expected to thrive as a primary technology well into the 21st century. The Redstone Technical Test Center (RTTC) has determined a need for development of a new automated approach for MRTD and resolution measurements. Although some "automated" MRTD methods currently exist, they do not actually model the human visual cognitive process involved with trained observer decision making. The method proposed should use a video frame storage and computer to replace the video display and the trained human operator which will remove operator subjectivity from the evaluation process. After digitization, the FLIR video signal will be processed through stages modeling the display-eye interface. A neural network will then analyze the processed image to determine the degree of resolution between the four bars of the target. The candidate neural network model to be investigated should use fuzzy logic with boundary and feature contour systems. This technique should offer the possibility of standardization between laboratories and test facilities.

Phase I: Complete conceptual design a development of a model for visual cognitive processing. Write computer code for image processing stages, boundary and feature contour models, as well as any other promising model(s). Conduct testing of actual FLIR data for repeatability and accuracy.

Phase II: Extension of the development effort into a deliverable system which will replace current subjective MRTD measurements using automated objective techniques via fuzzy logic and neural networks.

Potential Commercial Market: This project will extend the boundaries of both fuzzy logic and neural network technologies, resulting in unlimited commercial automation applications.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-353TITLE: GPS-Driven Battlefield Visualization

CATEGORY: Exploratory Development

OBJECTIVE: Develop an effective capability to utilize real-time 3-dimensional coordinates as reported from a troop, vehicle, or airborne mounted dynamic GPS receiver to animate the viewpoint of battlefield visualization software running at a remote location.

DESCRIPTION: The significance of real-time troop/vehicle location reporting is critical in the AirLand Operations (ALO) doctrine, which supports smaller, dispersed forces fighting on an extended, non-linear battlefield. A real-time 3-D display of troop vehicle locations will facilitate the maneuvering and synchronization of dispersed forces by tactical commanders. GPS has already demonstrated its effectiveness in providing continuous, precise position determination required for the navigation of soldiers, tanks, ships and aircraft in Operation Desert Storm. A GPS-driven battlefield visualization capability will furnish real-time awareness of the location of troops, vehicles, and targets on the battlefield and a 3-D display of terrain constrained threats, providing an added combat multiplier for the Army.

Phase I: Study existing GPS-driven tracking and visualization technologies both within the community and in related fields to determine the feasibility and application of this technique. The study should culminate in a recommended design approach for a 3-dimensional battlefield simulation capability in which the viewpoint of the Army's visualization software is animated by the input of real-time, 3-dimensional GPS coordinates.

Phase II: Implement and demonstrate the design described above, to provide a system capable of delivering highly accurate, battlefield visualization software.

Potential Commercial Market: Phase III potential should be high. The use of GPS for tracking is already in use in the commercial trucking industry. Simulation in a growing industry, and the two together may have a commercial application in expanding opportunities for vehicle and aircraft traffic control, industrial monitoring, and entertainment.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-356TITLE: Massively Parallel Graphics Workstation for Battlefield Visualization

CATEGORY: Exploratory Development

OBJECTIVE: Develop an effective approach to utilize massively parallel graphics workstations for battlefield visualization.

DESCRIPTION: The common bottleneck in real time computer graphics is the serial nature of computation, known as the Von Neuman Bottleneck. To resolve this bottleneck, the first "real" parallel computer was introduced about a decade ago. However, the high cost of these parallel machines and the lack of adequate algorithms for massively parallel processing has excluded its usage at the workstation level. The situation is changing. Size and cost are decreasing, and the availability of algorithms for general use on massively parallel machines is increasing. A need exists to investigate alternative graphics rendering schemes that take maximum advantage of massively parallel machines.

Phase I: Study the connectivity between conventional graphics rendering boards and a massively parallel machine's CPUs. Investigate efficient graphics rendering algorithms suitable for use on massively parallel machines with greater than 1000 processors. Document the feasibility of a massively parallel graphics workstation for battlefield visualization.

Phase II: The goal of this phase is to demonstrate the concept of massively parallel visualization using commercially available components and the algorithms and techniques detailed in phase I. The details of the work will depend largely upon the results of the previous phase.

Potential Commercial Market: The potential for commercial market is large. The fact that today's graphics applications are suffering mostly from the lack of computing power attests to it very well.

TECHNOLOGY CLUSTER: A-4
TOPIC: A93-357TITLE: Cartographic Animation System

CATEGORY: Exploratory Development

OBJECTIVE: To develop a geographically-based software animation system which is capable of displaying the movement of military operations over time.

DESCRIPTION: A cartographic animation system is needed to display the movement of military operations. Current animation systems lack the geographic referencing and temporal database links necessary to monitor the changing battlefield. The system should have the capability to display changes to point (ie. Military Units), line (ie. Forward Edge of Battle Area (FEBA)), and area features (ie. Area of Interest (AIO)) over time. The system should be geographically referenced and able to incorporate standard Defense Mapping Agency products for the map background. The system should also be able to extract data from a geographic information system for use in either the map background or for the changing features of the battlefield. Basic 'tweening' and 'morphing' capabilities for interpolating point, line, and area features between known positions are required. IN addition, the system should be capable of displaying environmental effects such as day/night illumination, snow, rain, fog, smoke, and other obscurants. Battlefield sounds will also be linked to the animation. Users should be able to develop custom symbols for display based on the attributes of the features in the geographic database. The system should allow flexible display of the movement of the military operations. Users should be able to control the rate of animation, move forward or backward in time, freeze the display, and zoom in on portions of the display. Users should also be able to annotate the animation using a capability similar to the 'chalkboards' on television instant replay and output the results to video tape.

Phase I: The contractor shall develop the concept for a cartographic animation system and demonstrate the basic capabilities to link to a geographic information system; animate dynamic point, line, and area features, incorporate environmental effects, and sound, and output the images to video tape.

Phase II: The contractor shall develop a prototype cartographic animation system. The system will have the capability to generate a new temporal database for mission planning or exploit an externally generated database for evaluating a previous operation. Full geographic referencing and use of Defense Mapping Agency products will be demonstrated, along with the capability to generate user-defined symbols.

Potential Commercial Market: Phase III potential should be high. A cartographic animation capability would be valuable for applications such as environmental monitoring, disaster planning and prevention, and transportation administration.

A-5ADVANCED PROPULSION TECHNOLOGIES (I.E. MOBILITY AND LETHALITY)

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-076TITLE: Critical Interior Ballistic Effects for Regenerative Liquid Propellant Guns

CATEGORY: Basic Research

OBJECTIVE: Develop an experimental capability to simulate the effects of high pressure/high frequency oscillations encountered by high-velocity projectiles and components during launch from the new generation of Army regenerative liquid propellant artillery/tank guns.

DESCRIPTION: This research concerns the development of a structural model to simulate the effects of high pressure (p up to 25ksi) and high frequency (f up to 50 Khz) oscillations encountered by projectiles/components during launch from liquid propellant (LP) guns. The model provides the scientific underpinning for the theoretical and experimental simulation of the LP effects. Using high velocity impact mitigation techniques coupled with mechanical dampers and filters, controlled high-frequency structural oscillations may be synthesized, spectrally shaped, and directed into the projectile/component structure at impact inside gasgun devices (2" to 7" caliber). This capability is critically needed to validate the survivability and capability is critically needed to validate the survivability and performance of new concept/prototype projectiles, components and submunitions designed to operate with the new family of guns.

Phase I: Develop a Lumped-parameter model which combines structural-dynamic effects (geometry-dependent wave-propagation behavior, time-dependent loading rates, constitutive material properties) and crush mechanics/dynamics of impact mitigators (aluminum and steel honeycomb cylinders and cones), to describe the onset, dissipation, and decay of the oscillatory LP loading throughout the projectile/component structure as a function of time (t up to 50ms). Perform limited experimental validation on the 7" gasgun.

Phase II: Develop a 3D finite-element working model, using the considerations outlined for Phase I; validate the model on the 7" gasgun, and provide all mechanical devices used to synthesize, shape, and direct the structural oscillation into the test projectile. The model's objective is to predict experimental behavior within 20% of the measured dynamic response.

Potential Commercial Market: This new method will provide for the qualification of the commercial potential for electronic subsystems for communication, weather, and earth-observation satellites to space environments. The new method will provide for a substantial reduction in operating and support cost for LP projectiles & components. Single shot field launches could reduce from $20K per launch to less than $1K per launch.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-136TITLE: Advanced High Temperature Strain Isolator Material System

CATEGORY: Exploratory Development

OBJECTIVE: Develop a durable, low modulus material system having long life capability at temperatures of 2000 degrees F or higher.

DESCRIPTION: Intended use of material is as a thermal strain mismatch buffer between a high temperature structural ceramic and a conventional superalloy substrate. This "sandwich" structure is a candidate for application to advanced combustor liners, turbine seals, duct or end wall liners, or other static hot section components. Application of this material technology to future gas turbine engines will substantially reduce SFC (up to 3-4%), thereby reducing fuel costs.

Phase I: Identify low modulus material system; develop interface bonding techniques; select application for demonstration of system.

Phase II: Demonstrate low modulus strain isolator system in full scale component test incorporating ceramic outer layer and structural superalloy substrate.

Potential Commercial Market: Low modulus strain isolator material concept is applicable to static hot section components in commercial gas turbines as well as military.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-137TITLE: Depleted Oxygen Gas Turbine Combustor Design

CATEGORY: Exploratory Development

OBJECTIVE: Develop a gas turbine combustor which can operate with large levels of dilution (recirculation).

DESCRIPTION: Advanced gas turbine cycles can involve combustion of air which has been diluted with combustion products. The dilution (recirculation) is introduced for NOx control or other benefits, and has an impact on combustor stability and performance. Gas turbine combustor performance using low levels of dilution has been investigated, but the allowable limits have not been established. It is anticipated that current gas turbine combustor design criteria will not be satisfactory for large dilution concentrations. Thus, novel combustor designs will be required for advanced gas turbine cycles. Advanced gas turbine cycles with novel combustor designs using dilution (recirculation) are expected to decrease gas turbine weight, volume, and fuel consumption, resulting in significant reductions in acquisition and life cycle costs.

Phase I: Demonstrate combustion stability of novel design concept(s) in a simple experiment. Measure basic performance parameters and sooting characteristics over a wide range of combustion product dilution. Recommend a candidate combustor configuration for Phase II development and testing.

Phase II: Develop, build and demonstrate the performance of a combustor with satisfactory stability and performance at high levels of combustion product dilution. Determine the limits of allowable dilution (recirculation).

Potential Commercial Market: This concept could be applied to all commercial gas turbine combustion systems.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-138TITLE: Brush Seal Shaft Wear Resistant Coatings

CATEGORY: Exploratory Development

OBJECTIVE: Develop wear resistant coatings for use on shafts and other surfaces upon which brush seals rub.

DESCRIPTION: Since brush seals, in their application, must rub against a mating surface, tribological complements to the brush material must be utilized. Brushes are being investigated, developed and implemented in both metallic and non-metallic materials. Therefore, complementary rub surfaces must be developed for brush seals to realize their full potential. Significant savings are expected from the use of brush seals, due to their demonstrated SFC reductions (due to reduced leakage), and smaller performance degradation over the life of an engine.

Phase I: Identify potential tribological couples for representative metallic and non-metallic brushes. Identify and screen coating application methods. Screen coating materials for system demonstration.

Phase II: Demonstrate at least one metallic and one non-metallic brush rubbing against its tribological pair as a system at representative conditions.

Potential Commercial Market: Advanced brush seals are applicable in commercial as well as military gas turbines.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-139TITLE: Electromotive Propulsion Concepts for Rotorcraft

CATEGORY: Exploratory Development

OBJECTIVE: Develop concepts at the main drive system or subsystem level (fuel control, lubrication, cooling, power control) supporting the ultimate development of electromotive propulsion concept for rotorcraft. Primary drive generators, motors, and controls, as well as all secondary and accessory systems inter-facing with the gas turbine prime mover are appropriate subjects.

DESCRIPTION: The electric drive system must be light weight, 0.3 lb/hp or less (comparable to advanced mechanical drives) and at least 95% efficient). Overall potential improvements in propulsion efficiency of the rotorcraft will result in substantial fuel savings over the operational lifetime. Compatible accessory and secondary systems are an essential part of the drive system and can instead be addressed in the program.

Phase I: Define overall drive system concept for two rotorcraft size classes (10,000-20,000 lb, and 60,000-80,000 lb); identify technology readiness for electric drive components comprising the system; or for associated subsystems; propose development plan required to address identified critical enabling technologies; assess overall system payoffs and risks.

Phase II: Execute high priority segments of development plan; demonstrate overall feasibility of achieving program objectives.

Potential Commercial Market: Results will be applicable to future commercial rotorcraft including conventional helicopters, tiltrotors, convertible drive systems, and fan-in-wing concepts. Retrofit to existing aircraft is also possible.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-140TITLE: Fast Acting Valves for Turbomachinery Bleed Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop a controllable valve to bleed or inject air into a turboshaft/turbojet engine compressor. This valve must operate and be controllable to frequencies high enough (150 Hz) to be used to locally influence the performance of a circumferential segment of a given compressor rotor.

DESCRIPTION: Recent research has indicated that the inception of a flow disruption in compressor rotors known as "rotating stall" can be delayed by locally affecting the flow conditions of the critical compressor stage rotor. The flow conditions might be locally modified using bleed behind or fluid (air) injection in front of the rotor. This would result in improved performance for the compression system. To accomplish this task, a valve is required that can cycle from full close to full open to full close at a speed of approximately 150 Hz. The valve would be sized to pass a maximum of approximately 1.65 ft(3)/sec of air at standard day conditions. Successful control of rotating stall inception will allow improved performance of turbomachinery which will reduce operating, replacement and repair costs by eliminating compressor surges which often result in hardware damage.

Phase I: Evaluate potential methods and innovative ideas to produce a valve that will meet these maximum requirements. Factors to be considered are: flexibility, size, cost, durability, and growth potential. Recommend a candidate approach to be pursued in phase II. Develop a methodology to describe the valve system fluid response to valve position.

Phase II: Demonstrate the approach by fabricating and testing a valve that meets the required specifications.

Potential Commercial Market: This concept could be applied to all commercial turbomachinery compressor systems.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-149TITLE: Electrical Energy Recovery for Gas Turbine Engine Exhaust

CATEGORY: Exploratory Development

OBJECTIVE: Determine the feasibility and potential payoffs for using thermoelectric devices to recover waste heat in rotorcraft propulsion systems. Utilizing thermal energy available in engine exhaust systems results in an improved cycle efficiency and thus a lower specific fuel consumption (SFC). Therefore, the program addresses the Army's goal to reduce operating and support costs.

DESCRIPTION: Currently, the propulsion community is striving to double the capability of aircraft powerplants around the turn of the century. Advances in simple cycle (air standard Brayton cycle), however, may not be sufficient to achieve the ambitious cycle thermal efficiency required. Therefore, innovative cycle concepts need to be explored that offer advancements in engine SFC without compromising the horsepower-to-weight ratio of the simple cycle

engine. Accordingly, it is desired to investigate/evaluate the feasibility of a lightweight, low packaging volume, bottoming cycle which utilizes thermoelectric/thermionic or other concepts to extract useful electrical energy from the exhaust of rotorcraft gas turbine engines.

Phase I: The Phase I effort shall include the selection of a baseline gas turbine engine and the identification of sufficient cycle parameters to describe the system. A feasibility analysis shall be conducted to determine the practicability of using thermoelectric/thermionic technology as a viable means to recover waste heat. This bottoming cycle concept shall be considered as a candidate to supply power to operate engine accessories, anti-ice systems, etc. The analysis, as a minimum, shall address materials, controls, related electronics, SFC versus weight, horsepower-to-weight ratio, packaging, exhaust temperature reduction, reliability, and manufacturing cost. The culmination of the Phase I effort shall be a preliminary design of the most viable electric bottoming cycle concept and a comparative performance summary to the baseline configuration.

Phase II: The Phase II effort shall include performing a detailed design, fabrication, and bench testing of the electric bottoming cycle.

Potential Commercial Market: Recovering waste heat from the engine exhaust results in an improved cycle efficiency and thus a lower SFC for commercial gas turbines. Any reduction in SFC is always of great interest to commercial aviation firms.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-156TITLE: Surge Control for Turboshaft Engines

CATEGORY: Exploratory Development

OBJECTIVE: To design a system capable of avoiding an impending surge and smoothly recovering from rotating stall in a gas turbine engine.

DESCRIPTION: Gas turbine engines used in military applications require high performance and high reliability in order to ensure that the required missions can be completed effectively and safely. When a gas turbine engine experiences a compressor stall or surge, the given mission will be effected slightly or significantly. In cases of severe surge, the engine or drive train components can fail, causing loss of engine operation. When this happens on airborne platforms, the results can be catastrophic. Surge/stall has three causes: 1) engine deterioration, 2) aerodynamic distortions (especially at the air inlet), and 3) hot gas injection (from weapon firing). With modern technology, it may be possible to design new gas turbine engines, or modify existing ones so that occurrences of surge/stall are nearly eliminated. This can be done by implementing innovative control techniques using Digital Electronic Controls and fast temperature and pressure sensors, or by using methods that change the internal aerodynamics of the engine in order to actively avoid surge. Some of these methods are: movable plenum walls, air injection into the compressor, oscillating fuel flow, bleeding air from the compressor, actuating variable geometry etc. Using these techniques, it may be possible to reduce the required surge margin and operate near the surge region, thereby, running the engine at a more efficient speed.

Phase I: Perform a trade study that investigates new developments in the area of active surge control. Evaluate new methods by taking into account the maturity of the technology, developmental risk, ability to validate by using computer simulation, ability to engine test, and cost. Select specific method(s) to be engine tested in Phase II. Finally, perform an analysis that will quantify the effect that the most promising methods will have on engine weight, engine size, cost, specific fuel consumption (SFC), and power-to-weight ratio. Generate a formal report that includes the details and results of all of the activities performed in Phase I.

Phase II: Validate the method(s) selected in Phase I by performing extensive computer simulation. Fabricate and test a surge control system complete with all necessary software and hardware (in breadboard form). Generate a formal report that includes the details and results of all Phase II activities.

Potential Commercial Market: Manufacturers of gas turbine engines (especially engines used in fixed-wing and rotary-wing aircraft).

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-157TITLE: High Velocity Combustors for Gas Turbine Engines

CATEGORY: Exploratory Development

OBJECTIVE: To develop improved diffuser/combustor aerodynamics that minimize diffusion and combustion pressure losses while maintaining proper combustor stability and turbine cooling backflow margin. Minimizing these losses results in an improved cycle efficiency and a lower engine specific fuel consumption (SFC). Therefore, the program addresses the Army's goal to reduce operating and support costs.

DESCRIPTION: As pressure ratios increase for modern engines, it becomes more difficult to design efficient diffusers which normally decelerate the compressor discharge flow from a Mach number of around 0.9 to around 0.1. If high velocity combustors could be designed to accept the diffuser exhaust at high Mach numbers, some of the pressure loss associated with the diffuser could be saved since the diffuser would not have to operate over as wide a range of pressures, thus giving a higher pressure recovery coefficient. The problem is that combustors are presently designed to operate at low reference velocities to maintain proper stability. To develop higher velocity combustors while maintaining stability will demand great attention to the air admission process. Stability is difficult to maintain at high altitudes and low power conditions where lean blowout is most likely to occur.

Phase I: Conduct preliminary design of combustors which will operate at entry Mach numbers up to 0.3. Different geometrics of the combustor's primary zone shall be considered along with various methods of fuel and air admission.

Phase II: Design, fabricate, rig test, and evaluate combustor for existing Army helicopter engine.

Potential Commercial Market: Improved diffuser/combustor aerodynamics will result in a better SFC for commercial gas turbine engines. Any reduction in SFC is always of great interest to commercial aviation firms.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-161TITLE: Particle Trajectory Analysis for Turbine Engine Inlets

CATEGORY: Exploratory Development

OBJECTIVE: Develop advanced trajectory analysis techniques to improve the prediction of inlet particle separator sand removal efficiency and to expand the capability to model 3-D, non-axisymmetric flow paths.

DESCRIPTION: Current methods used in industry to model particle trajectories in inlet particle separators (IPS) have several limitations. Current trajectory analysis techniques are generally limited to 2-D axisymmetric ducts. Most of the modeling only uses a deterministic approach to model particle trajectories at the boundary conditions and to model bounce. The shortcomings of current particle trajectory analysis techniques result in the prediction of 100% efficiency of large particles and typically underpredict efficiencies for fine particles. One possible improvement would be to take a statistical approach to modeling bounce and to modeling particle trajectories at the inlet conditions. Expanding current codes to permit full 3-D modeling would permit the impasse of obstructions such as struts and scavenge vanes to be evaluation. A full 3-D code would also permit the modeling of engine nacelles and intake ducts, which would permit an assessment of IPS installation effects, and for non-axisymmetric IPS designs. Other potential improvements could include improved bounce modeling and to model particle interaction.

Phase I: Using a conventional fully 3-D flow analysis code, develop a 3-D trajectory analysis code capable of analyzing non-uniform particle flow boundary conditions and incorporating a probabilistic bounce model.

Phase II: Phase II work performed shall involve analysis of at least two previously tested IPS configurations to validate the code. Identify and implement enhancements to the code to improve the accuracy, speed, and user interface.

Potential Commercial Market: An advanced trajectory analysis code could be applicable to the design of inlet protection systems for commercial aircraft and ground vehicles, and for industrial air cleaners.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-162TITLE: Adaptive Electric Anti-Icing for Turbine Engine Composite Inlets

CATEGORY: Exploratory Development

OBJECTIVE: To develop an adaptive electric anti-icing system for composite engine inlets including: the engine inlet nacelle, inlet protection system, and engine inlet housings.

DESCRIPTION: With the Army's interest in developing a more electric helicopter, industry is increasingly looking at electric anti-icing for inlet protection systems (IPS). Electric anti-icing offers reduced power utilization and lower weight over conventional methods using compressor bleed air. Moreover, the increasing use of composites in engine components is also driving industry to consider electric anti-icing due to the complex flow passages required for conventional anti-icing. Electric anti-icing composite materials can be accomplished in a variety of ways including: embedded wire, coated filament, and thermoelectric film. Unlike conventional anti-icing, electric anti-icing, would permit incorporation of adaptive features to better utilization of power, the ability to anti-ice localized icing patterns in the IPS associated with various flight conditions, and the ability to compensate for damaged sections.

Phase I: Develop and analyze the thermodynamic cycle and control logic for an adaptive anti-icing (AA/I) system. Fabricate a demonstration model of the system incorporating a composite specimen with electric anti-icing and an embedded thermocouple, and a breadboard control system. Conduct icing tests on the model to validate thermodynamic analysis and control logic.

Phase II: Fabricate several test specimens and conduct testing to determine the mechanical properties of the composite. Design and fabricate a prototype AA/I system for a current inlet component. Test the prototype to determine the performance of the system in a variety of icing conditions and in a simulated damaged configuration, and to validate the endurance of the system.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-163TITLE: Braze Joining Ceramic Matrix Composite Components for Turbine Engines

CATEGORY: Exploratory Development

OBJECTIVE: To develop a joining method to attach ceramic matrix composite (CMC) components to the engine, where most components are metallic.

DESCRIPTION: The high temperature capability of CMC material will potentially allow for uncooled operation of hot section components in gas turbine engines. This will result in a reduction of the engine specific fuel consumption. Additionally, the high fracture toughness of the CMC will greatly enhance the component furability. A critical need for the commercialization of CMC components in turbine engines is the development of joining methods to attach these components to the engine, where most components are metallic. One promising joining method is brazing. Research is required in order to successfully apply this joining technology to ceramic composite components in gas turbine engines. The operating temperatures in CMC turbine engine components will require joining techniques which can withstand increasingly higher temperatures. The presence of fiber which may be attached by molten metals will also require very careful selection of the braze material. Additionally, the difference of thermal expansion between the CMC and the metal to which it will be joined will require careful management of the thermal gradients across the joint.

Phase I: Conduct a literature search to fully understand the current state of the art in brazing CMC composites to metals. Braze candidates will be selected based on the liquids temperature, expected strength, and an evaluation of the propensity of the molten braze to successfully wet the metal and the ceramic without attacking the fiber. Perform several brazing experiments to attach CMCs to metals consistent with those found in gas generator turbine engines. Complete an analysis and characterization of the resultant brazes. Mechanical and thermal testing will be done to evaluate the strength and ability to withstand thermal cycling for each braze combination. Recommend most promising braze for Phase II.

Phase II: Based on the recommendation from Phase I, perform additional experimentation and characterization, if necessary, to refine the braze metallurgy. Design an attachment scheme consistent with joining a CMC component to a supporting metal structure. The design shall include a finite element analysis of the braze including the thermal and stress maps of the braze. Braze the CMC component to the metal supporting structure and test.

Potential Commercial Market: Joining technology sufficiently developed to allow incorporation of CMC component into an automotive or aircraft engine demonstration.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-165TITLE: Ceramic Matrix Composite Component Improved Load Bearing for Turbine Engines

CATEGORY: Exploratory Development

OBJECTIVE: To improve the mechanical load bearing capability of ceramic matrix composite (CMC) 2-D fabric for future application in gas turbine engine components.

DESCRIPTION: The high temperature capability of CMC materials will potentially allow for uncooled operation of hot section gas turbine engine components resulting in significant reductions in specific fuel consumption. Additionally, the high fracture toughness of CMC greatly enhances the component durability. Currently, fabrication of mechanical load bearing fiber reinforced CMCs require the use of 3-D fabric preforms, which are a magnitude more expensive than 2-D preforming. As an alternative, the development of higher interlaminar shear strength would allow fabrication of load bearing CMC structures using cost effective 2-D fabric preforming techniques. Furthermore, composites with higher interlaminar shear strength would provide components with long-term durability.

Phase I: Evaluate a minimum of two technical approaches to increase the load carrying capability of 2-D fabric CMCs. Fabricate 4-6 CMC plates consistent with the approaches identified. Characterize the resulting composites by examining microstructure and performing a mechanical test matrix. Mechanical tests will include, as a minimum, interlaminar shear, coefficient of thermal expansion, and thermal conductivity.

Phase II: The improved material system developed in Phase I shall be tested in a turbine engine structural component. Additional fabrication, characterization, and mechanical testing of the plates utilizing the improved material system will be performed to provide sufficient test sample size for preliminary design values. Conduct an engine test of the CMC component to validate the design.

Potential Commercial Market: Will provide CMC technology sufficiently developed to allow incorporation of CMC components into aircraft engines cost effectively.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-173TITLE: Turbine Engine Component Repair Concepts

CATEGORY: Exploratory Development

OBJECTIVE: To identify advanced concepts for the cost effective repair/refurbishment of high-dollar value components for small turbine engine systems in order to improve component and system life cycle costs. This program directly addresses the OSCR initiative generic cost driver number one "causes of electrical/mechanical replacement costs."

DESCRIPTION: Recently fielded and developmental turbine engine systems are utilizing components manufactured with material systems and fabrication processes for which there are no well defined repair procedures. Examples of these might be the utilization of single crystal turbine vanes and blades, and various other investment cast structural components. It is not unusual for these components to experience varying degrees of cracking and/or wear. If this damage progresses beyond allowable limits, component removal will be required. As it is well known, structures such as single crystal airfoils are very expensive to replace. For this reason it is very desirable to repair the components and return them to service. It will be the intent of this program to survey and identify potential processes which may be capable of providing the means to effectively repair or refurbish high-dollar value components.

Phase I: The Phase I effort shall consist of several activities. First, a thorough survey of the turbine engine industry, as well as Government/industry operated repair facilities, will be conducted to develop a definitive understanding of current and anticipated repair limitations and requirements for a matrix of high value components. Available data should be compiled which indicates actual and anticipated component failure rates, component damage/failure mechanisms, and actual or anticipated component costs. This data will be needed for cost benefit analysis and repair process identification. A second survey will be performed to identify those repair/refurbishment techniques and processes possessing the highest probability of providing a cost effective repair of high value components. It must be remembered that identified repair/refurbishment processes should not possess known limitations in their ability to return a component to usable condition. Repair processes must not degrade the mechanical integrity or component functional characteristics. An assessment of anticipated repair cost(s) associated with the

processes should be conducted and an initial estimate of component(s) life cycle cost improvements made. Following the survey activities, a detailed assessment of the most promising repair/refurbishment techniques should be conducted. This would be anticipated to include an assessment of repair practicality, and repair effectiveness with respect to durability, quality, and yield. Sub-scale trials of the identified repair/refurbishment processes should be conducted to allow for preliminary assessment of the mechanical properties of repaired structures and initial screening of processes and processing parameters.

Phase II: The Phase II effort will consist of the preliminary development of the detailed repair/refurbishment process specifications. Process parameter refinement requirements will be identified following a preliminary repairability/refurbishment demonstration. Mechanical property screening tests will be conducted to identify potential repair problems. Following preliminary repair trials, necessary process refinements shall be incorporated into each of the selected processes and full-scale component repairs will be demonstrated. The repaired component(s) will be subjected to mechanical and metallurgical evaluations to assess strength and durability characteristics.

Potential Commercial Market: Due to the extensive use of turboshaft and turboprop engines in the civil aviation community, the potential for exploitation of the repair technologies identified by this program is considered very good.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-174TITLE: Auxiliary Bearings for Turbine Engine Magnetic Bearing Systems

CATEGORY: Exploratory Development

OBJECTIVE: Design and demonstrate auxiliary rolling element bearings to be used in conjunction with magnetic bearings for aircraft gas turbine engines.

DESCRIPTION: The use of magnetic bearings in aircraft gas turbine engines offers many potential advantages. These include the ability to operate at high temperatures and high speeds. The lubrication system could be eliminated, resulting in lower weight and reduced logistic support considerations. Magnetic bearings could be actively controlled to offer improved rotordynamic characteristics. The use of magnetic bearings requires auxiliary bearings to support the rotor while power to the magnetic bearings is off, if the magnetic bearing fails, and during transient conditions when the maneuver loads are too great for the magnetic bearing to handle. The engagement and disengagement of auxiliary rolling element bearings at full rotor speed will impose unique dynamic conditions on the bearings. The dynamic effects of these conditions must be considered in order to design durable, reliable auxiliary bearings.

Phase I: Perform a preliminary design of an angular contact ball bearing and cylindrical roller bearing for use as auxiliary bearings for a magnetic bearing system applicable to gas turbine engines. The bearings should be designed to operate at high speeds (3.0 to 3.5 million DN). An analysis shall be performed to investigate the dynamic effects of sudden engagement and disengagement at high speeds such as might occur during magnetic bearing failure or engagement due to maneuver loads or blade-out conditions. Results of the analysis shall be used to refine the bearing design.

Phase II: Design auxiliary bearings for use in a magnetic bearing rig test. Expand dynamic analysis to investigate rotordynamic effects due to changing bearing stiffness, changing rotor speed, and applied forces on the rotor system as a result of auxiliary bearing engagement. Fabricate auxiliary bearings. Perform rig testing of auxiliary bearings to investigate dynamic effects of sudden engagement and disengagement.

Potential Commercial Market: If magnetic bearings become feasible for aircraft gas turbine engine applications, the commercial market would be large. This program could also be applicable to industrial applications of magnetic bearings.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-261TITLE: Personal Computer Based, Graphical User Interface Configured, Generic Airbreathing Propulsion System Cycle Deck

CATEGORY: Exploratory Development

OBJECTIVE: Development of a P.C. based generic cycle deck for airbreathing propulsion systems that is configured through a graphical user interface.

DESCRIPTION: A generic airbreathing propulsion system thermodynamic cycle analysis model (cycle deck) is required. The cycle deck shall be utilized to predict the steady-state performance of various air-breathing propulsion cycles. The cycles of particular interest are: turbojet, turbofan, turboprop, ramjet, ducted rocket, and airturbo ramjet. However, the deck should not be limited to these cycles and should be able to accommodate the analysis of propulsion systems incorporating combinations of critical features from those previously mentioned cycles. The model shall incorporate libraries of generic scaleable components. Components of particular interest are compressors (axial, centrifugal, mixed flow), combustors, gas generators, turbines (axial, radial, mixed flow), nozzles, exhaust ducts, afterburners, inlets, propellors, and ejectors. The cycle deck shall incorporate a graphical user interface that utilizes the Windows operating system and shall operate on an IBM compatible computer. The user shall configure a given propulsion cycle (graphically) by selecting and scaling a series of components from the generic libraries. This configuration process shall utilize a graphical interface that allows the user to interactively construct the particular cycle. Once a cycle is constructed, the graphical interface shall be utilized to execute on-design, and off-design performance predictions. The cycle deck shall easily (graphically) accommodate parametric variations of input variables such as critical component performance or flight conditions. The cycle deck shall have graphical outputs of various formats that permit ready analysis of parametric studies. The structures shall be modular in nature and allow for the continuous addition of component libraries and thermodynamic models.

Phase I: Under the Phase I effort, a detailed software structure shall be designed for the graphical user interface configured generic airbreathing propulsion system cycle deck. In addition, the executive program, with the graphical user interface, shall be developed, along with various airbreathing propulsion system component thermodynamic models. The ability to configure and analyze an airbreathing propulsion cycle (such as turbojet) shall be demonstrated. A complete demonstration of graphical interface is required. The software that is developed and any required computer software and hardware necessary for program execution shall be delivered to the Government for evaluation.

Phase II: Under the Phase II effort, the complete graphically configured generic cycle deck shall be developed. Numerous components libraries and component thermodynamic models shall be developed and integrated with the cycle deck. Complete documentation for operation and for the development and incorporation of new modules shall be produced. All software, required computer hardware, and documentation shall be delivered to the Government.

Potential Commercial Market: This item could be utilized by commercial gas turbine manufactures and by educational institutions.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-270TITLE: Low Cost Generic Digital Thrust Controller for Tactical Missile Smart Propulsion Systems

CATEGORY: Exploratory Development

OBJECTIVE: To develop a Low-Cost Generic Digital Thrust Controller for tactical missile propulsion systems

DESCRIPTION: Traditionally, tactical missile systems have exclusively utilized solid rocket propulsion. However, the mission requirements of the next generation of tactical missiles will demand a level of propulsion system flexibility that cannot be met with a solid rocket. On-demand thrust control will be required which will dictate the use of non-traditional propulsion systems such as: turbojet, ramjet (liquid or solid), air turbo ramjet (liquid or rocket), bi-propellant rocket, monopropellant rocket, hybrid rocket. All of these propulsion systems have a common functional element in that in order to achieve on-demand thrust variation, some form of control is required. Regardless of the specific propulsion cycle, the engine controller will require the same basic functionality - an external throttle command signal must be received by the controller, data must be acquired from control system sensors, and an output signal must be transmitted to a throttling device. Due to the functional commonality of the required control system for each of the throttleable propulsion systems, it is desirable to develop a generic engine controller that can readily be adapted to each specific application. The desired engine controller shall be digital and utilize a microprocessor as the central controlling element. The controller shall permit digital inputs to receive throttle commands and other external information. The controller shall have digital outputs to transmit information to the missile system and to command discrete events. A

number of analog input channels shall be provided to receive sensor data. A number of analog output channels shall be provided to drive analog control devices. The controller shall be fully programmable to accommodate the specific logic requirements of the engine. The controller shall be modular in nature and shall be configured to accept input and output signal conditioning modules which are specific to the control requirements of the given engine. The generic controller shall be designed for a minimum unit production cost. Commercial technology shall be utilized to a maximum extent. The final control system is envisioned to consist of a generic control module combined with a number of more specific (but multi-application) input and output modules. The control system shall be a self-contained, stand-alone system requiring only throttle input commands. A unit production cost estimate shall be generated.

Phase I: Under the Phase I effort, a detailed design for the generic engine controller and interface modules shall be generated. The programmability and functionality of the central control unit shall be demonstrated either through a bread-board system or through a personal computer based system. This demonstration system shall be delivered to the Government for evaluation.

Phase II: Under the Phase II effort a production-ready configuration of the control unit and of the interface modules shall be designed, developed, fabricated, demonstrated, and delivered to the Government for evaluation.

Potential Commercial Market: This low cost controller could be utilized as a fuel control for lawn mowers and recreational vehicles.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-277TITLE: Portable Static Test Facility for Small Expendable Turbojet Engines

CATEGORY: Exploratory Development

OBJECTIVE: To develop a portable static test facility for small expendable turbojet engines

DESCRIPTION: In recent years a number of small, low cost, expendable turbojet engines have been developed for missile applications. Due to the relatively small sizes (4.0 to 15.0 in diameter) and thrust levels (50 to 1000 1bf) of these engines, static test performance evaluations of these turbojets does not require (or justify) the use of a large-scale, dedicated engine test facility. The small size and simplicity of these engines make it feasible to perform static test evaluations in relatively confined locations with a minimum of supporting facilities. To permit the convenient and economical performance evaluation of these small turbojet engines, the development of a suitable small scale test facility is required. The test facility to be developed shall permit the static test evaluation of a wide range of small turbojet engines. The test facility shall be small in physical size and designed for installation and operation in relatively confined locations. The test facility shall be a self contained system that requires a minimum of external support facilities. The test facility shall be comprised of the following major subsystems: A. Test cell, B. Fuel storage/delivery, C. Instrumentation Interfaces, E. Control center, F. Personal computer based data acquisition system, G. Personal computer base engine control system, H Personal computer based data display system, and I. Signal conditioning. The test facility shall be modular and completely portable. All components shall be designed for movement and position with a fork lift. All components shall be transportable by a flat bed truck. The facility shall be designed for minimum emplacement and set-up time.

Phase I: Under the Phase I effort a preliminary design of the portable test facility shall be developed. To validate the feasibility of the design concept, the test cell component of the facility shall be designed, developed, fabricated, and delivered to the Government for evaluation.

Phase II: Under the Phase II effort the complete portable test facility shall be designed, developed, and delivered to the Government for evaluation.

Potential Commercial Market: This item could be utilized by commercial gas turbine manufacturers and educational institutions.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-279TITLE: Windows Based Graphical User Interface for FORTRAN Based Propulsion System Analysis Codes

CATEGORY: Exploratory Development

OBJECTIVE: Development of a Windows Based Graphical User Interface (Input and Output) for Existing FORTRAN Based, Batch Executed Propulsion System Analysis Codes.

DESCRIPTION: Over the past thirty years, thousands of propulsion system engineering analysis computer codes have been developed. The vast majority of these codes were written in FORTRAN source code for execution in a batch mode on a mainframe computer. Predominantly, these codes utilize card image input sets with fixed field and/or namelist formats. In addition, output was typically configured in a tabular format that could be accommodated by a line printer. These codes represent irreplaceable investment in time expertise, and for the most part, are valuable and technically valid engineering tools. However, in light of the computational power of the current 80486 based IBM compatible personal computers (P.C.) and the convenient graphical user interface offered by the WINDOWS operating environment, the input/output interfaces and the mode of execution of these older codes are obviously antiquated. What is required is a methodology for the conversion of these existing propulsion system analysis codes for execution on a P.C. with utilization of a WINDOW based graphic input/output interface. A generic WINDOWS based user interface shall be developed. Through this interface the user shall graphically and conveniently specify the required input sets for a given analysis code. The interface shall also be used for execution of the codes and provide for convenient user configurable outputs in either graphical tabular format. The user interface shall be as general as is practical to allow incorporation with the widest possible range of analysis codes. The interface shall require virtually no modifications to the FORTRAN source language of the existing codes. In addition convenient user modification and expansion of source code shall be readily accommodated. Integration of the interface with new FORTAN source code is also required. The interface shall be executed on commercially available IBM compatible P.C. hardware. The interface shall utilize commercial software development tools. All required hardware and software shall be delivered to the Government. The source code for all custom software shall also be delivered, along with all associated documentation.

Phase I: Under the Phase I effort, a detailed software structure for the graphical user interface shall be developed. The required commercial software, custom software, hardware, interface procedures, and operating procedures shall be specified in detail. A limited (but fully functional) version of the interfaces shall be demonstrated on an existing FORTRAN program. The desired program for the demonstration is the NASA Lewis Chemical Equilibrium Code (CEC) SP-273. This code can be obtained from NASA Lewis. All hardware and software required to execute the demonstration shall be delivered to the Government.

Phase II: Under the Phase II effort the complete graphical user interface shall be developed. Detailed code documentation, configuration procedures, and operating procedures shall be delivered to the Government. The utility of the interface shall be completely demonstrated through incorporation and utilization with several Government furnished FORTRAN analysis codes. All hardware, commercial software, custom software (with source code) required to develop, modify, configure, and execute the interface shall be delivered to the Government.

Potential Commercial Market: There is a huge commercial market. Any user of FORTRAN computer programs can utilize the user interface that is developed.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-284TITLE: Airdrop Impact Decelerator Using Magnetic Technology

CATEGORY: Advanced Development

OBJECTIVE: To develop an Airdrop Impact Decelerator using Magnetic Technology.

DESCRIPTION: The application of magnetic technology for use as an airdrop impact decelerator has been proposed. Additional development and testing is required to effectively demonstrate this technology in an airdrop application. Magnetic technology offers tactical and logistical improvements over current technology (paper honeycomb). Combat effectiveness is improved through enhanced load survivability, reduced derigging times and elimination of paper honeycomb storage requirements. This technology may be applicable to cargo and personnel airdrop.

Phase I: The contractor will formulate and define a conceptual design for a magnetic technology based load decelerator. Perform calculations necessary to develop detailed performance specifications for load decelerator.

Phase II: The contractor will develop and test a full-size working prototype magnetic impact decelerator. Optimization of performance, materiel, weight and cost parameters shall be documented. The prototype shall demonstrate compatibility with existing airdrop components.

Potential Commercial Market: Commercial Aviation Industry

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-333TITLE: Air Tank Recharging System

CATEGORY: Exploratory Development

OBJECTIVE: Provide an alternate system of starting a diesel engine.

DESCRIPTION: Engine-cranking system using compressed air are becoming commercially popular. If a vehicle has lost its air supply in the field, a recharging of its tank is required, usually from an assist vehicle, when available. There have been commercial installations where a hand powered pump was used to recharge a starting tank. It would also be possible to use a gas-generating cartridge fired into the tank; possibly even a 7.62 round with projectile removed.

Phase I: The contractor will research the energy requirement to successfully start various engines in the tactical fleet at -40 degrees F. He will develop two methods of charging the tank which are independent of the subject vehicle or an assist vehicle: one using a manual pump designed and/or modified to efficiently utilize soldier power, and one, if possible, to use one or more small arms rounds with projectile removed. In the latter safety ramifications, variability of results and deleterious effects of chemically induced corrosion on the starting system will be analyzed.

Phase II: Given a successful prototype of either or both systems, develop optimum designs which one producible and suitable for competitive solicitation.

Potential Commercial Market: Minor adaptation of teh subject system could provide a marketable kit for any air-started engine, particularly in cold climates.

OPERATING & SUPPORT COSTS: The hardware needed to recharge the air tank is low cost commercially available and/or stocked military items. An alternate starting method for air equipped vehicles is important if an when the air is depleted in the tank and no air source is immediately available to recharge the system.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-337TITLE: Advanced Military Diesel Engine

CATEGORY: Exploratory Development

OBJECTIVE: the objective is to examine and develop technologies to increase fuel economy, increase power density with respect to volume and or weight, reduce specific heat rejection and provide RAM-D improvements for high output military diesel engines.

DESCRIPTION: Anticipated future high output engine operating conditions where cylinder heat loading will be greater than 4 HP per square inch (piston surface area), 4 cycle brake 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: (1) high temperature tribology (Tribological system approaches should address high temperature lubricant capability, and friction and wear minimization in areas of borderline lubrication); (2) insulative componentry (Components to be considered shall include pistons, rings, liners, valves, valve guides and seats, head or head combustion face and intake and exhaust ports. Novel monolithic and coating applications for these components will be considered); (3) fuel injection system/combustion enhancement (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 turbomachinery (Military diesels require compact, high efficiency, broad range, low inertia and tolerance to high exhaust pressure. Concepts to use a turboalternator as a compounding unit are being considered for electric drive applications); and (5) engine lightweight structural concepts (requirement are to provide dramatic weight reduction in diesel engine structure and componentry). Engine RAM-D goal of 1000-hour life expectancy shall be pursued in all designs or concepts proposed. Also concepts designs presented shall be consistent with army initiatives to reduce operating and support costs. Two generic cost drivers (1) causes of electrical/mechanical replacement costs and (2) causes of fuel/fuel distribution costs are directly applicable to this topic.

Phase I: The contractor shall research promising engine 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 on 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 diesel engines ae generally operated at lower brake mean effective pressures (BMEP) than their military counterparts, the trend for commercial engines is now directed toward higher BMEPs for improved fuel economy and emissions reasons. THis trend has been observed in teh "Advanced Diesel Engine Program" being sponsored by teh Department of Energy. These advanced commercial diesel engines will require high temperature insulative and tribological componentry because of the higher operating temperatures encountered with the increasing BMEP levels. Insulating in-cylinder components and exhaust ports will provide an increase in exhaust energy which is beneficial when used in conjuction with exhaust energy recovery (turbocompond) devices. Turbocompound devices are an integral part of the design concept for these advanced engines. Power generated from these devices is returned to the engine crankcase which is key to the efficiency gainst to be made. It is therfore expected that the high temperature component and tribology technologies developed in this effort will have direct applicability to future advanced commercial diesel engines.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-339TITLE: Innovative Heat Pipe Cooling System

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this effort is to design, fabricate and test an innovative heat pipe cooling system for the M109 A6 Howitzer that is damage resistant, more thermodynamically effective than the present system and increasing the performance.

DESCRIPTION: The current M109 radiator is vulnerable to core damage causing the loss of engine coolant which immobilizes the vehicle. The cooling system is small and uses a high percent of the engine power to drive the fan. It would be desirable to have an innovative heat pipe cooling system with a 50 mile limp home capability that is also more effective than the current M109 cooling system while increasing the performance.

Phase I: In Phase I, the contractor would develop a concept for the innovative heat pipe cooling system 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 M109 and provide the desired improvements. Current M109 radiators continuously cool the engine and transmission at full power, 14,400 BTU/MIN without exceeding 230 degrees F coolant temperature and 275 degrees F transmission oil temperature.

Phase II: In Phase II, the contractor shall fabricate and test a breadboard prototype of the innovative heat pipe cooling system. 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, armored trucks, or other vehicles exposed to rought field usage and where an added measure of reliability and serviceability will save lives. For example, this concept could provide a cooling system not susceptible to small arms fire as in a more exposed conventional radiator. THus heat pipe location flexibility results in eliminating potential engine failures due to coolant loss leakages, which also impacts on limiting a vehicle's performance and mobility. In conclusion, this technology could lead to a reduced operation and support (O&S) cost and improve the mission capability of any vehicle used in security or police type applications where radiator damage is at higher risk.

OSCR: This project has the potential to save lives, money, and equipment in a military conflict as well as help to assure successful completion of the intended mission.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-340TITLE: Heat Exchanger Precleaner

CATEGORY: Exploratory Development

OBJECTIVE: Precleaner design concepts for military heat exchangers (e.g., engine coolant and oil, transmission oil, charge air, hydraulic oils) will be developed and demonstrated. Integration with the air cleaner scavenging system will be a primary objective.

DESCRIPTION: High fin density heat exchangers and heat exchanger locations contribute to fouling which result in high fluid temperatures. The design and installation of a precleaner ahead of the heat exchanger can remove most contaminants resulting in improved vehicle performance. Sizing of the precleaner to obtain high efficiency at air flows up to 10,000 cfm within confined space constraints is needed. Combat vehicle designs present unique challenges for packaging a precleaner within tight spaces. Integration of a precleaner heat exchanger scavenging system with the air cleaner scavenging system will be a target goal. Design goals include foul free heat exchanger scavenging system for the life of the vehicle. Primary emphasis will focus on new and present combat vehicles and tactical trucks.

Phase I: Heat exchanger precleaner integration development and design approach shall be investigated from a feasibility concept. This shall include a matrix trade-off and survey analysis to determine if any other approach concept is practical. This includes the investigation of a reverse flow fan. Bench breadboard tests will be conducted determing the best concept approach to eliminate fouling from dust and military fluids.

Phase II: The precleaner heat exchanger design concept shall be demonstrated in a mock-up combat vehicle propulsion system. Testing shall be accomplished in a lab to a duty cycle representative of cooling air flows. The demonstration will prove precleaner heat exchanger efficiency by demonstration of a floul free system when tested with dust and fluid contaminants. The design will incorporate were practical the engine's air cleaner scavenging system. Militarization and hardening of the heat exchanger components will also be verified and demonstrated.

Potential Commercial Market: Applications can be applied to off-highway commercial equipment which operates in dustry environments and results in heat exchanger clogging. This technology will improve reliability, ability and maintainability in both commercial and military applications resulting nin increased engine perofrmance and longer service life. In commercial markets this technology will also show a reduced maintenance burden through less servicing and replacement heat exchanger parts. In conclusion, commercial markets should realize lower operation and support (O&S) costs resulting in increased vehicle usage per year while maximizing a fleet or equipemnt owners profit margin.

OSCR: Heat exchanger clogging occurs in dusty environments causing engine overheating and increased vehicle down time. A clean radiator/heat exchanger will reduce maintenance costs through less servicing and spare parts. Cleaner heat exchangers will also allow a vehicle to operate at its maximum cooling capability resulting in improved vehicle fleet readiness.

TECHNOLOGY CLUSTER: A-5
TOPIC: A93-342TITLE: Electric Drive Power Conditioning Units

CATEGORY: Exploratory Development

OBJECTIVE: To develop and demonstrate power electronic packaging and cooling concepts which will significantly reduce the volume of the solid state rectifier and inverter modules used in electric drive configurations.

DESCRIPTION: The current technology rectifier and inverter modules require space claims which exceed the volume of the electric machinery they service. Additionally, the operating temperature of the switching devices used in these modules require large cooling systems. The packaging methodology appears to be a part of the technology development which may offer acceptable solutions for future military and commercial vehicles.

Phase I: In Phase I the contractor would determine the limiting constraints of the available switching devices through lab evaluation. These limiting characteristics would include the operating temperature, the power ratings, and the power volumetric density (kw/m3). The contractor will then develop a solid state rectifier/inverter module packaging concept that will optimize the power density of both the module and its required cooling system. A breadboard prototype of the concept will be built and demonstrated.

Phase II: In this phase the contractor will design and build a rectifier/inverter module for 30 ton electric drive system. This power conditioning unit (PCU) must be suitable for installation in GFE electric dirve testbed which has a total power requirement of 1.1 MW.

Potential Commercial Market: Improved packaging of the power semiconductors will allow the power conditioning devices to operate at a higher temperatures and will significatnly reduce the size of the rectifier, inverter

and their cooling systems. This is critical for both military and commercial vehicles full and hybrid electric where limited spaces under the hood make it very difficult to package auxiliary cooling systems for the silicon devices. Improved power electronic packaging will make it possible to use a common coolant for both engine and electric transmission and will reduce the size of the motor and genrator controllers approximately by a factor of 3.

OSCR: The knowledge obtained from this SBIR will be introduced in the current TARDEC electric drive programs for their merit in increasing the efficiency of the PCU and reducing the cooling load both of which will favorably affect the O&S cost.

A-6POWER GENERATION, STORAGE AND CONDITIONING
(I.E. DIRECTED ENERGY, MICROWAVE)

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-075TITLE: Precision Triggered High Power Oil Dielectric Spark Gap Switches For Flash Gamma-ray And X-Ray Simulators

CATEGORY: Basic Research

OBJECTIVE: Develop triggered oil dielectric spark gap switches to improve the performance of Terawatt pulsed power nuclear weapons effects (NWE) simulators.

DESCRIPTION: Advances in oil dielectric spark gaps are sought to obtain reduced jitter, higher reproducibility, and lower inductance switching of multi-Terawatt, multi-megavolt NWE simulators. Oil switch configurations presently in use include V/N and rail edge-plane spark gaps that have been developed during the last 15-20 years. New applications such as SREMP testing require the development of a more precise triggering mechanism with emphasis on reproducibility of streamer initiation, number and spatial distribution of streamer channels, and characteristics that will reduce simulator risetime. The advanced oil dielectric spark gap should be scalable for use in small and large pulse power applications spanning the parameter space including: gap potential 100 kV to 12 MV; switch energy up to several megajoules; currents 10kA to > 1 MA; and electric fields-50 kV/cm to 300 kV/cm.

Phase I: Perform an experimental and theoretical investigation of the proposed concept. Design and perform a proof-of-concept experiment (POCE) which demonstrates the superior performance of the POCE device and determines the feasibility of scaling the switch concept for application as the output switches for the AURORA simulator.

Phase II: Further develop the switch concept for scaling to small and large pulse power systems. Design, construct, and test improved spark gaps as the output switches for the AURORA Blumlein pulse forming lines.

Potential Commercial Market: Advanced oil dielectric switches have several potential applications in the commercial sector. These applications make use of the high dielectric strength of transformer oil and the reduced flashover constraints that make high pressure, gas spark gaps and plasma/gaseous electronic switches expensive and complicated to manufacture. The principal applications of the switching technology to be studied are in ultra-wideband impulse radars (UWB), accelerators for industrial processing, and as alternatives for superpower thyratrons. UWB radars can permit high resolution measurements at long range. G. Mesyats (Russian Academy of Science, Urals Div.) reported on such a radar system at the recent BEAMS '92 conference in Washington, DC (May 1992). Many such systems use a high pressure spark gap switch and achieve a 1-2ns risetime. However, oil switched systems in the US and elsewhere have obtained much faster risetime, but the triggerability, jitter, and reproducibility of such systems is not as good as gas dielectric switches. This is largely because very little basic R&D has been performed on oil switches i the last 15 years. Recent observations at AURORA (ARL in collaboration with Berkeley Research Associates and NIST) suggest that significant improvements are possible. Electron accelerators for industrial processing have long been in development. However, the commercially viable accelerators use conventional gaseous electronics switch tubes, e.g., hydrogen thyratrons, or spark gaps. Generally, such accelerators have low peak power and high average power. Applications such as pulsed lasers, super-power-electron beam welding, material modification, and radiation processing that might require high peak power have faced limitations because of opponent lifetime and reproducibility. Switches are a principal limitation. In this case, oil switches offer an alternative that has not received sufficient study. Finally, oil switches may offer a lower cost alternative to the super-power thyratrons that are being used for high power modulators that drive high power microwave sources. Such thyratrons cost 50-100 k$; oil dielectric spark gaps switches are expected to cost an order of magnitude less. The microwave systems have military application s that will

soon make major changes in the way warfare is conducted. In addition, these microwave systems have applications similar to the industrial uses of electron accelerators, namely material processing and manufacturing.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-084TITLE: Ferroelectric Capacitors for High Resolution - FPAs

CATEGORY: Exploratory Development

OBJECTIVE: Develop high dielectric permittivity thin films, such as barium titanate or lead zirconate-titanate (PZT) and high yield 3-dimensional capacitors to fabricate high capacitance per unit area capacitor structures for very high density read-out integrated circuits (ROICs), as required for infrared focal plane arrays (FPAs), to be used in both, non-radiation and radiation environments.

DESCRIPTION: General: ROICs for FPA read-out use capacitor storage and transimpedance amplifiers at each pixel node. As we move to longer wavelengths and much higher pixel densities, the number of quanta and hence the number of electrons to be stored increases and the physical area available for the capacitor shrinks. Therefore performance can only be maintained with the higher resolution by increasing the capacitance per unit area of the capacitors at each pixel node, compared with todays technology, using single level $Si0_2$ capacitors.

Phase I: Suitable ferroelectric thin film fabrication techniques should be developed, as well as their control and reproducibility.

Phase II: Developing a ferroelectric thin film capacitor technology for ROICs that has a capacitance per unit area of at least a factor of 4 improvement over today's single level $Si0_2$ capacitor.

Potential Commercial Market: Improved noise performance for state-of-the-art FPAs will have a positive impact on the development of radiation hardened and other SMART FPAs.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-085TITLE: Very High Energy Primary and Rechargeable Lithium Batteries and Battery Chargers

CATEGORY: Exploratory Development

OBJECTIVE: Materials and technology for ambient temperature primary and rechargeable Li batteries. Power and energy density goals are: greater than 60 watts/kg and greater than 350watts/kg respectively for primaries (Option 1); greater than 40 watts/kg and greater than 200 watts/kg for rechargeables (Option 2). Development of a low cost battery charger for rapid recharge of 6, 12 and 24 volt lithium batteries (Option 3).

DESCRIPTION: General - Primary Batteries (Option 1) - Presently, energy densities upwards of 300 watt-hrs/kg can be obtained using $Li/SOCl_2$. A doubling of that energy density may be possible using solid electrolytes (bipolar construction) and/or more energetic cathode materials (e.g., fluorides, complexed halogen, atmospheric oxygen). Achievement of low temperature performance and good voltage regulation may be addressed from the systems point of view if necessary. Rechargeable Li Batteries (Option 2) - Utilization of solid electrolytes with Li-insertion cathodes is the only approach yet identified. The performance goals stated above must be met over most of the ambient temperature range, -40° to 71C°. Battery chargers (option 3) - This program should concentrate on control methods for series - connected stacks of up to 4 cells with 5 Ah capacity.

Phase I: (Options 1 and 2) - identify one or more lithium couples with a theoretical energy density greater than approximately 1200 watt-hr/kg and compatible electrolytes which will allow maximum utilization of the intrinsic energy density. (Option 3) - Identify specific approaches and techniques for recharging both elemental and non-elemental Li batteries over a range of environmental conditions and demonstrate concepts using a battery stack of at least 2 cells in series.

Phase II: (Options 1 and 2) - Demonstrate advanced lithium battery technology by developing prototype cells or (better) bipolar batteries of up to 24V terminal voltage and over 10 A-hrs of capacity. (Option 3) - Demonstrate a prototype charger with the capability of recharging a 12 volt, 5 Ah battery in less than 3 hours.

Potential Commercial Market: Improved batteries and battery chargers will result in significant O&S cost reductions (OSCR) for many fielded C/E equipments and are urgently needed for future Soldier Systems and other future C3I applications.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-095TITLE: Solid Electrolyte for Fuel Cells

CATEGORY: Basic Research

OBJECTIVE: Synthesize/fabricate a novel proton-conducting membrane for use in manportable fuel cells. The membrane is intended to enable lightweight fuel cells which will require minimum components for water management.

DESCRIPTION: General - Army manportable applications require fuel cells which are of minimum size and weight, minimum complexity, are robust and attitude-insensitive. At present, polymer electrolyte membrane technology appears best suited to such applications. However, the sulfonic-acid membranes presently available require water management in order to keep the membrane properly hydrated and to prevent "drowning" of the air electrode. An anhydrous proton-conducting membrane which could operate at temperatures between approximately 100-150 C° would be highly beneficial. The appropriate membrane should have good ionic conductivity and low permeability to hydrogen. The material must also lend itself to fabrication into sheets which are upwards of 100 CM^2 in area. Inorganic, polymeric and composite materials may be considered for this purpose.

Phase I: Phase I should include the evaluation of one or more classes of substances which are known proton-conductors or can be converted to that state. Evaluation may comprise measurements of conductivity, thermal stability and permeability to hydrogen. Phase I should result in the recommendation of one or more materials or composites for further study in Phase II.

Phase II: Phase II may include chemical modification and optimization of candidate materials selected in Phase I. It should result in samples of membrane and their evaluation for the properties specified above. The program may also include preparation of polymer-catalyst fuel cell laminates and their evaluation in small prototype H_2/air or $H_2/0_2$ fuel cells.

Potential Commercial Market: Manportable fuel cells are required for future Soldier Systems.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-098TITLE: Components for Thin Film Bipolar Pulse Power Batteries

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop and demonstrate techniques to fabricate thin film bipolar cells for pulse power applications. The goal is the development of a 100 MJ battery with energy density of 100-200 kJ/kg and power density of 3-5 kW/kg in a volume of about 0.5 cubic meter.

DESCRIPTION: General - Thin film battery components are required to make high density/high power molten salt or solid state batteries for pulse power applications. Specifically, for electric gun applications, a 100 MJ battery is required with energy density of 140 kJ/kg, power density of 3kW/kg and a volume less than 1.0 cubic meter. The objectives can be achieved if thin film battery components such as the anode, cathode and separators can be successfully fabricated. This program should concentrate on the preparation of thin film battery components.

Phase I: Phase I should result in one or more approaches to the fabrication of thin film battery components. The thin films of high energy density cathodes such as Iron Disulfide, Cobalt Disulfide, Lithium Cobalt Oxide, etc., will be deposited on various substrated for use in bipolar batteries. Attempts will also be made to fabricate thin films of battery electrolyte separators such as the lithium ion conducting solid electrolytes lithium tetrachloro- aluminate, Lisicon etc., and composite porous sintered ceramic separators incorporating molten salt electrolyte such as MgO, AlN, BN containing LiCl-KCl, LiCl-LiF-LiBN, etc. Finally the thin films of anode, separator/electrolyte and cathodes will be stacked together to make complete cells. Attempts will also be made to deposit layers of current collectors, cathodes electolyte/separator and anodes as multicell bipolar thin film batteries. Phase I will result in the selection of optimum conditions for fabrication of thin film battery components.

Phase II: In Phase II, a scale up of the technology developed in Phase I will be demonstrated as 10 MJ scalable modules. The approaches will be further refined so that a 100 MJ battery with required energy and power densities can be fabricated from thin film components.

Potential Commercial Market: Identified applications include electric gun, robotics, soldier integrated protective assembly, electric vehicles including non-military commercial applications.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-099TITLE: Dielectric Materials for High Energy Density Capacitors

CATEGORY: Exploratory Development

OBJECTIVE: Develop novel materials with high dielectric constant, high dielectric strength, high resistivity, and low dissipation factor for high energy/high power capacitors.

DESCRIPTION: Some future Army missions will require capacitors for high energy pulse power applications. The goal is a capacitor of a nominal rating of 10,000 volts and an energy density in the range of tens of kJ/kg. To achieve this goal, novel materials with properties aforementioned in the objective are required. The materials will include but not be limited to the following two categories: 1) Solid dielectric films of polymeric or inorganic nature. The ideal films should possess dielectric constants around 10; high dielectric strength; high insulation resistance; and low dissipation factors over a wide range of temperatures and frequencies. 2) Liquid dielectrics of organic, inorganic or polymeric nature. These liquids could be used as impregnants in capacitors to increase the maximum voltage of existing or new high energy dielectric films. Liquids with higher dielectric constants are our goal.

Phase I: Phase I should result in one or more candidate high energy dielectric/high strength films or liquids through new syntheses or structural modification of existing materials. Validity of the candidate materials should be demonstrated through preliminary dielectric tests including measurements of dielectric constant, dissipation factor, and dielectric strength.

Phase II: At least one of the candidate materials should be explored further through optimization in structure modification, purification or processing. The dielectric properties of the candidate materials should be evaluated. A scale-up production of the most promising material should be sought after. Complete small capacitors containing candidate materials will be constructed and evaluated.

Potential Commercial Market: High energy dielectric materials have direct applications and impact on the development of electric materials.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-102TITLE: Array of High Power, Photon Triggered Ultra-wideband RF Radiators

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop, and demonstrate phased-array techniques for constructive wave generation in the far-field, using high power, photon triggered ultra-wideband RF radiators.

DESCRIPTION: General - The free space transmission of a high peak power impulse produces a frequency spectrum that extends from several megahertz to several gigahertz. Utilization of this wide frequency spectrum results in a unique system applicable to the areas of impulse radar, remote sensing, communications, and weapons. The frequency spectrum of the impulse is widely spread, and therefore the energy allotted per frequency interval is small. In addition, the radiated power from a single ultra-wideband RF source is limited mainly due to the switch breakdown strength. The power limitation of the individual RF source can be overcome by operating arrays of these RF sources. A critical technological barrier is in the phased array technique, in which arrays of these radiators produce a constructive wavefront, so that an extremely high radiated power at the far field can be achieved.

Phase I: Phase I should result in mathematical formulations correlating the triggered time sequence of the radiating elements with a constructive wavefront formation in the far field. The operating sequence for the array of RF radiators involves charging and discharging the elements at controlled time sequences. The timing sequences of this

array are controlled in such a way that the radiated waves result in a constructive wave in the desired direction of space. A rigorous computer simulation is required for the follow-on proof-of-concept demonstration.

Phase II: In Phase II, the proof-of-concept field demonstration will be performed. Radiated waveforms from arrays of photon-triggered ultra-wideband RF generators, comprising a reasonable number of RF radiators, will be measured in the far-field. At least 5 radiators will make up an array. A wide range of experimental data will be collected, analyzed, and documented for further refinement and development.

Potential Commercial Market: Identified applications include Wide-Band Communications, Impulse Radars (for counterstealth, environmental studies, and air traffic control), Electronic Countermeasures, Mine Clearance, and High Power Microwave Weapons. The solid state based arrays of compact, high peak power, ultra-wideband RF radiators should impact all the aforementioned systems.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-143TITLE: Magnetic Induction Launch-Coils for Plates or Plate-Like Structures

CATEGORY: Exploratory Development

OBJECTIVE: (1) To identify space-efficient magnetic-field configurations and concomitant containment structures with high mechanical strengths that can be used to launch plates and plate-arrays and (2) to identify and utilize innovative fabrication/manufacturing techniques to produce coils capable of withstanding very large mechanical stresses.

DESCRIPTION: The explosive launch of a plate or plate arrays is a very well-developed technology although it does have some disadvantages, e.g. self-hazards associated with explosives and logistics considerations. The electromagnetic launch of plates or plate arrays, in orientations both normal and perpendicular to the plane of the late, is an attractive alternative to explosive launch for various applications. The induction launch coils required, for the first phase of this effort, must withstand the stresses associated with accelerations which produce a momentum change of 200 kilogram-meters/sec over a distance of 0.15 meters or less.

Phase I: A successful phase I will identify one or more concepts for induction launch coils and provide a working brassboard coil based on one of these concepts which is capable of meeting the above specifications.

Phase II: A successful phase II will produce a scaled-up version of the coil produced in phase I.

Potential Commercial Market: Breakthrough in this technology has future applications in pulsed high-magnetic field environments and may impact in the design and fabrication in space, aerospace, ship and energy segments. Industrial application to high speed forging is a possible result of this effort.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-177TITLE: Future Soldier System Power Source

CATEGORY: Exploratory Development

OBJECTIVE: Develop very high power density engines and electric generators with controls suitable for powering the future soldier systems.

DESCRIPTION: The future soldier is envisioned to require multiple enhancements and capabilities to improve fighting and survivability. Current DoD efforts are defining and projecting those capabilities. Multiple sensors, displays, and communication systems will allow greater mission effectiveness and a high degree of autonomy on the battlefield. Global deployment will require protective climate and chemical protective subsystems. One of the critical shortcomings has been identified as a lack of very high power density power sources to support the various subsystems that the individual soldier will be using. These range in power from 1 to 3 horsepower combined with a 50 to 100 watt generator with controls for basic systems to 5 to 10 horsepower source with hydraulic pump for supplying high pressure oil for an "augmented" externally assisted soldier.

Phase I: Preliminary analysis and design of the basic system and/or the hydraulic power system.

Phase II: Prototype systems suitable for concept demonstrations.

Potential Commercial Market: Lots of Commercial Applications, additionally, the systems will beintegrated into Advanced Technology Demonstrations in support of the Warrior's Edge. This effort addresses S&T Thrusts in sharping the warrior's edge and Star 21 focal values for methods and technology for integrated systems design.

OSCR: 1 and 4 Erosion/Wear and Fatigue (Mechanical Systems); Corrosion/Material Deterioration; Field Diagnostics/Prognostics; Reduce generator/battery size, improve efficiency of the Power Generator/Storage System, Provide alternate power sources; reduce power usage and improve battery systems.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-304TITLE: High Energy Laser Gaussian Beam Generation Optical Development

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-335TITLE: Infrared Lamp and Reflector

CATEGORY: Exploratory Development

OBJECTIVE: Development of an Infrared Lamp

DESCRIPTION: General: Development of an infrared lamp that will operate off a 24V DC power supply, will use less than 1200 watts, will generate infrared energy primarily in the 3-5 micron region, and can be focused into a 6 ft by 6 ft spot at approximately 6 feet. The effort sought in this solicitation is for new technological approaches to efficiently produce radiation in the 3-5 micron band. Basic: The desired attributes of an infrared lamp and reflector include: (1) capable of being integrated into a ground combat vehicle; (2) Useful durability and ruggedness for a ground combat vehicle; and (3) capable of operating at temperature extremes (0-50 degrees C).

Phase I: The contractor shall investigate, design hardware, and provide hardware for a proof of principle demonstration of an infrared source.

Phase II: The contractor shall fabricate and provide the hardware for a ground combat vehicle demonstration.

Potential Commercial Market: Medical light sources.

OPERATING & SUPPORT COSTS: This technology could significantly lower power demands on a ground combat vehicle and reduce electrical replacement costs. This technology could significantly reduce the weight of ground combat vehicles, resulting in more efficient fuel and ammunition usage.

TECHNOLOGY CLUSTER: A-6
TOPIC: A93-347TITLE: Ultra-Wide Band Electromagnetic Source Development

This topic is CANCELLED.

A-7BIOTECHNOLOGY

TECHNOLOGY CLUSTER: A-7
TOPIC: A93-073TITLE: Engineering Ribosomal Biosynthesis

CATEGORY: Basic Research

OBJECTIVE: Research to define scope of applicability for transfer RNA-mediated synthesis of novel materials.

DESCRIPTION: In the gene-directed biosynthesis of proteins, transfer RNA (tRNA) molecules serve to translate messenger RNA (mRNA) nucleotide sequence into proper sequence of the amino acids comprising the particular protein coded for by the original DNA sequence found in the gene. Carrying a specified amino acid at one end, and a particular mRNA nucleotide triplet binding site at the other, only the tRNA molecule, and not its attached amino acid, determines whether, and at which point on the growing polypeptide chain, the amino acid is incorporated. Recently, methods for adding engineered amino acids of desired structure into a tailor-made peptide polymer have been introduced. These techniques offer great promise in their potential for a low cost, energy efficient and environmentally benign method for manufacture of specialty polymers and possible novel matrices for composite structures, electronic/photonic materials, etc. The importance of this technology for competitive manufacturing capability in the commercial sector cannot be over emphasized, nor can its impact on DoD's "Technology for Affordability" S&T thrust be over estimated. In keeping with Army's identification of "Genetically Engineered and Developed Materials" as a STAR 21 strategic advanced technology, basic research is needed to generate the information necessary for moving this technology from laboratory to demonstration scale for novel material synthesis.

Phase I: Generation of fundamental data in support of concept feasibility and merit of further investigation. Characterization of process.

Phase II: Demonstrate technology use in fabrication of protein polymer incorporating engineered amino acids with interesting material properties, including optimization of process, suitable for further development as manufacturing technology.

Potential Commercial Market: Commercial users of this technology would include a broad range of manufacturers of specialty polymeric materials, and perhaps even some classes of novel general-use polymers. Manufacturing process engineers would find this technology very attractive for transfer because of its high energy efficiency and low environmental costs.

TECHNOLOGY CLUSTER: A-7
TOPIC: A93-220TITLE: Development of Non-Mammalian Antibody Expression Vectors

CATEGORY: Exploratory Development

OBJECTIVE: To explore the potential use of antibodies expressed in non-mammalian vectors, such as those formed between the fusion of hybridoma cell light-chain genes and E. coli, for use in immunodiagnostic assay systems. In addition, the potential of antibodies developed in eggs will also be explored.

DESCRIPTION: Recent advances in genetic engineering have allowed the development of antibody systems whereby light chain fragments from the antigen-binding region of antibodies can be expressed in non-mammalian cells. This has the potential to decrease the cost of production of antibodies and to develop a class of standard antibody preparations that may be subclass independent. The incorporation of antibodies into this type of vector system may also allow the cloning of reporter molecules, such as enzymes or fluorescent-proteins, adjacent to the antigen-conjugates to be made by genetic engineering techniques rather than through separate chemical reactions. The successful development of such a system should significantly decrease the cost of antibody reagents proposed for use in test kit and biosensor efforts. In another area, chickens' antibodies expressed in egg yolks have also been shown to be an effective means to produce large quantities of antibodies. The antibody is purified from the yolk of the egg, rather than by invasive techniques of the animal. This approach has the advantage of decreased non-specific activity, high yield, and low cost.

Phase I: Would consist of development of an antibody in a non-mammalian host with subsequent demonstration of the utility of the antibody in an immunoassay format.

Phase II: Would consist of the development of additional antibodies with demonstration of the utility of these materials on a biosensor system of interest to the Government.

Potential Commercial Market: The commercial market potential of these materials are high. Several efforts are already underway in the marketplace for this effort, both in diagnostic and therapeutic applications.

TECHNOLOGY CLUSTER: A-7
TOPIC: A93-243TITLE: Fused Cholinergic Synaptosomes

CATEGORY: Exploratory Development

OBJECTIVE: Develop a cell-free system for studying the mechanism(s) of and interactions involved in cholinergic neurotransmitter release.

DESCRIPTION: Develop methodology for producing large fused cholinergic synaptosomes which are stable, consistent in their physiologic/biochemical composition and thus suitable for a variety of in vitro studies of neurotransmitter release mechanisms. The synaptosomes should be electrically excitable and contain the complete "machinery" necessary for calcium regulated, multiquantal release of acetylcholine. They would also be sufficiently large to allow for the introduction of chemical substances and voltage control by microelectrodes and patch pipettes. The ultimate goal is to co-culture these synaptosomes with skeletal muscle cells and attempt to overcome the botulinum toxin-induced block of neurotransmitter release by introducing putative antidotes. It is suggested that the synaptosomes be generated from torpedo electric organs, since these are a rich source of cholinergic nerve endings, and fused after purification with polyethylene glycol.

Phase I: Develop the methodology necessary to produce and characterize the synaptosomes.

Phase II: Produce research quantities of a stable, consistent product.

Potential Commercial Market: Studies of neurotransmitter release and cholinergic neuromuscular transmission are currently limited primarily to in vivo, ex vivo, or cell-culture systems, all exhibiting a certain inherent degree of variability. Large fused synaptosomes as described would allow for uniform, consistent cell-free or admixed cell/cell-free systems for studies of neurotransmitter release and neuromuscular transmission. Such a product would have wide applicability in the areas of Basic Research and drug development.

TECHNOLOGY CLUSTER: A-7
TOPIC: A93-246TITLE: Hydrazine Air Monitor

CATEGORY: Engineering Development

OBJECTIVE: The ACGIH has recently proposed reducing the exposure levels for hydrazine and monomethyl hydrazine from 100 and 200 to 10 ppb, respectively. Monitoring instrumentation needs to be developed to measure these new exposure levels for hydrazine and monomethyl hydrazine.

DESCRIPTION: Our laboratory has recently developed continuous extraction technology for air toxics. Since analytical procedures already exist for determining low levels of hydrazine and monomethyl hydrazine, we would like to combine our extraction technology with the existing analytical procedures in order to develop a fuel vapor monitor to detect fuel at these new low levels.

Phase I: Evaluate currently available hydrazine detection capability for detection limits, precision, accuracy, selectivity among various hydrazine compounds, and the effect of possible interferences. Choose several of the methods which are amenable to automation and which could be used in conjunction with real-time extraction techniques for air toxics. Construct a bench top version of each of these extraction/detection systems and build a field prototype for laboratory and field evaluation. Complete laboratory testing of this first prototype.

Phase II: Field testing of the prototype will be conducted and completed. The prototype will be optimized for portability, field calibratability, low reagent consumption, and ease of operation. Ten prototypes will be delivered to the army for further field testing and evaluation.

Potential Commercial Market: The army, air force, and nasa will have need of such instrumentation to meet the proposed new acgih levels for these hydrazine compounds.

A-8LIFE, MEDICAL AND BEHAVIORAL SCIENCES

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-070TITLE: Executive-level Decision Skill Enhancement

CATEGORY: Exploratory Development

OBJECTIVE: To develop an appropriate technology for assessing and accelerating the development of the basic cognitive skills underlying effective executive-level decision-making.

DESCRIPTION: A substantial amount of research now points to a relatively small number, perhaps as small as three, of critical cognitive processes which appear to underlie effective decision performance at the topmost levels of large-scale organizations. These are: mapping of the relevant decision environment (constructing a representation of the cause-and-effect relationships among the salient factors with which the position incumbent must deal); envisioning (constructing a communicable concept of an end state toward which complex activity can be directed); and long-range planning (constructing a path which will over a long time frame -- 15-25 years or more -- achieve a communicated end state). Coloring all these processes is a probable requirement for some degree of preference for innovation (proclivity to think outside bounded and well-defined solutions). Little is known about the development of these processes and their precursors.
Phase I: Phase I will require the development of a theoretical model that identifies and incorporates the three complex processes identified above, and the fundamental cognitive processes that underline them. A substantial amount of work has already been done toward this end. Phase I may therefore be considered a validation of that work. In Phase I, the existing conceptualization will be re-examined to confirm that it is consistent with the existing literature, and to determine if the literature identified developmental order effects.

Phase II: Phase II will require the design of "blueprints" for the construction of courseware designed to produce significant development of these complex cognitive processes. In addition, Phase II will require the completion of a demonstration module, with before and after measures, that successfully increases the performance level of students in these three areas. The module will be applicable to Army Senior Service College use, but the blueprint will be generic to enable its application within non-military settings.

Potential Commercial Market: The theoretical model, the "blueprint," and the demonstration module will constitute a technology that can be applied broadly to improve executive development programs, both in large scale private sector firms and in the federal government. A major intended utility of this technology will be its generic applicability to a variety of different substantive content areas, and thus to a variety of different organizational contexts.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-071TITLE: Component-Group Training Strategies

CATEGORY: Exploratory Development

OBJECTIVE: To estimate experimentally how component-group performance in situations requiring unit collective performance (e.g., mission planning) is influenced by amount and type of prior sub-group training.

DESCRIPTION: The dynamics of future conflicts will require timely and confident decision making, founded on effective training and mission rehearsal. The Army, however, is facing reduced training budgets. Training to achieve required collective (group) proficiency demands efficient, imaginative training strategies, especially for training command and control planning tasks potentially trained and rehearsed in synthetic environments. A key research issue is the question of the contribution of pre-training of sub-groups (e.g., S1-S4 elements or G1-G4 elements) before these elements are brought together for full-group mission training. Research is required to determine representative, and if possible, generalizable functions relating amount and type of sub-group training to group training performance. Four major sources of training variance are of concern: part-task vs. whole task training, skill acquisition vs. transfer-of-training, massed vs. distributed practice, and effects of prior knowledge. The literature on these areas should provide useful points of departure. Recent engagement simulation data have shown problems in performance where command and control staffs had not been trained as sub-groups before being brought together as a staff in realistic simulated exercises. While the focus could be on combat command and control planning and operations, surrogate tasks may be more suitable for this effort.

Phase I: The anticipated result of Phase I is a research plan and pilot data. The plan should include a focused and selective review of the literature. It should also include a preliminary model of sub-group functioning in a group context and provide a rationale for experimental task selection and research design. Pilot data should be sufficiently conclusive to warrant a full-scale study in Phase II.

Phase II: Based on the collection of more extensive data, this phase should result in a set of functions and conclusions relating amount and type of prior sub-group training to group training and performance. The data from this

phase should be sufficiently conclusive to warrant refinement of the model so that it can be used for selection of the most cost-effective sub-group/group training strategy.

Potential Commercial Market: The results of this research can have wide applicability to training in security organizations such as law enforcement and fire fighting. The results will also apply to many group tasks in business, industry, and non DoD government agencies (e.g. emergency relief) where sub-groups, pre-trained in component tasks, are convened ad hoc, for special projects, or as permanent teams.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-072TITLE: Measuring the Costs and Benefits of Army Service

CATEGORY: Exploratory Development

OBJECTIVE: To develop methods and data sources for evaluating the economic and social costs and benefits of Army service.

DESCRIPTION: To provide a more objective basis for military personnel decisions such as determining appropriate compensation levels, the Army needs to develop data sources and method for measuring the economic and social costs and benefits of military service for individuals. These methods and measures must account for the long-term as well as the short-term costs and benefits. There is a particular need to evaluate these costs and benefits of Army service for women and minorities.

Phase I: The major task for Phase I is to identify relevant data sources and statistical methods and procedures for modeling the economic and social costs and benefits of Army service. A preliminary model or models would then be specified.

Phase II: In Phase II, a prototype model or models would be fully developed, articulated, and evaluated using data sources identified in Phase I.

Potential Commercial Market: The recent award of the Nobel Prize in Economics to Dr. Gary S. Becker at the University of Chicago, for extending "economic analysis to new areas of human behavior and relations" demonstrates the recognition of the importance of "behavioral economics". He effectively applied economic analysis to "settings where the economic forces don't seem to be most central". The proposed tools for modeling the economic and social costs of Army service will be used in a similar way in a military context. Their future extension to civilian applications can look at the long-term as well as the short-term economics effects of work group participation, especially for minorities.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-104TITLE: Human Performance Issues in Automatic Target Recognition and Situation Awareness Displays

CATEGORY: Exploratory Development

OBJECTIVE: To experimentally investigate variables affecting human performance with situation awareness and automatic target recognition displays.

DESCRIPTION: For the foreseeable future Automatic Target Recognition Systems (ATR's) will include a man-in the decision-making loop. The man machine interface thus becomes a critical factor in determining how the system will perform. The program is aimed at investigating display parameters and human abilities and limitations (i.e., memory, keeping track performance, workload, stress) that impact system performance with both ATR and situation awareness displays.

Phase I: Conduct preliminary Human Factors experiments on target acquisition (recognition, identification, detection, keeping track performance, etc.) exploring variables such as (but not limited to) false alarm and miss rate, human confidence in information displayed, target priority and number, threat (real or perceived), cognitive load, etc.

Phase II: Pursue advanced experimental investigations of the parameters deemed to be the most important (i.e., having the most impact on system performance), with an eye towards generating man-machine interface design recommendations for both ATR systems and Situation Awareness displays.

Potential Commercial Market: Drug interdiction, search and rescue, reconnaissance, airline navigation.

OSCR: One of the goals of MANPRINT is to reduce the operating and support costs associated with a system. This is accomplished through influencing design in order to reduce training requirements, reduce personnel skill requirements, and reduce the number of operator and maintenance personnel required. The products produced by the Human Research and Engineering Directorate (HRED) do not directly impact the Generic Cost Drivers; they are more directly impacted by hardware and software developers. The SBIR efforts initiated by the HRED are aimed at enhancing human performance and expanding the data base related to human capabilities and limitations. It is when these human performance characteristics are applied to a specific hardware or software acquisition program that the reductions in operating and support costs can be realized.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-106TITLE: Development of an Unmanned Ground Vehicle (UGV) Simulator

CATEGORY: Engineering Development

OBJECTIVE: Design and build a modular, interactive UGV simulator to evaluate operator machine interfaces and human factors design parameters to assist in the development and evaluation of remote UGV operations.

DESCRIPTION: The simulator will be modular in design, support graphic display(s) and incorporate a reconfigurable operator control unit to enable the Human Research and Engineering Directorate of the Army Research Laboratory to evaluate alternative control concepts and feedback issues for both simulated and actual unmanned vehicle operations. Many UGV operator control units are in existence and are in need of evaluation. In order for the simulator to be used to evaluate these units, it must interface to various control unit software and hardware designs and allow for reconfiguration to support software protocol interfaces and hardware integration. This capability will allow for comparative evaluation of alternative control units, user interfaces and control strategies to assess an UGV operator's ability to process data (i.e., video, graphic information, and audio) and execute mission tasks. The simulator must be able to control a software based emulated vehicle, to be developed under this effort, and an actual teleoperated vehicle. This simulator must be easily integrated to external communications equipment to allow teleoperation of an actual UGV. This simulator must also be equipped with tools to automatically collect and evaluate interactive operator/control station/vehicle responses to provide data for workload analysis and cognitive operator assessment. All operator stimuli and responses must be captured for analysis. To allow for complete evaluation of the UGV system and maximize the usefulness of the simulator to the military user, the system must be interfacable to one of a number of GFE simulators of tactical ground combat to allow for evaluation under realistic combat conditions.

Phase I: Produce the hardware and software prototype of key components for the operator control unit interface to the simulator. Identify the technical issues and develop the approach to be used to completely develop the UGV simulator, to include identifying the means of integrating the tactical simulation, developing the emulated vehicle model, developing external communications interfaces, and developing the basic layout design concepts of the modular graphic simulator system.

Phase II: Deliver hardware and software of a complete system and use the resulting system to fully evaluate candidate UGV control interfaces.

Potential Commercial Market: The equipment and techniques developed under this effort could support driving simulators for automobile design and drivers education programs, and feed into aircraft simulators which have been in use for years and continue to be developed for the aircraft industry. Opportunities exist still in the video arcade game industry for driving games with enhanced displays and techniques for operator feedback. This effort will also find markets in the conduct of studies and evaluations to support military battlefield simulation models currently under development.

OSCR: One of the goals of MANPRINT is to reduce the operating and support costs associated with a system. This is accomplished through influencing design in order to reduce training requirements, reduce personnel skill requirements, and reduce the number of operator and maintenance personnel required. The products produced by the Human Research and Engineering Directorate (HRED) do not directly impact the Generic Cost Drivers; they are more directly impacted by hardware and software developers. The SBIR efforts initiated by the HRED are aimed at enhancing human performance and expanding the data base related to human capabilities and limitations. It is when these human

performance characteristics are applied to a specific hardware or software acquisition program that the reductions in operating and support costs can be realized.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-166TITLE: Adaptive Algorithms for Optimal Configuration of Cockpit Information

CATEGORY: Exploratory Development

OBJECTIVE: Develop software prototype for applying adaptive techniques, e.g. genetic algorithms, to cockpit configuration layout.

DESCRIPTION: New tools for cockpit information display and management will require novel approaches to cockpit design and evaluation. Genetic algorithms or similar adaptive techniques may prove to be a valuable approach to integrating such display and information management tools in future crew systems. The proven success of genetic algorithms at designing other complex mechanisms, such as semiconductor layouts and telecommunication network topologies, forms a reasonable basis for extending the methods to the configuration of cockpit information systems. Genetic algorithms are optimization techniques based on the theory of biological evolution, wherein such algorithms "evolve" a design to fit the specified criteria. It is expected that their ability to adapt without preconceptions to the data provided them would be beneficial to solving the problem of configuring cockpit information systems,a domain in which there is insufficient human expertise to carry out the design task well.

Phase I: Conduct an in-depth study of candidate crew system design issues appropriate to adaptive algorithms, isolating a canonical case for development. Produce interface specification with the Army/NASA Aircrew-Aircraft Integration (A3I) Man-Machine Integration Design and Analysis System (MIDAS) and develop stand-alone software demonstration of capabilities.

Phase II: Further integrate effort with MIDAS and extend approach to fully address constraints of practical crew station design problems. Demonstrate/test feasibility through comparison of adaptive algorithm recommendations with those produced by extant design practices.

Potential Commercial Market: Expertise gained from applying adaptive approaches to complex, multi-dimensional problems such as crew station design will greatly extend their potential commercial application. Genetic algorithms, like expert systems, fuzzy logic, or neural networks, are a general problem solving technique which can be applied to many domains. Their commercial viability is determined by their ability to help with practical problems. This project would be one of only a few applied examples in this emerging discipline and may open the door to very widespread use and commercialization.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-176TITLE: Non-Lethal Weapons For Helicopter Use

CATEGORY: Exploratory Development

OBJECTIVE: Develop Non-lethal weapons suitable for firing/use from a helicopter.

DESCRIPTION: Currently U.S. helicopters are equipped solely with weapons which defeat the threat through explosive/catastrophic means. Many mission objectives could be achieved with weapons which temporarily or permanently disable equipment or crew without being lethal to the operators. The weapons may achieve mobility, forced landing or mission abort type "kills" against airborne and ground targets. They may achieve the "kill" through mechanical, electrical or optical disruption or failure and/or incapacitation of the enemy crew. These weapons must be suitable for use (launch or firing) from a helicopter platform and must be effective at ranges to 2km with greater than 2km desired.

Phase I: Develop the weapon-system concept for non-lethal weapons for helicopter use. Conduct laboratory demonstration of component technologies. Quantify estimated system performance. Produce final report.

Phase II: Develop a breadboard system for ground testing. Test against suitable target components and subsystems. Assess System Performance. Generate final report.

Potential Commercial Market: Effective Non-lethal weapons have significant commercial application for use by law enforcement agencies (Police, DEA, ATF, National Guard, etc.)

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-218TITLE: Generic Biodetection

CATEGORY: Exploratory Development

OBJECTIVE: The project shall explore methods of using single or combined sensors to detect the presence of protein, bacterial, and viral samples and to identify these materials in a rapid and semi-quantitative manner.

DESCRIPTION: A need exists to rapidly and semi-quantitatively detect protein, bacterial, and viral samples above the environmental background. This suggests a multi-sensor approach whereby the sample is first immediately identified as being "different", and then subjected to successively more refined analyses. The ideal system would be automated and perform a complete sequence of analyses in five minutes. The end-of-analysis data would be the identity of the sample and some idea of how much.

Phase I: The offeror shall design and fabricate a laboratory prototype system which shall demonstrate the proof-of-principal of the general requirements on two model systems of interest to the Edgewood RDE Center.

Phase II: The offeror shall expand on the Phase I results by optimizing the detector system, testing it against at least two more bioagents of interest to the Edgewood RDE Center, and fabricating a breadboard for testing at Edgewood.

Potential Commercial Market: The offeror would be expected to apply the work outlined in this topic to the environmental area.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-219TITLE: Biosampling

CATEGORY: Exploratory Development

OBJECTIVE: Investigate methods of bioaerosol sampling which use low power and still achieve high collection efficiencies in a two minute timeframe.

DESCRIPTION: A bioaerosol sampler is needed which can perform within the parameters stated in the project objective. Additionally, it must operate unattended for at least 24 hours. The bioparticles must be impacted into a liquid or onto a surface which releases the particles quickly into solution.

Phase I: A prototype sampler be built and tested to prove the feasibility of the concept. Although materials such as latex beads and ammonium fluorescein may be used for testout, the sampler must collect bacteria of choice at an efficiency which will provide 10,000 organisms in a 200 ul liquid aliquot after two minutes of sampling the aerosol.

Phase II: A phase II effort will involve a more in-depth analysis of the most promising avenues determined in Phase I. This phase shall include necessary design modifications, operational improvements, extensive and exhaustive testing, and final fabrication. An extremely important requirement is that the sampler must be able to be interfaced to a sensor. That is, it must have a solution flow capability. The project deliverable shall be a sampler meeting the requirements noted above.

Potential Commercial Market: The offeror would be expected to gain valuable experience and data in the portable biosampler area which could be applied to the environmental market.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-223TITLE: Flow Cytometry

CATEGORY: Exploratory Development

OBJECTIVE: The project objective is to apply flow cytometric methods to biodetection (bacteria and viruses), and design and fabricate an instrument which meets CRDEC's detection needs. Light scattering and fluorescence approaches are to be used in the developed system.

DESCRIPTION: Flow cytometry is a method which has matured through the years to the point where it warrants attention as a potential biodetection system. A prototype flow cytometric based biosensor needs to be developed which uses both light scattering and fluorescence based methods to detect biomaterials. The system must produce qualitative results in two minutes and quantitative information in five minutes. The system must be configured to accept a fluid stream from an aerosol sampler.

Phase I: For the Phase I effort, the offeror may use a model bacteria and virus of his choice. This phase shall serve as a proof-of-concept in which a two minute assay of the model bacteria and virus shall be demonstrated and a portable flow cytometer designed.

Phase II: This effort shall use the results obtained in Phase I to fabricate, modify, and test a prototype flow cytometric system on at least four bioagents (vaccines and simulants) of interest to the Army. The basic chemistry, hardware, software, and analysis methods shall be optimized. Quantitation shall also be developed and optimized.

Potential Commercial Market: This work has potential applications in the environmental marketplace.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-224TITLE: Less-Than-Lethal Immobilizing Chemicals

CATEGORY: Exploratory Development

OBJECTIVE: To suggest, acquire, evaluate and develop chemical immobilizing materials for application to various missions such as: rescue, embassy protection, anti-terrorism, barricade situations, domestic disturbances, and other law enforcement scenarios.

DESCRIPTION: Most recent Less-Than-Lethal (LTL) programs at the U.S. Army Edgewood Research, Development and Engineering Center have focused on the fentanyls as candidate compounds. Some of the fentanyls are widely used as injectable anesthetics. Others are being studied as wildlife and veterinary tranquilizers. Many of these compounds are well-characterized, rapid acting, very potent and reliable in their activity. However, for many LTL applications, they have safety ratios that are too low and durations of action that are too long. Ideally one needs a material that will act safely, virtually instantaneously and last for just a few minutes. Thus, candidate chemical immobilizers with improved safety ratios and shorter duration of action are needed.

Phase I: The feasibility phase of this program should result in the identification of one or more candidate LTL materials. In some situations, for example, close encounters, such as domestic disturbances, barroom brawls and stopped motorists or for rescue missions, materials should optimally be extremely fast-acting (few seconds), very safe and relatively short acting (few minutes). In other situations, such as barricades, speed of onset and duration of action may be less important, but safety will still be of paramount interest. Thus, it is desirable to identify more than one candidate material. It is preferable that a candidate material(s) should include the following steps: determination of the "state-of-the-art"; selection of candidates for preliminary evaluation; acquisition of test materials; and animal tests to indicate sufficient efficacy and safety to warrant further study.

Phase II: During this phase, further tests should be conducted to: establish effective doses and safety ratios sufficient for human estimates; establish times for onset and duration of effects; assess the effects of stress on effective dose and safety ratio; identify and conduct other toxicology tests necessary for human testing; and provide information for dissemination techniques and delivery devices.

Potential Commercial Market: Less-Than-Lethal chemicals that are safe and effective should have great commercial potential because they are likely to be adopted by many federal, state and local law enforcement agencies. In addition, there is a good potential market for similar products for use in wildlife management and veterinary medicine.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-226TITLE: Chemiluminescence and Bioluminescence

CATEGORY: Exploratory Development

OBJECTIVE: To determine if the use of detectors other than photomultiplier tubes (i.e., charge coupled devices) will allow an acceptable limit of detection and reduction in size to develop a portable luminometer for detection of toxins, bacteria and viruses by chemiluminescent immunoassays. The potential of new or non-standard luminescent chemistries is acceptable if it will improve detection or work better in the offeror's luminometer.

DESCRIPTION: This project will be useful in determining whether or not bio/chemiluminescence has potential as a biological agent detector system. Bio/chemiluminescence immunoassays, as shown in the open literature, have superior limits of detection when compared to standard fluorescence immunoassays. The use of a Charge Coupled Device (CCD) based detector rather than a photomultiplier tube based detector would appear to offer the possibility of fabricating a fieldable portable biological agent detector system. Also, many immunoassay formats and bio/chemiluminescence chemistries have been developed which can be explored in a detector fabrication effort.

Phase I: The offeror shall develop and assemble a luminometer using a commercially available CCD. The detector should be capable of measuring glow, flash and enhanced flash reactions if possible. The luminometer shall be capable of presenting quantitative results. A determination of the sensitivity and detection limit using a standard chemiluminescent immunoassay will be required. (For example, CSA-1 antigen can be measured in less than 200 Salmonella typhimurium cells) A luminometer prototype is required at the end of this phase.

Phase II: The offeror shall fabricate a "breadboard" luminometer with a CCD sensor and the capability of being operated from an external IBM PC compatible computer. They shall develop an optimized bio/chemmiluminescent immunoassay of interest to the Army using the breadboard luminometer.

Potential Commercial Market: The successful completion of this effort would demonstrate the feasibility of developing a portable luminometer. A portable luminometer would allow competition in the areas, such as immunoassays, now using full size more expensive luminometers and fluorimeters and could be useful in the clinical and environmental areas.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-227TITLE: Bifunctional and Catalytic Antibodies

CATEGORY: Exploratory Development

OBJECTIVE: The project objective is to investigate the potential of using chimeric and/or catalytic antibodies in immunodiagnostic assays.

DESCRIPTION: Current efforts with biosensors involve standard immunoassay techniques. The use of bifunctional and catalytic antibodies could serve to simplify the production of reagents to support these systems. For example, a catalytic antibody could be developed which mimics the enzyme capable of transducing a signal in a biosensor system. This antibody could then be utilized in lieu of enzyme in a biosensor or could then be conjugated through chimeric techniques to an antibody fragment which has activity to a specific antigen. These approaches could have a positive impact on the logistical and stability requirements of proposed biosensor-based detector systems. Enzyme activities of interest include urease, phosphatase, peroxidase, beta-galactosidase, or acetylcholinesterase.

Phase I: Would consist of the development of a reagent for an antigen or enzyme activity of interest to the Army, the utility of which shall be demonstrated in an ELISA or equivalent system.

Phase II: Shall develop at least two more assays of interest to the Army on two dissimilar materials. Protocols for the synthesis/formation, purification, and storage of the antibodies shall be developed. The properties of the antibodies shall be fully characterized to include crossreactivity to the other assay materials and to their stability in solution for 24 hours at 37 degrees Celsius and in a lyophilized state at 60 degrees Celsius for one week. The demonstration of the reagents on a biosensor system of interest to the Army shall also be demonstrated.

Potential Commercial Market: The results of this work will offer improvements to assays used in the clinical diagnostic area as well as for environmental applications.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-234TITLE: Passive Immunoprophylaxis And Immunotherapy Of Malaria

CATEGORY: Basic Research

OBJECTIVE: Produce, Characterize and develop functional igg human monoclonal antibodies for the treatment or prevention of malaria and the identification of protective epitopes for vaccine development.

DESCRIPTION: Malaria parasites are targets of humoral immune responses at several points in their lifecycle, and these targets form the basis of active vaccine development. An alternative approach is to screen or stimulate in vitro human immune lymphocytes for the production of human monoclonal antibodies (humabs). Igg class humabs have preferred pharmokinetics but table igg clones have been notoriously difficult to produce. Proposals are requested that 1) identify new methods of identifying and/or producing igg humabs against malaria 2) demonstrate their activities using in vitro functional assays and 3) prepare selected humabs for phase I clinical trials 4) demonstrate methods by which such humabs may further be used to select or map epitopes for the development of active vaccines.

Phase I: Demonstrate methods of producing one or more stable functional igg human monoclonal antibodies against asexual erythrocytic stage plasmodium falciparum parasites.

Phase II: Produce and characterize one or more humabs in sufficient quantities to permit feasibility demonstration of passive transfer studies in animal models.

Potential Commercial Market: drug companies, who, military, travelers.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-235TITLE: Systems To Automate The Deglycerolization Of Thawed Frozen Human Blood

CATEGORY: Basic Research

OBJECTIVE: To remove the glycerin-cryopreservative from human red blood cells in a sterile, rapid guide (<30 min), labor non-intensive manner.

DESCRIPTION: A unit of frozen-thawed red cells contains about 200ml of red cells and 200ml of cryopreservative containing about 100-150g of glycerine. The glycerine must be removed from the red cells by a sterile procedure which does not harm the cells, and is quick, and low in labor requirements. Final equipment should be less than 8 cubic feet in size and have expendable components competitively priced with the currently-approved centrifugal techniques. Device should require minimal operator interaction and minimize maintenance.

Phase I: Show feasibility of a closed, automatable techniques, perhaps using membrane technology, to safely separate red cells from glycerin solution. Saline wash solutions should be used.

Phase II: Develop a prototype and show its capabilities on units of frozen thawed blood. Performance/costs must be superior to current centrifugal technology.

Potential Commercial Market: Several million units of red cells per year could be processed in this manner.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-236TITLE: Directed Biosynthesis Or Isolation Of Soluble Porcine Lipopolysaccharide Receptors

CATEGORY: Basic Research

OBJECTIVE: To develop soluble lipopolysaccharide (lps) receptor sites, suitable for injection into microswine, capable of binding endogenous lipopolysaccharide released from gut flora in response to reductions in splanchnic blood flow.

DESCRIPTION: We have recently hypothesized that the pathophysiology of environmental injury or illness may result in part from the release of endogenous lps when blood flow is diverted from the splanchnic bed in response to exposure to severe heat or cold. Exogenously administered soluble lps receptors would competitively inhibit lps binding to its endogenous receptors on macrophages, thus interfering with the cascade of events leading to endotoxin morbidity or

mortality. The soluble lps receptors should be developed from the microswine to assure compatibility with the animal model used for efficacy testing.

Phase I: Synthesize, isolate, or otherwise develop soluble lipopolysaccharide receptors suitable for injection into the vasculature of the microswine model.

Phase II: Demonstrate the efficacy of injected lps receptors as either immunoprophylaxis or immunotherapy against endotoxemia resulting from heat and cold injury in microswine.

Potential Commercial Market: Companies seeking therapeutic procedures for toxic shock or other endotoxemic pathology.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-237TITLE: Neutralizing Monoclonal Antibodies Against Biological Toxins

CATEGORY: Basic Research

OBJECTIVE: Provide neutralizing monoclonal antibodies for specific toxins and threat agents.

DESCRIPTION: Using traditional approached or novel techniques of in vitro stimulation of human spleen or peripheral cells or recombinant conversions of mouse monoclonals, produce humanized neutralizing monoclonal antibodies with specificity for important toxins and threat agents. Antibodies for specific toxins such as: Bacterial (botulinum, staphylococcal enterotoxins, blue-green algal toxins (microcystin), dinoflagellate toxins (saxitoxin), vertebrate toxins (tetrodotoxin) protein synthesis inhibiting plant toxins (ricin), protein and peptide toxins of other biological origin (including pre- and postsynaptic neurotoxins, and membrane active substances), and other bacterial toxins such as clostridium prefringens toxin, are of particular interest. Physiologically active compounds of biological origin are also of interest as are anthrax, tularemia, q-fever.

Phase I: Generate antibodies and demonstrate neutralizing specificity in a model system.

Phase II: Produce research quantities of the specific humanized monoclonal antibodies.

Potential Commercial Market: Several militarily relevant toxins (eg., Saxitoxin, botulinum toxin) present significant public health hazards through oral ingestion. No specific treatment regimen exists. Neutralizing monoclonal antibodies against these toxins would be a significant advance in protecting the public health.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-238TITLE: Development Of A Reactive Topical Skin Protectant (RTSP)

CATEGORY: Exploratory Development

OBJECTIVE: To explore, identify and develop materials and methods of incorporating reactive materials that will neutralize chemical warfare agents (cwas) into a protective barrier that can be applied to the skin of a soldier to protect him from the cutaneous hazards of a noxious chemical environment.

DESCRIPTION: There is currently a requirement to develop and to field a rtsp to serve as a reactive barrier when applied to skin of soldiers that will render ineffective the dermal threat of chemical warfare agents by decreasing skin exposure and by neutralizing the agent. Desirable characteristics of this skin applied product include efficacy against all known dermal cwa threats, safe and nonirritating, stable, and compatible with other soldier use and chemical agent detection systems. Strategies that have been identified to accomplish this task include incorporation of the following materials into an ointment or other medium that already has barrier qualities: Reactive chemicals, reactive assemblages of molecules, reactive resins, enzymes, antibodies, catalytic antibodies. Successful proposals must possess a viable concept and an evaluation plan demonstrating a logical sequence of steps to identify, and incorporate and test the reactive materials to prepare the final product.

Phase I: Survey, test and establish the reactive and/or adsorptive species to be used in the rtsp. Characteristics such as reactivity (kinetics) stability, skin toxicity, availability, cost and compatibility with the protective barrier must be considered. Concurrently, a protective barrier that is compatible with reactive species and also with skin use must be developed. Finally, reactivity and stability of the combined protective barrier and reactive species must be demonstrated.

Phase II: Establish in vitro efficacy of proposed rtsp against cwa stimulants using testing procedures already established by the U.S. Army.

Potential Commercial Market: Industries currently exist in which workers are exposed to toxic materials e.G. Pesticides, herbicides, as well as other chemicals that represent health hazards. Use of a rtsp would provide these workers with protection against these noxious chemicals.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-239TITLE: Develop Methods For In Vivo Delivery Of Dengue Proteins To The Cytoplasm Of Cells For Antigen Processing and Presentation

CATEGORY: Basic Research

OBJECTIVE: The objective of this proposal is to provide a method for stimulating cd8 lymphocytes in a recombinant protein vaccine. The method or product must be potentially usable in a human vaccine.

DESCRIPTION: The method with the most potential as a vaccine engineering tool for stimulation of cd8 lymphocytes is acid labile liposomes. There has been some method development and patents obtained concerning production of acid labile liposomes for vaccine production. This project would focus on the adaptation of this proven method to in vivo delivery of dengue proteins. Acid labile liposomes are stabilized by serum proteins if not properly engineered. Recent publications indicate that this problem has been largely overcome and that the major focus of the project would be adaptation of the technology to dengue proteins.

Phase I: The first phase would be continued adaptation of the methodology in in vivo conditions. Completion of this phase of development would be essential for progression to the next phase.

Phase II: Dengue proteins supplied by the department of viral diseases, wrair would be packaged by the small business and returned to wrair for assessment of the immunogenicity of the packaged product.

Potential Commercial Market: Dengue vaccines, other vaccines of interest to the dod.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-240TITLE: Tissue Adhesives For Battlefield Hemorrhage Control

CATEGORY: Basic Research

OBJECTIVE: Develop a fibrin-based tissue adhesive that can be used to control life or limb-threatening hemorrhage on the battlefield (pre-hospital setting).

DESCRIPTION: Hemorrhage is the cause of many battlefield deaths and increases the morbidity of surviving casualties. An effective method for controlling hemorrhage in forward treatment elements (pre-hospital, non-physician providers) would greatly impact on combat mortality rates and decrease logistical requirements for combat casualty care. Fibrin tissue adhesives have been widely used in surgery to control surgical bleeding, increase the adherence of skin grafts and nerve anastomoses, and to increase tissue adhesion in eye and ear surgery. No products have been developed that could be used to control arterial and venous hemorrhage in a first aid setting. Furthermore, the opportunity exists for adding growth factors and anti-microbials to fibrin adhesives, allowing definitive closure and accelerated healing of soft tissue injuries that would otherwise require surgical treatment (e.G., Suturing).

Phase I: Identify products and methods for developing a fibrin-based tissue adhesive that can be used for pre-hospital control of hemorrhage from penetrating trauma.

Phase II: Develop durable low weight delivery systems for fibrin adhesives that can be used by combat medics under austere conditions with minimal preparation.

Potential Commercial Market: Directly applicable to controlling hemorrhage by paramedics and emts in the pre-hospital setting.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-241TITLE: Medical Vision Enhancement Prosthesis For Military Laser Retinal Injury

CATEGORY: Basic Research

OBJECTIVE: To develop a rationale for and an optical prosthesis for military laser retinal injury.

DESCRIPTION: Laser/photic retinal injury alters color vision mechanisms and affects spatial vision depending on the size and retinal location of the lesions. The potential exists to improve color vision and thereby enhance color

discrimination (e.G. Detection of camouflaged targets) by modification of the spectral input to the eye. Spatial vision changes result from localized retinal injury. Small rapid shifts in the retinal image location produced by optical or electro-optical techniques which rapidly move the image plane between normal and damaged retinal sites could potentially improve visual performance of the inured eye. Thus, the impact of a partial or absolute scotoma would be minimized and the quality of life of a patient injured by laser radiation would be enhanced.

Phase I: Develop and articulate the rationale for vision enhancement prosthesis and initiate device concept analysis.

Phase II: Fabricate prototype devices and begin testing. Provide five prototypes to the usamrdc for further evaluation.

Potential Commercial Market: Potentially applicable to laser and other blinding retinal diseases.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-242TITLE: Development Of Field Oriented, Nucleic Acid Amplification Methods For Rapid Identification Of Biological Threat Agents

CATEGORY: Basic Research

OBJECTIVE: To develop a system for identifying militarily relevant agents of disease, such as anthrax, botulinum, etc. Under possible field environments and to evaluate such a system against relevant clinical specimens.

DESCRIPTION: Gene amplification methods such as polymerase chain reaction have proven to be a tremendously powerful, rapid and sensitive tool for identification of pathogens. The techniques have found application in clinical diagnostic settings, but are currently too unwieldy for field-expedient use. A system is required to diagnose casualties of biowarfare agent exposure, which simply and efficiently processes appropriate tissues for nucleic acid extraction, amplification and post-amplification detection of products. Additionally, this system should possess little or no risk for cross-over contamination, have high stability, and be relatively user-friendly.

Phase I: Design a field-expedient system that provides specific nucleic acid amplification and post-amplification detection.

Phase II: Evaluate system against other diagnostic methods using clinically relevant specimens and scale-up for production.

Potential Commercial Market: Physician's offices, hospital laboratories.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-244TITLE: Development Of Diagnostic Probes For The Detection And Surveillance Of Drug Resistant Parasitic Infections

CATEGORY: Exploratory Development

OBJECTIVE: To develop probe(s) that will provide rapid field identification of drug resistant plasmodium falciparum malaria and leishmania species.

DESCRIPTION: The phenomenon of resistance to drugs by prokaryotic and eukaryotic pathogens is a matter of great practical concern. The prevalence of multidrug resistant strains of p. Falciparum and the unresponsiveness of cutaneous and visceral leishmaniasis to antimonial therapy is a serious clinical problem that represents an important threat to the complete direct identification of drug-resistant parasites in easily obtainable patient samples. The probes would call for a single reading of results by semi-skilled technical staff. The probes should be specific, sensitive and inexpensive. The quantities required for in vitro and field testing of each probe submitted is about 100 and 1000 reactions, respectively.

Phase I: Submission of potential probe(s) in the appropriate quantity and quality for in vitro testing against reference drug resistant and sensitive parent clones of the parasites.

Phase II: Submission of additional quantities of specific probe(s) for field testing and evaluation.

Potential Commercial Market: Malaria is a world wide health problem. Rapid, specific, sensitive test for malaria would have broad market application.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-245TITLE: Systems To Detect Bacterial Contamination Of Banked Blood In A Rapid, Non-invasive, Low Technology Manner

CATEGORY: Basic Research

OBJECTIVE: To determine if banked blood is contaminated with bacteria by a rapid (1 hour?) Method that does not require entering the blood bag, or the use of high tech analytical instruments.

DESCRIPTION: To develop a device to detect bacteria in bags of stored blood without contaminating the blood, removing the blood from the bag, or the usual long delays and equipment requirements of culturing techniques. Perhaps a disposable sensor-type device which could be manufactured into the bag system, or a small portable "box" into which the blood bag could be placed for a few minutes to "sense" the presence of bacterial in the bag.

Phase I: Develop bacterial sensor technology which works in presence of whole blood.

Phase II: Produce prototype that works on banked blood in plastic blood bags.

Potential Commercial Market: 12 million units of blood in u.S. Each year.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-247TITLE: Identification And Diagnosis Of Toxin Exposure And Infectious Diseases

CATEGORY: Basic Research

DESCRIPTION: Develop systems to identify/diagnose toxins or infectious diseases in biological samples at sub-nanogram levels using amplification immunoassay or other technologies. Development of means of detection or diagnosis of exposure to toxins or infectious diseases of interest. Systems must be simple, sensitive, specific, reliable, and rapid for field use, without cumbersome equipment requirements. Systems should be applicable to biologic matrices such as blood, urine or other clinically obtainable samples. Toxins of principal interest include ricin, microcystin, botulinum toxin, saxitoxin, staphylococcal enterotoxins and clostridial perfringens toxins as well as other low molecular weight, peptide, and protein toxins. Infectious agents of interest include anthrax, plague, tularemia and selected virus diseases (e.G. Vee). Ability to identify/diagnose engineered organisms would be of special interest. Diagnostics for channel active toxins, pre- and post-synaptic toxins, and protein syntheses inhibitors are also of interest.

Phase I: Show proof-of-principal.

Phase II: Show utilization of the system for a variety of toxins in a variety of biologic matrices.

Potential Commercial Market: Several toxins and infectious agents that present a military threat also pose a significant public health hazard. These diagnostic kits would be of great value in determining the cause of outbreak of food poisoning or undetermined infectious disease.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-248TITLE: Remote Water Quality Evaluation

CATEGORY: Engineering Development

OBJECTIVE: Determine feasibility and develop hardware and software to determine quality of water at remote locations.

DESCRIPTION: The corps of engineers has developed satellite imaging capability to detect water resources throughout the world. It is proposed to examine application of this capability to determine some basic health-related water quality parameters at remote locations.

Phase I: Explore concepts and determine feasibility for determination of water quality parameters by remote sensing.

Phase II: Develop bread-board system for testing remote sensing concepts.

Potential Commercial Market: Assessment of environmental quality and detection of environmental degradation.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-249TITLE: Delivery Of Vaccines By Biodegradable Polymeric Microcapsules With Bioadherence Properties

CATEGORY: Basic Research

OBJECTIVE: To demonstrate the feasibility of biogradable microspheres for the encapsulation of vaccines with or without immunoadjurants which would evoke complete protection for a duration of at least one year by single administration.

description: To achieve maximum protection, most vaccines require two or three booster doses, causing logistical difficulties. Furthermore, parenteral administration of the vaccine by trained medical personnel considerably increases the cost of vaccination. Therefore, biodegradable microspheres for the encapsulation of vaccines with or without immunoadjuvants are needed which would evoke complete protection for a duration of at least one year by single administration. Toxins of principal interest include ricin, microcystin, botulinum toxin, saxitoxin and staphylococcal enterotoxins, clostridial perfringens toxins as well as other low molecular weight, peptide and protein toxins. Infectious agents of interest include anthrax, plague, tularemia and selected virus diseases (e.G. Vee).

Phase I: Demonstrate feasibility in laboratory animals, using a vaccine against agents listed above.

Phase II: Extend to include preclinical trails to support ind submission.

Potential Commercial Market: Microencapsulation of vaccines present a significant advancement in vaccine technology by allowing one immunization to replace a vaccine and several boosters. All commercial vaccine manufacturers would be a potential commercial market for development/utilization of this technology.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-250TITLE: Development Of In Vitro And Animal Model Tests To Assess User Acceptability Of Topical Skin Products

CATEGORY: Exploratory Development

OBJECTIVE: To develop and validate an in vitro and/or for an animal model test that will serve as a predictor of user acceptability in humans for topically applied skin products.

DESCRIPTION: The u.S. Army is currently developing solider use, skin products to serve as topical skin protectants (tsp) and reactive topical protectants (rtsp) to protect soldiers from the dermal threat of chemical warfare agents. Candidate TSPS and RTSPS are evaluated for efficacy, safety, stability and compatibility with other soldier use and chemical agent detection systems. Another critical that must be fulfilled is user acceptability. However, since these materials are regulated by the fda as drugs, human testing for user acceptability cannot be performed until the products are well along in the developmental process. To move this to an earlier stage of development, an in vitro or animal model test is required that would allow an assessment of user acceptability. The test must be validated by human testing and serve as a good predictor for user acceptability.

Phase I: Survey, test and establish methodologies that permit assessment of the characteristics of topical creams and ointments using an in vitro and/or an animal model that can be correlated with human user acceptability. Specifically, correlates of subjective human assessments of tackiness, oiliness and smoothness should be sought. Considerations of methodologies to accomplish this goal should include rheological, resistance, shear and interfacial tension measurements, but should not exclude other methodologies. Development of models should consider the use of a collagen matrix, leather or human skin equivalents as potential in vitro examples and the hairless guinea pig (HPG) as the in vivo animal model. The HGPS already used extensively for in-house efficacy testing.

Phase II: Design, establish and execute a testing procedures to validate the previously developed in vitro and/or animal model against user acceptability in humans.

Potential Commercial Market: Evaluation of user acceptability is a necessary step in the development of skin products in industry. A less costly means of performing this evaluation earlier in the development process would be expected to very useful.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-251TITLE: Mobile Field Waste Incinerator

CATEGORY: Engineering Development

OBJECTIVE: Develop a small, mobile incinerator for field disposal of solid waste, human waste and hospital waste.

DESCRIPTION: There is a need to incinerate solid waste, human (sanitary) waste and hospital (infectious) waste in the field. This could be achieved by a small, mobile incinerator, a family of such incinerators, or a single incinerator adaptable for each use. Such a device must be capable of operation using military power supply and/or fuel and must be transportable by equipment available to field units. Economy of size and energy consumption are essential requirements; a secondary requirement would be a minimal heat signature.

Phase I: Identify operational criteria for a mobile field incinerator, including minimum temperature and residence time, size of incineration chamber and requirements for emissions control (for use during training). Deliverables will include a conceptual design package, which can be based on a loading rate up to and including that suitable for a 400 bed field hospital.

Phase II: Design, construct and test a preprototype incinerator.

Potential Commercial Market: Parks, construction sites, disaster areas, open air concerts.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-252TITLE: Medicinal Chemistry Synthesis Of Potential Drugs Effective Against Toxic Agents Of Biological Origin

CATEGORY: Basic Research

OBJECTIVE: Develop prophylactic/therapeutic compounds for treatment of intoxications caused by toxins of biological origin.

DESCRIPTION: Toxic agents of biological origin such as botulinum toxins, saxitoxin, staphylococcal enterotoxins, ricin, etc. Are potential threat agents for which protective measures are required. There is an interest in chemical compounds which will prevent (pretreatment) and/or counteract (antidote/treatment) the toxic effects of such agents. Airway or systemic applications will be considered. The drugs need to be reasonably non-toxic and fast acting. The compounds prepared are to be fully characterized and of high purity (>99.5%), For screening against the targeted threat agents.

Phase I: Demonstrate efficacy of the compound in a model system.

Phase II: Demonstrate efficacy against other toxins or conduct preclinical trials in support of ind submission.

Potential Commercial Market: Several militarily relevant toxins (eg., Saxitoxin, botulinum toxin) present significant public health hazards through oral ingestion. No specific treatment regime exists. Chemical compounds for treatment or protection against these toxins would be a significant advance in protecting the public health.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-253TITLE: Development Of An Aviator Restraint System Locking Device

CATEGORY: Basic Research

OBJECTIVE: Develop a locking device, for use on u.S. Army helicopter personal restraint systems that will allow no more than 2.5cm Of webbing extension exclusive of webbing stretching lock under all potential crash conditions. Inadvertent lock activation during normal use shall be minimized.

DESCRIPTION: Current restraint system locking devices are activated by strap acceleration and utilize a pawl and ratchet mechanism to lock the reel. This technology has allowed unacceptable upper torso flailing during army helicopter crashes resulting in serious and occasional fatal injuries to pilots. This situation has been compounded in "crashworth" helicopters equipped with energy attenuating landing gear and crew seats where crash force onset rates and peak accelerations experienced by the occupants are markedly reduced. Resolution of this problem will require the development of new concepts in webbing locking devices. It is desirable for the device's lock activation to perform independently of the occupant's torso displacement since the intent of the restraint system is to prevent occupant motion. An activation reliability level of 100 percent when subjected to various crash loadings is desirable while maintaining minimal inadvertent activation during normal flight duties.

Phase I: Review current state-of-the-art technologies in the aerospace and automotive industries and explore new ideas in sensing crash force accelerations and providing restraint system locking. In addition, develop appropriate test conditions and methods to evaluate the new restraint system locking devices. Proposed concepts should consider all helicopter types under all possible crash and near-crash conditions. Fulfillment of this phase should include a state-of-the-art technology review critique, a proposal for at least three separate locking device concepts, and appropriate test methods for each locking device technology.

Phase II: Provide working prototypes of two concepts selected by the government from the concepts proposed in phase I and apply at least one test method from phase I to detail the performance of each concept prototype.

Potential Commercial Market: Personal restraint system locking devices developed during this project can be used in commercial and military aircraft and the concepts evaluated in this work may lead to an innovative product for passive restraint in other vehicle types including automobiles.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-254TITLE: Medical Countermeasures Against "Toxic Agents Of Biological Origin"

CATEGORY: Basic Research

OBJECTIVE: Refine or develop new model systems to determine pathophysiologic mechanisms. Provide new methods of therapy and prophylaxis for biological toxins.

DESCRIPTION: Biological toxins, such as botulinum, ricin, anthrax, and staphylococcal enterotoxins are agents for which protective measures are required. The molecular sites of action of several of these toxins have been identified, however, cellular and organ pathophysiology as well as integrative mechanisms in whole animal models require further study. Research proposals designed to develop in vitro model systems and determine pathophysiologic mechanisms for developing potential medical countermeasures such as vaccines, antibodies, or drug prophylaxis and treatment regimens are strongly encouraged.

Phase I: Demonstrate usability of new methodology for a single toxin.

Phase II: Demonstrate usability of methodology for a variety of biological toxins from various diverse sources, plant, bacteria, etc.

Potential Commercial Market: Several militarily relevant toxins (eg., Saxitoxin, botulinum toxin) present significant public health hazards through oral ingestion. No specific treatment regimen exists. Study of the molecular sites of action leading to medical countermeasures against these toxins would be a significant advance in protecting the public health.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-255TITLE: Development Of Anthropometric Analogous Headforms

CATEGORY: Basic Research

OBJECTIVE: Conduct a scientific review on the mass properties, biodynamic response, skin properties, and the occipital and cervical pivot locations of the adult male and female head and neck. Apply this information to the development of three different sized manikin headforms to be used in testing military crashworthy and ejection seats. These headforms should be representative of actual mass properties, equivalent skin thicknesses, retrofit to existing hybrid iii and adam manikins through the denton 6-axis load cell, contain a tri-axial accelerometer located at the head center of mass, and the occipital pivot shall be anthropometrically located.

DESCRIPTION: Currently accepted manikin headforms used by the department of defense include the hybrid ii, hybrid iii, and adam. Anthropometrically, these headforms are undefined and do not represent any specific percentile aviator. Three anthropometrically sized headforms have been developed by USAARL for evaluating the protective capabilities of aviator headgear. Manikin headforms are required which represent the anthropometry of these three headforms. The manikin headforms must possess realistic and reproducible mass properties, a tri-axial accelerometer located at the head center of mass, skin thickness equivalent to humans, an anthropometrically located occipital pivot, and be compatible with the denton 6-axis load cell and retrofit to existing hybrid iii and adam manikins.

Phase I: Conduct a scientific review and prepare a report on the mass properties, biodynamic response, skin properties, and occipital pivot location of the adult male/female head and neck. Design three headforms (small, medium, and large), that possess the appropriate mass properties, skin properties, anthropometrically located occipital pivot, have a tri-anial accelerometer located at the head center of mass and be compatible with the denton 6-axis load cell. The anthropometric features of the three headforms shall be representative of the three usaarl headforms.

Phase II: Fabricate one fully instrumented headform of each size and evaluate the following properties: Anthropometric dimensions, mass properties, and the biodynamic response as tested on a hybrid iii head/neck calibration test stand.

Potential Commercial Market: These headforms would be marketable to the automotive industries, protective headgear developers and manufacturers, and dod testing agencies.

TECHNOLOGY CLUSTER: A-8

TOPIC: A93-256TITLE: Cellular Immune Response To Diseases Of Military Importance

CATEGORY: Basic Research

OBJECTIVE: To develop new, sensitive, quantitative tests to monitor cellular immunity as a response to vaccinations.

DESCRIPTION: Recovery from, protection against and perhaps the disease process itself, of several diseases of military importance are mediated by cellular response or immunity. Sensitive, quantitative, and easily applied tests to detect relevant responses are needed both in evaluation of the immune status of antibody-negative subjects and to monitor the disease process and vaccine development. Typical systems in which such responses are thought to be biological relevant include diseases caused by q fever and the staphylococcal enterotoxins.

Phase I: Demonstrate proof-of-principle using an organism from those listed.

Phase II: Demonstrate applicability in specimens from infected individuals.

Potential Commercial Market: Monitoring cellular immunity may be used to evaluate immune status of antibody-negative individuals vaccinated against a variety of infectious diseases. Development of a sensitive quantitative test of cellular immunity would be of potential interest to all vaccine manufacturers in order to quantify levels of protection demonstrated by a new or existing vaccines.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-257TITLE: Insert Hearing Protector With Communications Enhancement For High Intensity Impulse Noise Environment

CATEGORY: Basic Research

OBJECTIVE: Develop an insert hearing protector with communications enhancement for high intensity impulse noise environments.

DESCRIPTION: The hearing protective device must be capable of amplifying ambient acoustic signals to increase the wearer's ability to detect and localize low level sounds. The output of the device, in the occluded ear canal, shall not exceed levels which are considered hazardous to hearing. The device design will minimize self generated noise and provide flat frequency response to maintain highest fidelity for the transfer of sounds to the ear. The device shall fit into the ear of the wearer and be compatible with equipment normally used by the soldier. Comfort and user acceptance are important factors in the design of the device. Phase I: A detailed study concerning insert hearing protection with face-to-face communication capability shall be accomplished. Talk-through characteristics needed to improve communications, detection and localization for personnel with normal hearing or mild to moderate NIPTS shall be established. Develop specifications for a device which conforms to results of the study and meets requirements stated in the above description. Provide design proposals to usaarl for review and selection for further development.

Phase II: Develop prototypes based on phase I design proposals. Quantify electro-acoustic characteristics and provide samples to USAARL for additional evaluation. Deficiencies identified in these evaluations will be used to establish final design criteria for the device. A sufficient number of final design criteria devices will be submitted to usaarl for laboratory and field studies.

Potential Commercial Market: High noise level industrial areas requiring conversation.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-258TITLE: Human Immuno-deficiency Virus (HIV) Research

CATEGORY: Basic Research

OBJECTIVE: Study the natural history of hiv infection, virus and immune response, chemoprophylaxis and vaccine prevention efforts, and hiv transmission.

DESCRIPTION: Research will be conducted to maximize the use of unique characteristics of military populations such as the broad cross-sectional nature of the community, their potential to be deployed to almost any area of the

world, and the total susceptibility of the group to the disease. Areas of research with military relevance include the following: 1) identification, isolation and characterization of hiv strains from diverse geographic locations. 2) Development of improved assays for diagnosis and epidemiological surveys. Development of experimental animal models of disease. 3) Risk assessments and methods of evaluating behavior modification to reduce risk of infection.

Potential Commercial Market: Applicable to world wide health problem.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-259TITLE: Development Of A Portable, Ultralow Freezer For Preservation Of Biological Products In An Austere Environment

CATEGORY: Exploratory Development

OBJECTIVE: Develop a lightweight, portable freezer, capable of maintaining temperatures of at least -80 degrees centigrade to preserve temperature sensitive biological materials.

DESCRIPTION: New biological products are being engineered for the emergent care of trauma victims and for the prevention and treatment of diseases. By virtue of their chemical nature, these products are heat sensitive and must be stored at very low temperatures to preserve their activity. Bulky insulation and heavy compressor(s) required to reach low temperatures preclude the use of commercial freezers in the field medical environment. To ensure the availability of biological products under these circumstances, there is a requirement for an ultralow freezer that (a) can reach and maintain at least -80 degrees centigrade, (b) has a capacity of about 14 cubic feet, and (c) operates on 110/220 volts ac and 24 volts dc. The freezer should incorporate new technologies in insulation and refrigeration to reduce unit weight and size and to increase its efficiency and durability.

Phase I: Incorporate extant technologies into a conceptual design package for a portable ultralow freezer. The package must document the potential of components to meet requirements for a lightweight, efficient, and durable product that can maintain at least -80 degrees centigrade.

Phase II: Develop and deliver at least one fully operational prototype ultralow freezer with documentation elaborating on its design and function and with data verifying its operational characteristics.

Potential Commercial Market: Ultralow freezers have broad application in the scientific and medical communities.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-286TITLE: An Analysis of Soldier Biomechanics Using Ambulatory Monitoring Techniques

CATEGORY: Exploratory Development

OBJECTIVE: To develop and/or adapt instrumentation and techniques for assessing, predicting, and improving the biomechanics of human performance through ambulatory monitoring.

DESCRIPTION: The biomechanics of human motion is fundamental to the execution of nearly all functional tasks in civilian and military environments. Under conditions in which there are no internal or external constraints, such motion exhibits basic characteristics that contribute to efficient performance. In reality, however, human motion is rarely performed without some encumbrance. Heavy loads, personnel protective clothing, fatigue and a variety of other extraneous factors may seriously compromise performance. When individuals perform specific tasks (e.g., lifting, reaching, and walking), it is important to quantify the motion changes that are imposed by nonstandard conditions in order to predict the dynamic changes that occur when unexpected demands are placed on the biomechanical system. More importantly, defining movement strategies that will significantly improve performance in critical situations can be accomplished by a biomechanical analysis of motor behavior using ambulatory monitoring techniques. Ambulatory monitoring refers to the use of a continuous recording system to evaluate kinematic function in the actual performance state. Typically, a miniature portable device is attached to a subject during performance of a specific activity, and the desired information is recorded automatically for later retrieval. The major advantage of this method is that it employs instrumentation that does not physically restrict the subject and it allows a given task to be performed under normal conditions without the use of artificial laboratory environments. Using such monitoring devices, the ultimate goal of the project is to derive biomechanical solutions that will enable the soldier to function in a more efficient manner during the execution of critical tasks. Additionally, a record of movement is made throughout the duration of the task which can be decomposed and provide input for graphical analysis of motion using computerized human models.

Phase I: During this phase, an ambulatory monitoring technique should be selected and used in an empirical study of one military task performed under normal and atypical conditions. A biomechanical analysis should then be made, demonstrating that it is possible to form quantifiable and functionally meaningful distinctions in performance among various environmental conditions.

Phase II: Phase II should: (1) expand the Phase I empirical study to a larger set of military-related tasks; (2) make available a graphics software system for immediate viewing of the experimental data, in the form of recreating the experimental trial with an animated human figure; (3) develop a predictive model that will accommodate untested circumstances; and (4) derive results for enhancing soldier performance under nonstandard conditions.

Potential Commercial Market: Ambulatory monitoring is widely used in the medical field. Cardiac and neurological assessments have been enormously improved by such monitors. An ambulatory monitor for kinematic and kinetic data acquisition together with evaluative procedures will have significant commercial potential, particularly in the field of rehabilitation, as a unique clinical instrument for disability assessment and patient management. Moreover, a biomechanical monitoring system integrated with graphical animation software will provide human factors engineers with a powerful tool to assess the impact of clothing and equipment on the biomechanical performance of humans in actual working environments.

TECHNOLOGY CLUSTER: A-8
TOPIC: A93-343TITLE: Develop an Enzyme or Fluorescent Linked Anti-body Based Biological Agent Detection/Assay System for Particulate Antigens

CATEGORY: Exploratory Development

OBJECTIVE: Develop a sensitive assay method to minimize the number of steps needed to equate the number of organisms or mass of antigen present for potential commercial Phase III application.

DESCRIPTION: The biological agent detector program has placed demands on the test facility at Dugway Proving Ground to be able to detect and quantify aerosolized particulate challenge material (antigen quantity) by physical means. Efforts to develop a sensitive assay for Bacillus subtilis var. niger during the latter part of FY 92 have been less than successful. Overall requirements are to develop an enzyme linked or fluorescent linked antibody-based assay system for particulate antigens (i.e. BG, MS-2, bacteriophage) that can be equated to number of organisms or mass of antigen present in a given sample. The sample material will be composed of viable and non-viable microorganisms. The detection/quantification assay system should be similar to the standard enzyme-linked immunoassay (ELISA) or the enzyme-linked immunofiltration assay (ELIFA). Other suggestions might include a piezoelectric crystal/antibody approach or a fluorescent antibody used in a microscope assay. It would be desirable, from an operational standpoint, to minimize the number of steps involved in performing the assay. For example, ideally, it might involve adding the unknown sample or standards to a labelled antibody, incubate the fluid and have the particulate/antibody complex remain on the filter to be read by fluorescent concentration. The PANDEX (now IDEXX) corporation fluorescent concentration analyzer seems suitable for such a task.

Phase I: Provide prototype kit which demonstrates technology feasibility for producing assay reliably.

Phase II: Provide shelf-type kit (one-year shelf life or better) for in-house assay production capability.

Potential Commercial Market: Significant potential for use in detection of airborne and waterborne particulates, especially in environmentally controlled areas such as hospitals, laboratories, etc..

A-9ENVIRONMENTAL AND GEO SCIENCES
(I.E. ENVIRONMENTAL PROTECTION AND SPACE)

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-046TITLE: Improved Luminous Tritium Sources

CATEGORY: Exploratory Development

OBJECTIVE: To make a safer, improved light source, containing 90% less tritium, for Army, Air Force & Navy users, and thus increase the source's applications and possibilities.

DESCRIPTION: Within the DOD there are over 1 million curies of tritium in their instrument lamps. The cost per curie is $3.19. This effort will reduce the $3,190.00 plus cost to less than $300.00. To achieve this savings a special machine which produces microspheres will have to be modified to enable the introduction of tritium gas and phosphors

into the microspheres. The result will enable a safer brighter light source with only 10% of the tritium previously required.

Phase I: Develop methodology for design and implementation of a system which will produce improved luminous tritium sources in the form of glass microspheres. These sources will be for illuminating instruments used by the Army, Air Force and Navy. Develop and define conceptual lamp designs for two selected Army fire control instruments requiring luminous sources. The improved source will have a five year useful life expectancy goal.

Phase II: Develop a full up laboratory prototype microsphere producing system capable of inserting controlled increments of phosphors and tritium gas into glass microspheres. The increments of phosphors and tritium will be optimized to create a luminous source containing a fraction of the tritium gas that an equivalent status quo luminous tritium source would contain. Two optimized microsphere arrays will be fabricated equivalent to two standard types of 10 curie lamps used in Army Fire Control Devices.

Potential Commercial Market: The commercial potential is very high in providing safer airline passenger exit signs at lower cost. The tritium sources will enable economical long-life instrument lighting for airline cockpits and motor vehicle cabs. In its final packaged form the tritium radiation hazard will be reduced to being only negligible in severe accidents. Since the source does not require electricity, it can be used as a fire safety device in homes and industry providing, at night, easy to follow illuminated directions to fire exits, alarms, phones, etc.

OSCR: A significant army generic cost driver involves electrical/mechanical replacement costs. Status quo electrical items including large and small lamps and associated hardware, housing, switches, contacts, connectors and power sources. These items are limited life components and cause most of the significant electrical/mechanical replacement costs. Many of these lamps can be replaced by the improved long life luminous tritium sources which do not require power sources, wires, switches, etc. and their associated hardware. The efficient improved source will use only about 10% of the tritium presently required by DOD systems. Almost $3M will be saved by the Army by reducing the current quantity of tritium in use, if the new source is incorporated. This new long life light source should save at least $3M annually.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-050TITLE: Development of a Chemical/Mechanical High Rate Process for the Detection of Residual Stress in 5.56mm Brass Cartridge Cases

CATEGORY: Engineering Development

OBJECTIVE: The objective of this program is the development and demonstration of a real time chemical or mechanical process for the determination of residual stress in 5.56mm brass cartridge cases after they have been annealed. The current test for determination of residual stress is conducted using mercurous nitrate to accelerate the formulation of cracks in the brass cartridge case as a result of any residual stress remaining after cartridge case anneal. Mercury compounds are recognized as known environmental and safety hazards. The process developed under this SBIR is intended to replace the current test used at Lake City Army Ammunition Plant (LCAAP). Upon completion of Phase I, the contractor will have demonstrated the feasibility of a new real time process for the determination of residual stress in 5.56mm cartridge cases. Upon completion of Phase II, the contractor will have fully developed and demonstrated this process for determining the residual stress in 5.56mm brass cartridge cases and demonstrate process capability to operate at the rate of 1200 parts per minute and be capable of being integrated into the 5.5mm cartridge case fabrication production process. Upon successful completion of Phases I and II, a Manufacturing Methods and Technology (MMT) program would then be submitted to place and integrate such a process into the case fabrication line at LCAAP.

DESCRIPTION: Residual stress remaining in brass cartridge cases could result in cracks or splits during extended ammunition storage. Defects such as cracks or splits could pose a safety hazard to soldiers when firing such ammo from their weapons. The current process for the determination of residual stress in 5.56mm brass cartridge case is accomplished as per ASTM B 154-92 Mercurous Nitrate Test for Copper and Copper Alloys. This test employs a mercurous nitrate solution to test in-process cartridge cases and fully assembled cartridges. Mercury accelerates the cracking or splitting of the cartridge case caused by any residual stress remaining in the case after case anneal. The test requires 30 minutes to complete. Mercury compounds pose known safety and health hazards to personnel requiring that extreme precautions be taken during its handling and use. In addition, the disposal of mercury waste in landfill as

is currently done can pose a serious environmental hazard and may become illegal in the near future. It is intended that this program develop a process for the determination of residual stress in cartridge cases which would eliminate the use of mercurous nitrate, a known environmental and health hazard. At the same time this process shall be capable of operating real time in the cartridge case fabrication line at the rate of 1200 cartridge cases per minute.

Phase I: A search is to be conducted for the identification of new methods/approaches to residual stress determination which do not have the hazards associated with the current mercurous nitrate test. These methods should be capable of real time operation of 1200 parts per minute. A selection process would be conducted to determine one or two viable processes/tests. This, in conjunction with testing and analysis, would be used to determine the feasibility of utilizing an identified process/test as a replacement for the current mercurous nitrate test. The contractor shall determine the advantages and disadvantages of each test/processes identified as a viable solution to the problem and which meet program objectives. A final determination will be made by the government as to which process will be pursued in Phase II.

Phase II: The contractor shall fully develop the most viable process as is determined in Phase I. He shall demonstrate its ability to determine residual stress at an operating rate of 1200 parts per minute. The process shall be capable of performing accurate stress measurements with little or no interference from normal variations found in the manufacturing process such case thickness, trace impurities, case curvature, etc. The process shall be capable of being integrated into the cartridge case fabrication at LCAAP.

Potential Commercial Market: The potential for a Phase III effort for commercial applications for this program is considered to be good. Most commercial producers of sporting ammunition and ammunition for law enforcement purposes utilize a mercurous nitrate test for the determination of residual stress in brass cartridge cases. Mercurous nitrate is recognized as a health and environmental hazard. Currently, spent mercury solution is disposed of in a landfill. This method of disposal will be banned in the near future. An environmentally safe and non-toxic method of residual stress determination will eventually have to be found. The results of this effort could be directly applied in the commercial segment of the ammunition market since that also now employ the mercurous nitrate test for residual stress determination in brass cartridge cases.

OSCR: The development of in-line non destructive inspection methods for detecting residual stress in brass cartridge cases will result in reduced operating and support costs associated with metal parts fabrication. Presently, the inspection of brass cartridge cases is conducted "off line" using mercurous nitrate which requires a minimum of 30 minutes to complete testing. In this time, approximately 36,000 defective cartridge cases can potentially be fabricated before a environmental safety and health hazard. An in-line inspection method would identify a residual stress problem in real time allowing for an immediate change in the annealing process and thereby eliminate a large amount of scrap material. Elimination of the disposal costs of mercurous nitrate is another potential area cost savings. A reduction/elimination of a safety and health hazard and its associated cost not the least of which may be potential legal action/lawsuits would result in additional costs savings.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-054TITLE: Electro-chemical Machining of Refractory Materials for Gun Barrels

CATEGORY: Exploratory Development

OBJECTIVE: Develop and Demonstrate Electro-chemical Machining (ECM) Processes for Refractory Materials used in Gun Barrel Liners

DESCRIPTION: New gun barrels are being developed utilizing internal liners of refractory materials of various metallurgical combinations. These materials cannot be machined by conventional machining processes. Electro-chemical machining in the form of an "Electronic Broach" has been developed for conventional gun barrel steels. The new refractory gun barrel liners require development of new electrode materials and process parameters to successfully machine these liners. Some liners are homogeneous and some are composite so as to maximize heat resistance, resist wear and maintain strength. It is necessary to develop specific ECM Processes and to establish machining parameters to obtain high quality surface finish and to maintain precise internal dimensions and rifling configuration for both constant twist and gain twist rifling.

Phase I: Develop methodology and design for implementation of optimum electrode material, electrolyte and electrode clearances that are suitable for various power inputs and cutting speeds.

Phase II: Develop laboratory prototype and demonstrate processes. Finalize parameters.

Potential Commercial Market: Commercial market potential is considered good. Components of refractory materials are used in high temperature applications such as gas turbine engines, heat exchangers, and high temperature valves.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-055TITLE: Cleaning of Depleted Uranium from Metal Parts

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a system capable of cleaning depleted uranium from metal parts.

DESCRIPTION: The disposition of metal parts from 120mm tank ammo cartridges with depleted uranium (DU) penetrators has been a problem for some time. Previous demilitarization procedures have provided for the crushing of the core and the metal parts and die burial of the remains. Not only does this threaten the environment around the dump site, but it also dismisses the potential cost savings of reusing the metal parts. The metal parts have come in contact with the DU core and have become coated with DU oxides (UO2 and UO4·2H20) as the core has aged and oxidized. The feasibility of cleaning these oxides from these metal parts has never been investigated. NOTE: It is intended that cleaning of metal parts should be done at a projectile or cartridge assembly facility.

Phase I: Develop process for removal of DU particulate from metal parts. Define conceptual design for facilities necessary in support of removal process.

Phase II: Design and construct prototype DU removal facility in support of DU removal process.

Potential Commercial Market: Depleted uranium (DU) has many commercial uses such as ballast weights for ships and planes, radioactive shielding materials, paint and dye pigments and others. Any machinery of materials in contact with the DU would need to be surveyed and cleaned periodically. Therefore, a process developed for the Army would have strong commercial application.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-056TITLE: Preferred Orientation in Tungsten Heavy Alloys (WHA)

CATEGORY: Exploratory Development

OBJECTIVE: Develop technology to impact preferred orientation in polycrystalline tungsten heavy alloys to improve their ballistic performance. Military applications include kinetic energy penetrators, shaped charge liners, EFPs and armor. Commercially these alloys are used for gyroscopes, counterbalances, semiconductor substrates, radiation shields, and machine tools.

DESCRIPTION: Tungsten heavy alloys and depleted uranium alloys have found usage in long-rod kinetic-energy ammunition. Attempts to improve the ballistic performance of tungsten heavy alloys have centered on improving the mechanical properties. These attempts, however, have been less than fully successful. Recent investigations to understand the penetration mechanisms using single crystal tungsten penetrators having rod axes parallel to the (100), (110), and (111) directions showed three distinct deformation behaviors and ballistic performances. The (100) orientation had penetration performance equalling that of depleted uranium alloy. The intent of this development effort is to develop technology to impart preferred orientation in polycrystalline tungsten alloys. Desirable technical approaches may include (but are not limited to) solid-state zone refining and advanced thermo-mechanical processing treatments.

Phase I: Develop technologies to impart preferred orientation in polycrystalline tungsten alloys. Develop the processing-orientation correlations. Conduct high strain rate testing and fracture analysis.

Phase II: Select and optimize the most promising material and processing technique from Phase I and fabricate sub-scale ballistic penetrators. Test and compare the ballistic performance with depleted uranium alloys.

Potential Commercial Market: Tungsten heavy alloys exhibit the unique property combination of high strength, ductility, density and toughness. These alloys find application both in the military and commercial field. Military applications include kinetic energy penetrators, shaped-charge liners, EFP's, and armor. Commercially these

alloys are used for gyroscopes, counterbalances, semiconductor substrates, radiation shields, and machine tools. Development of advanced tungsten materials and/or processes under the SBIR program will allow advancement in both military and commercial fields. An alternate material to replace the environmentally-sensitive depleted uranium in all DOD applications will be by far the most significant usage. Systems and programs such as SADARM, replacement for 829A1 KE round, unguided hyper-velocity projectiles, X-rod program, and segmented rod penetrators are a few of the many examples. Developed technology will also benefit the commercial products mentioned above.

OSCR: The SBIR proposal to develop new tungsten alloys and processing technology aims to markedly reduce the environmental, logistical and life cycle cost burden associated with the present use of radioactive depleted-uranium material in all DOD armament systems. The approach of the proposal is to develop a new generation of tungsten alloys and/or processing technologies that will enhance the ballistic performance of WHA to be equivalent or better than depleted uranium alloys. The goal is to make tungsten alloys a viable cost-effective replacement for the radioactive depleted uranium used in DOD munitions, and thereby eliminate the major environmental concerns that presently burden the DOD. The replacement of depleted uranium in munitions with an environmentally in-offensive tungsten alloy will have major cost benefits. These benefits will extend throughout the life cycle of these anti-armor kinetic energy penetrator rounds.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-057TITLE: Coated Tungsten Alloy Composites

CATEGORY: Exploratory Development

OBJECTIVE: Develop coating technology to fully or partially coat tungsten or tungsten alloy rods with material susceptible to localized failure during Armor Penetration. This technology can be applied to kinetic energy penetrators, shaped charge liners, EFPs and Armor. Commercially these alloys are used for gyroscopes, semiconductor substrates, radiation shields, and machine tools.

DESCRIPTION: High density is one of the key attributes of successful kinetic energy penetrator materials. Tungsten heavy alloys (WHA) and depleted uranium are two materials which possess required properties for ballistic penetration. Depleted uranium alloys, however, are more effective penetrator materials. Their ballistic superiority is attributed to their localized failure during penetration. Recent environmental pollution concerns related to the use of depleted uranium have spurred significant interest in enhancing the ballistic performance of tungsten alloys. The current technical approach is to induce thermo-mechanical instability in WHA's by replacing the nickel-base matrix with one or more materials susceptible to adiabatic shear localization. However, since the matrix is a small constituent of WHA, it is unlikely that a new matrix alone can induce localized failure of the whole composite. Thus, to enhance the effect of a new matrix material, it should be concentrated in specific areas of the penetrator rod. Development of a coating/surface modification technology is required to enhance the ballistic performance of tungsten and tungsten heavy alloys. Such a coating must be adherent and crack-free and must be able to withstand ballistic impact.

Phase I: The goal of Phase I is to identify candidate materials based on rational and scientific considerations. Conduct coating experiments on tungsten rods to partially or fully coat with selected materials to a coated composite density >17g/cm3. Evaluate the coating quality with respect to bond strength, microstructure, porosity and microcracks.

Phase II: Select and optimize the processing of two materials from Phase I. Fabricate sub-scale ballistic test penetrator with fully dense coatings in different configurations. Conduct terminal ballistic tests and compare the data with depleted uranium penetrators. Conduct fracture analysis of recovered penetrator materials.

Potential Commercial Market: Tungsten heavy alloys exhibit the unique property combination of high strength, ductility, density and toughness. These alloys find application both in the military and commercial field. Military applications include kinetic energy penetrators, shaped-charge liners, EFP's, and armor. Commercially these alloys are used for gyroscopes, counterbalances, semiconductor substrates, radiation shields, and machining tools. Development of advanced tungsten materials and/or processes under the SBIR program will allow advancement in both military and commercial fields. Alternate materials to replace the environmentally sensitive depleted uranium in all DOD applications will by far be the most significant usage. Systems and programs such as SADARM, replacement for 829A1 KE round, unguided hyper-velocity projectiles, X-rod program, and segmented-rod penetrators are few of the many examples. Developed technology will also benefit the commercial products mentioned above.

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TECHNOLOGY CLUSTER: A-9
TOPIC: A93-058TITLE: Tungsten Alloys with Enhanced Ballistic Performance

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a Tungsten Penetrator Material that is a viable substitute to depleted uranium penetrators. Alternate materials will replace the environmentally-sensitive depleted uranium in all DOD applications such as SADARM, replacement of M829A1 KE round, unguided hyper-velocity projectiles, and the X-rod program.

DESCRIPTION: Depleted uranium alloys are the material of choice for long-rod kinetic energy ammunition. Their ballistic superiority over tungsten heavy alloys is attributed to the localized failure these alloys exhibit during penetration of armor. The environmental pollution concerns related to the use of depleted uranium alloys, however, have spurred significant interest in enhancing the ballistic performance of safer tungsten alloys. Prior tungsten alloy development programs achieved significant improvements in mechanical properties; but failed to realize any improvement in penetration performance. More recent development efforts utilize an approach to induce a thermo-mechanical instability in the tungsten heavy alloys by replacing the nickel base matrix with one or more materials susceptible to adiabatic shear localization. The matrix, however, constitutes only a small percentage of the two-phase composite microstructure. Pure tungsten is the major constituent; therefore, it is unlikely that changes in the matrix alone can induce favorable failure modes. Thus, totally new tungsten alloys based on novel microstructure and advanced tungsten particles are needed to fabricate tungsten heavy alloys with altered and beneficial deformation failure modes. Desirable technical approaches to achieve alterations in deformation behavior of pure tungsten do not have to solely rely on thermal softing to create localized failure, but also should take advantage of structural or microstructural modifications. This may also include preferred orientation of microstructure.

Phase I: Synthesize novel tungsten alloys which exhibit altered and favorable failure mode as compared to pure tungsten. Device processing technique to produce fully dense monolithic bulk material containing novel tungsten particles.

Phase II: Select and optimize the most promising material/ processing combination addressed in Phase I. Conduct high strain-rate testing to develop property/microstructure correlationships for new alloys. Evaluate fracture mode of various alloys. Demonstrate sub-scale terminal ballistic parity between depleted uranium and tungsten heavy alloys.

Potential Commercial Market: Tungsten heavy alloys exhibit the unique property combination of high strength, ductility, density and toughness. These alloys find application both in the military and commercial field. Military applications include the kinetic energy penetrators, shaped charge liners, EFP's, and armor. Commercially these alloys are used for gyroscopes, counterbalances, semiconductor substrates, radiation shields, and machine tools. Development of advanced tungsten materials and or processes under the SBIR program will allow advancement in both the military and commercial fields. Alternate materials to replace the environmentally sensitive depleted uranium in all DOD applications will by far be the most significant usage. Systems and programs such as SADARM, replacement for 829A1 KE round, unguided hyper-velocity projectiles, X-rod program, and segmented rod penetrators are a few of the many examples. Developed technology will also benefit the commercial products mentioned above.

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depleted uranium alloys. The goal is to make tungsten alloys a viable cost-effective replacement for the radioactive depleted uranium used in DOD munitions, and thereby eliminate the major environmental concerns that presently burden the DOD. The replacement of depleted uranium in munitions with an environmentally in-offensive tungsten alloy will have major cost benefits. These benefits will extend throughout the life cycle of these anti-armor kinetic energy penetrator rounds.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-062TITLE: Development of Environmentally Friendly, Cost-Effective and Scaled-Up Synthetic Processes for New High Energy Density Materials

CATEGORY: Exploratory Development

OBJECTIVE: This project should mature towards industrial production of new more powerful explosives, viz GARDEC HMX, TNAZ, Dinitroimidazole, etc. The Phase II accomplishments toward feasibility of Scale-up preparation will be transitioned for possible commercial production.

DESCRIPTION: Several new explosives are being developed in the ARDEC Energetics & Warheads Division which have high potential for use in munitions to provide enhanced performance. They could be used both as more powerful/insensitive explosives and propellants. The objective of this solicitation is for investigations to scale-up the recently-developed preparative processes to the multi-pound level of a wide variety of energetic materials, viz. alpha and/or beta HMX (produced by the new GARDEC process); 2, 4 dinitroimidazole and TNAZ.

Phase I: a. Determine the feasibility of attaining scale-up quantities of the new explosive compounds TNAZ and 2, 4 dinitroimidazole via the newly discovered synthetic routes. b. Determine the feasibility of scaling up the newly developed GARDEC processes for the production of alpha and beta HMX.

Phase II: Conduct intermediate scale runs to produce multi-pound quantities of alpha/beta HMX, TNAZ and 2, 4 dinitroimidazole via the new chemical processes developed at ARDEC.

Potential Commercial Market: This topic has a high potential for commercialization. Already, HMX and TNAZ scaled-up processes are being investigated by Holston Defense Corporation, Hercules, and Slumberger companies. Dinitroimidazole has a high potential for commercialization since it is a highly likely candidate for DOE applications.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-064TITLE: Development of Nonpolluting Soldering Technology for Large Production Volume, High Shock Loaded Electronics Circuit Boards

CATEGORY: Advanced Development

OBJECTIVE: Provide specific tested and proven soldering technology which is non-polluting and is suitable for large production volume electronic circuit boards which are subject to high setback, high shock environments such as fuzes, mines, and smart munitions.

DESCRIPTION: Research and develop new soldering technology and waste recovery methods which do not rely on ozone depleting chlorofluorocarbon (CFC) cleaning solvents and do not result in waste product environmental contamination. Investigate use of aqueous cleaning techniques, conductive epoxy adhesive solder, water soluble flux compounds and/or other non-CFC cleaning agents. New method must involve recovery system for any waste product.

Phase I: Research nonpolluting and non-CFC based soldering processes and materials to determine best suitable technology for large scale production of assemblies required to endure extremely high shock environments. Consider aqueous and semi-aqueous cleaning with residue capture and elimination of the need for cleaning; the later being the preferred approach. Phase II: Develop cost effective nonpolluting, proven and high reliability soldering technology/process, equipment and materials specifically targeted to the large production volume electronics and electrical assemblies which are subject to the extremely high shock/high setback environments associated with cannon, tube or rocket launcher, or air drop emplacement. Define package available to Government ammunition plants and production contractors.

Potential Commercial Market: Nonpolluting soldering technology (including the eventual elimination of lead based solder) is the wave of the future. CFC and other soldering process pollutants will be outlawed in the future. A small business with readily available technical advice and technology (processes, equipment, materials) will be positioned to quickly fill the requirement of an industry searching for alternatives.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-080TITLE: Aerosol Cloud Imagery Identification and Segmentation

CATEGORY: Exploratory Development

OBJECTIVE: Develop enhanced image processing capabilities primarily for segmentation of smoke/obscurant clouds from multispectral imagery.

DESCRIPTION: Characterization of smoke/obscurant clouds is important for assessing system effects on electro-optical and other electromagnetic sensors operating under "dirty battlefield" conditions. Additionally, this characterization is important for the test, evaluation, and development of smoke and obscurant defensive and countermeasure systems. In order that this characterization be accomplished in three-dimensional space, as opposed to single lines of sight, multispectral imagery is a major part of the instrumentation suite used under field test conditions. The analysis of these data requires that the smoke cloud be identified and then segmented from the scene under study. In most situations, the cloud radiance/luminance is nearly the same as the background against which the observations are being made, which causes automatic segmentation schemes based on edge detection to fail. Possible alternative techniques could be based on, but not be limited to texture analysis, multispectral signature, or artificial intelligence. This topic supports the Reduction of Generic Cost Driver #2, "Causes of Training Ammunition Expenditure Costs" by reducing operating and support costs through an increase in First Round Hit Probability.

Phase I: The goal of this effort will be to develop enhanced algorithms/measurement techniques based upon existing imagery and/or easily obtained observations for the successful automatic segmentation of aerosol clouds from the scene.

Phase II: Evaluation and implementation of the enhanced segmentation scheme on a variety of existing imagery and/or field tests to acquire additional data for analysis of the developed capability.

Potential Commercial Market: A potential commercial market exists in the application of the technique to satellite imagery and the segmentation of meteorological clouds as well as the possible application of advanced techniques for real-time identification and segmentation of aerosol clouds other than smoke and obscurant clouds.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-081TITLE: Scanning Bi-Static Sodar for Measuring Wind Structure Parameter

CATEGORY: Exploratory Development

OBJECTIVE: Develop a scanning Bi-Static Sodar for measuring of the wind structure parameter with height from 50 meters to 700 meters above ground level.

DESCRIPTION: One atmospheric parameter which affects the propagation of sound is turbulence. Turbulence will dramatically affect the amplitude of sound propagating from battlefield targets and the Line-Of-Bearing measurements to the targets. The types of turbulence involved are the temperature and wind structure parameters. Therefore, to understand the degree of turbulence effects on sound propagating in the atmosphere, the magnitude of the temperature and wind structure parameter must be measured as a function of height above the ground. Currently, a Mono-Static Sodar is used to measure the temperature structure parameter. However, the magnitude of the wind structure parameter will make the largest contribution to the magnitude of the turbulence in the upper air. A Bi-Static Sodar will provide the measurements of both temperature and wind structure parameter with respect to height above the ground. This type of measurement is needed for the development of turbulent acoustic propagation models which will predict the effects of turbulence on the phase and amplitude of sound propagating from tactical targets and its influence on the detectability of those targets. This topic supports the Reduction of Generic Cost Driver #2, "Causes of Training Ammunition Expenditure Costs," by increasing the First Round Hit Probability.

Phase I: Development of a Bi-Static Sodar which will provide measurements of both temperature and wind structure parameter from 50 meters to 700 meters above ground.

Phase II: Evaluation of the performance of the Bi-Static Sodar by conducting field tests in conjunction with in situ measurements of the temperature and wind structure parameter from a tower or other verified techniques of measurements.

Potential Commercial Market: A potential market exists in the development of this type of measurement for use in aviation, obscurant cloud dispersal, and optical propagation.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-082TITLE: Normal Mode Analysis of Atmospheric Sound Ducts

CATEGORY: Exploratory Development

OBJECTIVE: Develop fast analysis techniques for determining the effectiveness of atmospheric sound ducts for the propagation of sound.

DESCRIPTION: A sound duct, at the surface, is a region in the atmosphere where sound is refracted back toward the ground and becomes trapped near ground. Optimal acoustic propagation conditions can occur when there is a sound duct present in the atmosphere. However, the effectiveness of the duct for the propagation of sound is dependent on the frequency, turbulence strength, shape of the duct, and acoustic impedance of the ground. Normal mode techniques can provide the ability to perform initial assessment of the acoustic propagation characteristics of a sound duct for a single or multiple tone acoustic signal. This type of analysis capability will allow rapid determination of the impact of a sound duct on the detectability of a battlefield target.

Phase I: Development of the theoretical relationships which determine the acoustic propagation characteristics of an atmospheric sound duct. The propagation characteristics will include the range of frequencies which will propagate well in the duct and what degree of "leakiness" of the duct exists at those frequencies.

Phase II: Development of a software package based upon the theoretical relationships in PHASE I. This software package will be written in ANSI-STANDARD FORTRAN 77, with the output being comprised of the parameters which dictate the effectiveness of a sound duct to propagate sound through it.

Potential Commercial Market: A potential commercial market exists in the application of these techniques in the evaluation of commercial and military noise impact on communities.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-212TITLE: Arid Land Revegetation with Blue-Green Algae

CATEGORY: Exploratory Development

OBJECTIVE: Develop a viable inoculation process using blue-green algae (Microcoleus vaginatus) to stabilize and restore ecological function to disturbed lands in arid ecosystems.

DESCRIPTION: Due to the perceived difficulties in restoring arid ecosystems, disturbed lands in those regions have been written off as permanent sacrifice areas. New research has shown, however, that microphytes, particularly blue-green algae, are a critical factor in soil stability and nutrient cycling in arid ecosystems. Long overlooked due to their inconspicuous nature, these organisms may be the key to successful land reclamation in arid regions. Unfortunately, very little is known about requirements for propagation, harvest, storage and inoculation of the organisms.

Phase I: In a laboratory setting, develop methods of propagating, harvesting, and storing (with minimal loss of viability) cultures of Microcoleus vaginatus. Develop methods to inoculate damaged lands with the cultured algae using slurry and/or granular/pelletized techniques.

Phase II: Develop commercial scale apparatuses for propagating, harvesting, storing and applying Microcoleus vaginatus cultures to disturbed lands in arid ecosystems.

Potential Commercial Market: The Departments of Defense, Energy, Interior and Agriculture, as well as various State and private organizations and individuals, are responsible for millions of acres in the arid West. A

product that has been proven successful in the reclamation of disturbed arid land ecosystems would have very high potential for commercialization in the United States. A potential market also exists in other arid regions around the world.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-214TITLE: Heavy Metal Ion Removal by Magnetic Particle Wastewater Treatment

CATEGORY: Exploratory Development

OBJECTIVE: Develop magnetic particle resin technology for use in heavy metal ion removal from wastewater.

DESCRIPTION: The traditional methods of removal of heavy metal ions from industrial wastewaters such as electroplating rinse waters involves the use of ion exchange technology. Ion exchange is plagued by high capital cost, the need for prior clarification and subject to fouling. A number of arsenals and depots such as Toby Hanna Army Depot, PA and Corpus Christy Army Depot employ electroplating technology which generates chrome, nickel and cadmium metal ions requiring removal from the wastewater. A cost effective method is needed for removal of heavy metal ions from small plating operations.

Phase I: Develop and prove the concept of using magnetic particle resins in wastewater treatment. The proof of concept should include a safety and environmental impact study.

Phase II: Develop a prototype magnetic particle technology which takes advantage of the negative charge present on colloidal impurities in sewage, effluence, and raw water. The theoretical treatment process would involve changing the ion charge on magnetite, contacting the effluent, inducing flocculation, clarifying, and release of the impurities from the magnetite.

Potential Commercial Market: The U.S. Army, DOD, and municipal waste treatment facilities all have a need to dispose of contaminated industrial wastewaters.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-215TITLE: Heavy Metal Adsorption From Combustion Gas

CATEGORY: Exploratory Development

OBJECTIVE: Development of a material or system which would preferentially adsorb heavy metals from a combustion system. Subsequent separation of the material from the combustion gas stream and extraction or concentration of the metals is desired.

DESCRIPTION: Incineration has the potential to be used as the Army's energetic wastes that are generated during the manufacturing process. All researchers int he field of explosives incineration agree that the development of an adequate feed method is the key to successful application and use of this technology. Experts also agree that size reduction as a minimum along with some other form of pre-treatment is important to the incineration process. Heavy metals frequently end up being volatilized and going up the stack. Most of the heavy metals will be regulated as toxic air pollutants under the Clean Air Act of 1990. This SBIR is intended to address the heavy metals and to find a way to capture them before they are exhausted to the atmosphere.

Phase I: Evaluate and prove feasibility of using a material or system to preferentially adsorb or separate heavy metals from a combustion stream.

Phase II: Develop a system and demonstrate.

Potential Commercial Market: The U.S. Army, DOD, and private manufacturers and incinerator operators all have a need to limit heavy metal emissions from combustions processes.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-222TITLE: Evaluation of Supercritical Fluid Extraction Technology for Decontamination

CATEGORY: Exploratory Development

OBJECTIVE: To evaluate the potential for using supercritical fluid extraction (SCFE) technology for chemical, biological and nuclear decontamination of small, delicate military equipment.

DESCRIPTION: The work will entail a detailed review of the current SCFE technology and evaluate, in detail, its applicability to the decontamination of small items of military equipment.

Phase I: The investigator(s) will make one visit to CRDEC for a briefing on the operational use and requirements for a small equipment decon system. They will then critically evaluate SCFE technology and equipment discussing such topics as the fluids which might be used; how these fluids would be stored and transported; the dimensions and weight of the SCFE apparatus; the anticipated power requirements; methods of moving equipment into and out of the SCFE apparatus; the spraying and/or washing system within the SCFE apparatus. The discussions will identify potential problem areas if using SCFE for this purpose, suggest technical approaches to overcome them and consider realistic advances expected in SCFE technology in the coming decade which may impact on the utility of this approach.

Phase II: The investigator(s) will prepare a reduced-size prototype SCFE apparatus suitable for studying the process using small test coupons based upon the SCFE approach which appeared most reasonable in Phase I. Depending on the complexity which would ultimately be required in the field model, this test apparatus would not necessarily have all the features of a full engineering prototype, but will have sufficient capability to allow testing to demonstrate whether the approach will work.

Potential Commercial Market: SCFE is already in use in commercial processing. Development which extends the use of this technique for applications involving hazardous materials could be useful in other industrial situations.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-229TITLE: Rapid Measurement of Ice Density

CATEGORY: Advanced Development

OBJECTIVE: Develop a system for rapid, accurate determination of density of ice samples obtained in field situations.

DESCRIPTION: Accurate measurements of densities of samples of sea, lake and river ice are necessary to calculate the mechanical and electrical properties of the ice. Likewise, the density of ice formed on objects by supercooled fog and sea spray are necessary to calculate loads caused by icing. Small errors in measured density can make large differences in calculated loads or properties. Two methods currently favored for measuring density are the mass-volume technique and submersion method. In the mass-volume method, the sample is weighed (usually on a portable electronic balance) and the volume measured with calipers. For the submersion technique, the sample is weighed in air and a fluid of known density, and the ice density can be quickly calculated. The submersion method is accurate on bubble free ice, but large errors occur on ice with connecting surface channels. The difficulty with the mass-volume method is generally the accurate determination of volume due to surface irregularities. A field portable method of accurately measuring ice density to an accuracy of 0.002 g/cm (cubed) is required. Sea, lake, and river ice is normally collected by core sampling resulting in samples that are 6 to 15 cm diameter cylinders (depending on auger diameter) and can be 2 to 25 cm in length. Sea spray or atmospheric ice samples may be a variety of shapes or configurations, some with volumes of only a few cm (cubed). Some ice may be permeable, thus, submersion techniques may not be appropriate. It is preferable, but not absolutely necessary, that the technique be non-destructive. Instrumentation and tools for making the measurements should be made rugged, and be packaged such that it can be deployed by one person (making several trips if necessary). AC power will often only be available from a small generator (l.5kva) at the field sites. The measurement technique should work in temperatures ranging from 0 to -40 degrees C.

Phase I: Determine the feasibility of developing instrumentation to accurately measure ice densities in the field conditions described above. Design and develop a "breadboard" system and prove the feasibility of the technique in laboratory tests.

Phase II: Make necessary modifications to Phase I concept and development then design and fabricate a prototype system. The prototype system will be used in field tests to demonstrate its applicability.

Potential Commercial Market: Instrumentation and techniques to measure ice density would be useful to government laboratories, academic institutions and private companies involved in ice research. Depending on the technique adopted, it also may be useful for determining the density of other natural materials, which would considerably expand its commercial potential.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-230TITLE: Near-Infrared Spectral Reflectances of Earth Materials

CATEGORY: Engineering Development

OBJECTIVE: To provide research and development resources sufficient for a small business contractor to develop to a marketable degree an instrumentation system for rapidly measuring the near-infrared reflectance spectra of earth materials and landscape features in the field.

DESCRIPTION: There are many current instruments that are suitable for field measurement of spectral reflectances in the visible and part of the near-infrared region (0.35 - 1 micron). However, there is a great deal of information in the near-infrared spectral signature (l.0 - 2.5 microns) of most earth materials, which allows identification and classification in remote sensing data, as well as more accurate specification of the wavelength-integrated albedo for energy balance calculations. This project requires systematic application of knowledge about large array sensing elements, spectral sensitivity of sensor materials, and integration of instrument packages with small computers to develop a light-weight near-infrared field spectroradiometer. Equipment is required that will reliably, accurately, and rapidly measure spectra in the 1.0 - 2.5 microns wavelength region, which is suitable for field use. High spectral resolution (more than 60 channels) is required. The instrumentation should be light weight and battery powered, it should have a sensing element that allows for easy pointing in any direction, and it should be able to store, manipulate, and display measured spectra. Moreover, communication with standard computers, PC's or workstations, should be straightforward. The system should operate in a wide variety of environmental conditions. The equipment is intended for measurements of the near-infrared spectral reflectances of landscape features during ground-truth campaigns for military captive flight tests and civilian remote sensing missions.

Phase I: a) Determine the feasibility of different sensors/sensor arrays to meet the above spectral standards, b) Develop a working "bread-board model" of the entire instrument package that will measure reflectance spectra as described above, and c) Develop and demonstrate appropriate calibration and validation methods to verify the performance of the "bread-board model."

Phase II: The contractor shall design and fabricate the equipment evaluated in Phase I. The end product to be a validated and calibrated prototype instrument, which will be used in field experiments to demonstrate the potential applications in this intended environment.

Potential Commercial Market: Valuable for research tool that has wide applications to various government agencies including Corps of Engineers, USGS, NASA, Forest Service amoung others. In addition this is a valuable tool for academic institutions.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-231TITLE: Millimeter-Wave Backscatter from Cold Regions Terrain

CATEGORY: Engineering Development

OBJECTIVE: To provide research and development resources sufficient for a small business contractor to develop to a marketable degree an instrumentation system for measuring the millimeter-wave backscatter from Earth materials and landscape features in the field.

DESCRIPTION: Current millimeter-wave radar systems for measuring the backscatter and aborption characteristics of Earth surfaces are research prototypes, which are generally not well suited for the rigors of field portability and use. Very few of these systems are fully polarimetric. The reliability of these systems is also not substantial; usually one or two technicians are required for maintenance and repair during field missions. This project requires systematic application of knowledge about polarimetric radar systems, and integration of instrument packages with small

computers to develop a dual frequency field-portable polarimetric FM/CW radar. Field operational equipment is required that will reliably, accurately, and rapidly measure backscatter in two frequency bands centered at 35 and 95 GHz. The radar should be designed to operate within a range of 5 - 50 m from the target, and the antenna/transceiver package should be light weight (less than about 100 kg). A data acquisition and instrument controller should be integrated with the instrument package. Moreover, communication with standard computers, PC's or workstations, should be straightforward. The system should operate in a wide variety of environmental conditions. The equipment is intended for measurements of the 35 and 95 GHz back scatter of landscape features during ground-truth campaigns for military captive flight tests, and for other special purpose investigations.

Phase I: a) Determine the feasibility of different transmitter/ receiver and controller systems to meet the above standards, b) Develop a working "bread-board model" of the entire instrument package that will measure radar backscatter as described above, and c) Develop and demonstrate appropriate calibration and validation methods to verify the performance of the "bread-board model."

Phase II: The contractor shall design and fabricate the equipment evaluated in Phase I. The end product to be a validated and calibrated prototype instrument, which will be used in field experiments to demonstrate the potential applications in this intended environment.

Potential Commercial Market: A valuable research tool that has wide applications to various government agencies including Corps of Engineers, USGS, NASA, Forest Service among others. This will also be a valuable tool for academic institutions.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-355TITLE: High-Speed Vehicle Positioning and Reporting System

CATEGORY: Exploratory Development

OBJECTIVE: To develop an accurate and reliable system to determine the position of high speed ground vehicle such as high speed trains or MAGLEV and report the positions to a central control facility.

DESCRIPTION: Vehicles on the magnetically-levitated (MAGLEV) system to be developed in the United States will need an all-weather 24-hour positioning system for effective traffic management. The system must have meter-level accuracy and must transmit the real-time positioning, along with speed and direction of travel, once every second to a traffic control facility that may be over 100 miles away. The system must be operable in rural or urban areas.

Phase I: The contractor will develop a design for the stated positioning system. The design will include the proposed positioning technology (i.e. inertial, laser, GPS) that satisfies the above requirements and the communication system to transmit the positions. The design will include technical specifications, system components, operational constraints, and performance and cost estimates. The design will also include the communication system to report the position to a control facility, and will include an analyses of the effect of data processing and telemetry delays on the real-time accuracy.

Phase II: The contractor will build a prototype, if the system is not guideway-dependent, and install it on a car or truck for field tests. The system performance will be documented. Computer simulations and analyses may also be included.

Potential Commercial Market: Phase III potential is high, since such a positioning and reporting system could have application to other forms of transportation in which traffic management is essential. A successful implementation in a MAGLEV prototype could also lead to positioning and position data communications standards, where various modes of transportation; such as MAGLEV, aviation, and intelligent vehicle highway systems; could share a common system.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-358TITLE: Mobile FAX Map Distribution System

CATEGORY: Exploratory Development

OBJECTIVE: To develop hardware and software to automatically request and distribute geographic data via mobile fax.

DESCRIPTION: The Mobile FAX Map Distribution System would allow a user 1) to telephone a request from a mobile fax for geographic data, 2) to execute the request on a remote computer, and 3) to receive the resulting map, chart, or text via fax.

Phase I: The contractor will deliver and demonstrate a capability to perform all the required processes, ie. request data mobile fax, extract data from a geographic information system and create a map display, and receive data via mobile fax. The demonstration shall be done in a completely automated fashion once the request is made via fax.

Phase II: The contractor will enhance the basic capabilities to refine the user interface and improve performance of the system. The contractor will deliver a rugged prototype system and demonstrate the system in an Army field exercise.

Potential Commercial Market: The fax map distribution system would enjoy great success in the commercial marketplace. Applications would include disaster relief, police and fire services, utilities, delivery services, commuter information services, and business travel.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-359TITLE: Feasibility Study to Determine the Ability to Use an In-situ Vitrification Tent to Contain Open Burning Gases

CATEGORY: Basic Research

OBJECTIVE: To control open burning emissions.

DESCRIPTION: The Army uses open burning to treat waste explosives and propellants. This practice is becoming more regulated and may be banned in the future. Open burning is a very inexpensive method of treatment. If we can convince the EPA of the effectiveness of the tent then we could continue to use open burning and not have to use a more expensive technology such as incineration.

Phase I: Perform an engineering study to determine the feasibility of using such a tent. If feasible prepare a system design to be used in pilot testing.

Phase II: Test the system designed in phase I to include emissions testing.

Potential Commercial Market: The commercial market would be limited to those concerns that can plan open burning of any material. This system could be used during fire extinguisher training. This project uses a current commercial market item used in In Situ Vitrification. This project uses a current commercial market item used in In Situ Vitrification. Improvements made to this device for Army use would enhance its use in the commercial field.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-360TITLE: Alternative Solvents for Asphalt Cement Extractions

CATEGORY: Exploratory Development

OBJECTIVE: Develop methods and procedures for the use of alternative solvents (pine or citrus based) for asphalt cement extraction and recovery.

DESCRIPTION: The solvents currently used include: trichloroethylene, trichloroethane, and methylene chloride. These are considered hazardous materials and require careful handling and controlled disposal. The test methods and procedures developed for the alternative solvents should involve the use of standard extracting devices currently specified in ASTM D 2172. Detailed procedures such as those currently outlined in the ASTM standard should be developed. A series of extractions shall be performed using these procedures and the results compared to those obtained using the existing solvents and test methods. Investigate possible methods of recovering the asphalt extracted by the use of alternative solvents to insure that the properties of the recovered asphalt are not affected by the solvent.

Phase I: Evaluation of available solvents to identify those most promising. Factors to consider include: ease of handling (safety considerations), solvent effectiveness, cost, disposal requirements, recyclability and ability for adaptation to existing equipment. At the end of this preliminary evaluation, an initial series of tests should be

conducted to evaluate the effectiveness of the solvents for asphalt cement extraction. Then run preliminary tests to investigate the viability of recovering the asphalt cement extracted with these alternative solvents.

Phase II: Finalize the details of the refined or developed test procedures for the extraction of the asphalt cement and establish reliability and repeatability in regards to variations encountered between different technicians and laboratories. If suitable test methods and procedures for recovering the asphalt cement can be developed, finalize the details and establish reliability and repeatability as in the extraction test.

Potential Commercial Market: The utilization of alternative (non-hazardous) solvents for asphalt cement extraction and recovery will eliminate the need for chloroflourocarbon (CFC) solvents currently in use. These CFC;s are hazardous materials and require care in handling and controlled disposal and they have been linked to depletion of the ozone layer in the atmosphere. The development of alternative solvents will provide an answer to these environmental concerns.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-361TITLE: Site Characterization and Analysis Penetrometer System

CATEGORY: Exploratory Development

OBJECTIVE: Develop materials and mechanical components to support a new environmental sensing system.

DESCRIPTION: A number of sensors are being evaluated for use in a Site Characterization and Analysis Penetrometer System (SCAPS). These sensors will give SCAPS the capability to map the presence and concentration of various subsurface contaminants at depths ranging from 0 to 150 feet. These electrical, electromagnetic, optical, and chemical sensors require cables or tubing to transmit and collect energy and/or samples from the cone penetrometer system. Research is needed in order to define materials for electrical and fiber optic cables, as well as to design and construct mechanical systems for feeding and retrieving the cables and tubes.

Phase I: Evaluate available materials and mechanical systems, recommend possible designs for incorporation into SCAPS. After review by the Army sponsor, prepare a detailed design and assemble prototype equipment for a limited laboratory test.

Phase II: Fabricate a fieldable prototype system for testing as part of SCAPS. A number of controlled experiments as well as field tests at contaminated sites will be conducted. Based on the results of these tests, the prototype system will be modified as required to achieve required performance, and a minimum of four complete systems will be supplied to the sponsor for follow-on testing.

Potential Commercial Market: There is considerable interest in developing fiber optic materials that can efficiently transmit energy in the thermal-IR band. In addition, there are commercial applications for electrical cables for microwave/millimeter wave applications that can be made insensitive to bending during installation and operation.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-362TITLE: Controlled Camouflage Systems for Advanced Land Combat Applications

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-9
TOPIC: A93-363TITLE: Radar Antenna Optimization

CATEGORY: Exploratory Development

OBJECTIVE: Define the antenna requirements of a low-frequency (50 MHz to 1 GHz) radar system for detecting plastic and metal anti-tank mines that are buried in specific soil types and conditions.

DESCRIPTION: The Army is currently involved in the measurement and modeling of electromagnetic energy propagation through soils. One of the products of this effort is a database of complex dielectric properties of specific soil/moisture/temperature combinations. The requirement of the work described in this solicitation consists of initially

analyzing the complex dielectric properties of a specific soil type/moisture/temperature combination, and of a limited number of anti-tank mine surrogates. The results of this analysis are then to be applied to design and fabricate a single-antenna that maximizes the probability of detecting the mines at burial depths ranging from 2 to 15 cm.

Phase I: Define the bounds on the electromagnetic conditions presented to a vehicle-mounted radar by various metallic and non-metallic anti-tank mines buried in well-defined soil conditions. Based on the results of this study, develop a preliminary design (operating frequency, polarization, signal-to-noise- requirements, etc.) of an optimized prototype antenna. A design review will be conducted with the Army sponsor prior to proceeding with a detailed design of a single-element antenna for detecting buried mines in a limited range of soil conditions.

Phase II: Fabricate the antenna designed during Phase I, integrate it into an FM-CW vector network analyzer based system, and perform a series of controlled laboratory experiments to demonstrate detection performance in a milited range of soil conditions.

Potential Commercial Market: Locating underground utilities, clearing hazardous and formerly used Defense sites, and various geophysical mapping applications.

A-10ENGINEERING SCIENCES
(I.E. ROBOTICS, DYNAMICS, STRUCTURES, MECHANICS AND CONSTRUCTION)

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-038TITLE: 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.

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. Particularly, for the Army, this technology can be used in programs like FARV-A and AFAS to perform ammunition fusing, handling and loading during re-supply operations.

OSCR: This technology will provide cost reductions to Army operations where elimination of operators is needed. For instance, in programs like FARV-A and AFAS, this technology will be beneficial due to its potential application to operations such as fusing, de-palletizing and transferring of ammunition to and from a re-supply vehicle.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-040TITLE: Micro-Mechanically Steerable Optical/IR Scanner

CATEGORY: Exploratory Development

OBJECTIVE: The conceptual design, prototype fabrication and demonstration of a micro-mechanical optical/IR scanner for precision munitions and commercial imaging application.

DESCRIPTION: Because most IR/optical seekers and sensors have relatively narrow instantaneous fields of view, it is usually necessary to provide scanning of some sort in order to search a large field or to point the sensor in any desired direction. Usually, this is accomplished with the use of mechanical gimbal contrivances. The ability to ultimately achieve strap-down seekers with no macro-size moving parts would be of considerable interest. Solid state or micro-device optical concepts which can provide dynamic and agile control over the instantaneous line of sight of a seeker with no macro-size moving parts are of interest in order to solve this problem. The concept must lend itself to lightweight, rugged, mass producible, and low cost objectives. The detector being scanned can range from a single detector, small linear array, or a full 2D imaging focal plane array. Examples of methods which can combine micro-device, principles with optical scanning are: mosaic reflecting or refracting optics with individually controllable optical properties, geometry, focal length, index of refractions, aperture, aspheric shape, etc. Micro Fresnel lenses, mirrors, gratings, holograms, binary optics, deformable devices etc., are further examples provided that they can be micro-controlled based on microdevice principles. The following are the desired program goals: * Scan Angle: + 30 degrees
* Scan Rate: 500 to 12,000 deg/sec
* 4 in. Aperture, volume downsizable to 12 in.3
* Number of parallel channels: 1-10
* Applicable IR band: 0.7 to 10 microns
* Typical power level of the beam which the optical/IR scanner should be capable of handling without degradation range from minuscule for passive scanners up to 20 watts for scanning ladar.
* The scanning system including packaging should be "G" hardenable to 20,000 g's.
* The system should be capable of operation throughout the military temperature range of -50 to +140 degrees F.

Phase I: The contractor will perform a detailed scientific and engineering analysis including, but not limited to, computer simulations and analytical analysis to develop a feasible concept of an optical/IR micro mechanical scanning mechanism compatible with the design goals specified above.

Phase II: The contractor will fabricate a breadboard prototype configuration of the optical/IR scanning mechanism specified in the Phase I design and will demonstrate the operation of the system design.

Potential Commercial Market: If successfully developed this product is potentially capable of providing low cost, mechanically rugged and agile sensing systems for: commercial satellites, aircraft and terrestrial terrain mapping, thermal imaging systems, security surveillance and optical display technology compatible with current and future liquid crystal display technology.

OSCR: Cost Reduction Drivers: 1. Replacement of high cost labor-intensive precision mechanical assembly with a lower cost mass produced solid state electronic micro-device system. 2. Increased compatibility with the "wooden round" concept by increasing storage reliability and eliminating the need for costly periodic maintenance and inspection. 3. Reduced power consumption due to use of solid state electronic components. 4. Reduced packaging volume obtained by replacing bulky mechanical components with miniature solid state de state devices.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-041TITLE: Azimuth Orienting Device for Towed Artillery and Mortars

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate an azimuth orienting device for light indirect fire weapons such as towed howitzers and mortars with the required characteristics of accuracy, response time, ruggedness, low power requirement

and portability. This device would apply to a broad segment of ARDEC systems in the fire support commodity area. There are also potential future commercial applications in survey technology and mapping.

DESCRIPTION: A requirement exists for an azimuth orienting device for towed artillery and mortar fire control systems. Current techniques for these types of indirect fire weapon systems require the establishment of an azimuth orientation line by survey techniques employed by a survey party. It is desired that towed artillery weapons, self-propelled mortars and ground mortars be equipped with an autonomous capability to establish laying azimuth referenced to grid north. Available orienting systems which are used on some self-propelled artillery weapons are based on internal navigation system technology and are too large and heavy, too costly, and impose an unacceptable power requirement for use on the weapon systems envisioned. The characteristics required of the device are: accuracy of azimuth determination +/- 1 artillery mil RMS; time to determine azimuth no greater than 2 min with options for less time with reduced accuracy at operator selection; output either in true or grid azimuth; power requirements minimized with provision for integral battery and 24 v military vehicle power input; sufficiently rugged to withstand the maximum firing shock on a 155mm towed howitzer (can be in a standby or off mode during firing); provision for verification of boresight, i.e., alignment with the center line of the weapon bore when mounted on the weapon; output available for visual reading by the operator and as a digital signal for input into a fire control computer. The device should minimize, in so far as possible, size and weight so as to allow portability for light weapon systems. Production cost is also a design consideration so that the device can be afforded in sufficient quantity to equip each towed howitzer and heavy and medium mortar with the device.

Phase I: Develop the design concept of the azimuth orienting device. Produce two broad board type proof of concept units, one to be applied to towed howitzers and one for mortar systems. Develop preliminary functional specifications based on results of laboratory and field testing of the units.

Phase II: Produce sufficient follow-on units based on the preliminary functional specifications from Phase I to fully evaluate the technical and functional characteristics of the concept in an operational environment. Support both technical and user testing of the units. Develop finalized functional specifications.

Potential Commercial Market: This system would have direct application in the engineering survey and mapping technology areas. It would apply to a number of similar commercial applications where an accurate directional reference with respect to north is required.

OSCR: The operational concepts of indirect fire control that would be permitted with fire control systems based on this subsystem would allow the reduction of the reliance on survey capability to orient artillery and mortar weapons in the field. When each howitzer or mortar is provided with its own capability to accurately orient itself with grid north, then the very expensive, labor and training intensive survey requirement can be significantly reduced. This should result in a substantial operations and supportability cost reduction in that equipment, personnel and vehicles are reduced.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-043TITLE: Advanced Adaptive Weapon Control Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate low cost high performance digital servo control technology for precision 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 control design techniques and LOG LTR design approaches. Further improvements in gun accuracy are anticipated through the development of improved robust nonlinear and adaptive control laws and control laws that exploit recent advances in H infinity and l1 technology permits these techniques to be implemented in high bandwidth digital servo loops required for precision gun stabilization. This project will address the broad spectrum of issues associated with the development of design tools and methodology, modeling, simulation and real time hardware/software implementation.

Phase I: Develop methodology for design and implementation of high performance robust adaptive and nonlinear control laws for precision weapon stabilization and tracking. Formulate specific control laws for nominal two input, multi output nonlinear plant with friction, backlash, resonant modes, high impulse periodic disturbances

nonlinear compliance and sensor noise. Determine performance and robustness characteristics with respect to structural and unstructured plant perturbations and provide analysis of hardware/software implementation requirements.

Phase II: Develop a fully integrated design, test and prototyping environment for advanced nonlinear and adaptive multivariable control systems. Provide a real time programmable digital control module with on-line data analysis capability and I/O capability 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 and design environment developed in this SBIR can be used by many industries such as hydraulic and electric motor manufacturers, machine tool manufactures, process control companies, automobile and aircraft companies, robotic applications, stabilized optical sight systems, etc. Anyone who designs control systems must confront nonlinearities, parameter variations, backlash, friction and resonant modes.

OSCR: Microprocessor-based control is a low-cost platform independent way to implement advanced control algorithms. One of it's biggest benefits is the ability to rapidly modify the control algorithms, making it very cost effective when upgrading a weapon platform or even moving the entire system to a new application. Nearly all of the current controllers in the Army are analog based; i.e. capacitors, op amps and resistors fixed to a circuit card. Changes are very hard to make and portability between weapon platforms is impossible. If one microprocessor could be used for each servo control application in the Army with only the code being modified, the cost savings could be large. Another cost saving aspect of this work is the ability to get very high performance out of systems with backlash, friction, resonant modes, etc. What this means is that the Army can use a low-cost microprocessor-based Adaptive-Nonlinear Controller rather than buying new, very precise (and expensive) mechanical hardware or retrofitting existing systems to eliminate the nonlinearities, i.e. improve the performance with better algorithms and software rather than hardware.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-045TITLE: Simulation of Optical Surface Errors Resulting from Manufacturing Processes

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate software for simulating errors in optical surface generation produced by the Opticam Spherical Module (SM) as a result of machine misalignments and integrate into SM in-process correction.

DESCRIPTION: As a result of the MANTECH optics program with the Center for Optics Manufacturing, generation of spherical surfaces via deterministic tubular tool grinding has been demonstrated. These surfaces have surface figure better than one wave, RMS surface roughness less than 100 Angstroms, and subsurface damage less than two microns. The Computer Integrated Manufacturing (CIM) capability of the Opticam SM machine can now be enhanced via software to predict surface manufacturing errors given machine positioning and alignment tolerances. In the Optical Design Phase, this would be used to predict optical performance of manufactured parts and aid in cost effective designs. In the manufacturing phase, this software would aid in closed loop control of the Opticam SM. Interferograms of manufactured optics would be compared to the desired surface shape to diagnose machine misalignments and yield automatic correction or operator intervention, if necessary. Phase III Objectives: The results of this effort will be incorporated into the MANTECH Optics Thrust Program at the Center for Optics Manufacturing (COM) in Rochester, N.Y. MANTECH programs are planned to be performed at the center for FY93 to FY97. The program resulting from this SBIR would become part of the Opticam (Optics Automation & Management) system software and be implemented in continuing technology transfer at the COM, a consortium of academe and the US optics manufacturing industry. This would be as part of an ongoing IMIP program. This technology would advance process control for optics manufacturing and optical design tolerancing.

Phase I: Develop and demonstrate software for predicting shape of optical surfaces resulting from misalignment errors in the Opticam SM. Formulate concept for interface of predictive software to commercially available optical design packages. Formulate concept for interface of predictive software with metrology equipment and the Opticam SM controller for closed loop operation of the machine.

Phase II: Develop an interface for the predictive software compatible with commercially available optical design packages. This might take the form of a standardized format ASCII file which the developers of Optical Design

Software can use. Develop and demonstrate interfacing the software with the Opticam SM to perform closed loop operation.

Potential Commercial Market: Opticam machines are already commercialized and being sold. It is very likely that the contractor or an optical design software provider will commercialize this software as a module which can interface with Opticam. All Opticam-related projects are directed toward dual-use commercialization for the US optics manufacturing industry.

OSCR Qualifications: This software would probably lead to a cost improvement in making lenses of approximately five percent. Approximately $100M in precision optical components are ordered by the government every year.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-051TITLE: Automated Vision Inspection of Threaded Weapon Components

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate advanced automated vision inspection system technology for characterization of threaded weapon surfaces.

DESCRIPTION: Develop and demonstrate advanced automated vision system/technology for inspecting threaded ordnance surfaces. There is an Army-wide need to improve the method by which threaded parts are tested. Recent legislation enacted through the Fastener Quality Act, and class 3 safety-critical fasteners, calls for quantitative thread measurement versus quantitative thread gauging. Many of the required inspection parameters cannot be adequately characterized by traditional mechanical gauging methods in use today, especially at the high inspection rates required by 100% inspection and SPC. Measurements of internal threads are particularly difficult because of the mechanical and visual access problems. The accurate dimensional characterization of internal surfaces that contain critical features, such as threads, bearing shoulders, and seal surfaces, has always been a major concern to the U.S. military, their manufacturing representatives, and their QA/QC representatives. This is especially true where functional failure of the part affects the safety or effectiveness of critical machinery used in weapon systems.

Phase I: Design, build, test and demonstrate a proof-of-concept laser-based testing system that is capable of providing a dimensional characterization of internal and external threaded surfaces.

Phase II: The objective will be the development of a full-scale prototype system that is lightweight, portable, and rugged. The device would be extendible to a wide variety of thread inspection applications both in the machine shop and in QC/QA laboratories.

Potential Commercial Market: The proposed thread inspection technology will find immediate application in a large variety of tasks where nondestructive, high accuracy dimensional characterization of complex surfaces are required. The proposed apparatus will be used in laboratory engineering studies, industrial control, and manufacturing process monitoring and control. The "system" to be designed will provide measurement capabilities mandated by law and often referred to in cited MILSPEC documentation, and which cannot be accurately obtained by other conventional measurement schemes. In addition to the compliance issues, immediate application of the measurement system for thread inspection alone is expected to decrease overall manufacturing costs, increase fastener performance, and decrease maintenance costs.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-052TITLE: Soldier Weapons Improvement by Development of an EMAT (Electromagnetic Acoustic Transmission) System for Non-Destructive Inspection of Cannon Tubes

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate the use of EMAT to detect flaws in cannon preforms and forgings.

DESCRIPTION: An EMAT system has recently been developed which is capable of measuring steel thickness up to 6 inches. EMAT has the potential to be used to detect flaws in steel, but further technology development will be required to address certain problems associated with flaw detection. Among these are: (a) Development of an effective means

of differentiating flaw and noise signals, (b) Optimize the system sensitivity in order to enable detection of small cracks and inclusions.

Phase I: Develop the concept for the system and the methodology to be used to detect flaws in cannon preforms and forgings. Test the system concept on sample material and on actual preforms and forgings.

Phase II: Develop an inspection system capable of flaw detection in forging preforms and in the rough forgings. Provide a report describing the development work and the system.

Potential Commercial Market: In numerous commercial applications, ultrasonics are used as a means of inspecting material for flaws. Conventional methods of generating an ultrasonic wave within a material are limited by the need to be physically coupled by either a solid or liquid bond. The ability to produce an ultrasonic wave without physical contact offers a number of advantages, including reduced inspection time, the ability to operate in remote and inaccessible locations, reduced transducer wear, and the ability to operate at elevated temperatures.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-060TITLE: Automation Friendly Fuze Packaging

CATEGORY: Exploratory Development

OBJECTIVE: To Develop automation-friendly fuze packaging for use with the autoloader technology of future artillery cannon and resupply systems such as AFAS and FARV-A.

DESCRIPTION: Future artillery and cannon resupply vehicles will feature an increased reliance on the automated handling of artillery components. While much work has been done in the areas of autohandling of the projectiles and propellant, little has been done with respect to fuzes. The current packaging for artillery fuzes requires manual access and handling of individual fuzes. A need exists to explore new packaging designs that lend themselves to automation. The result will be direct manpower savings, a decrease in resupply time and a reduction in ammunition logistics costs.

Phase I: The contractor shall analyze established robotic artillery autoloader technology in order to develop container design concepts. A minimum of 2 designs shall be proposed that are consistent with current, state-of-the-art autoloader technology. At the end of Phase I the contractor shall deliver a report that includes an analysis of the autoloader technology and recommends a minimum of two container configurations.

Phase II: Container designs shall be either physically prototyped and/or modeled using computer simulation technology in order to demonstrate their use in the artillery autoloader mechanism. Modifications to the design shall be made as necessary to ensure successful performance of the automated package/autoloader interface. The contractor shall recommend an optimal container configuration for manufacture. If the designs are physically prototyped the contractor shall deliver 10 containers of an agreed-upon design to the U.S. Government for testing purposes. If the designs are modeled with computer simulation technology the contractor shall deliver 3 disk copies, each containing the proposed container design and components, and an animated computer simulation of the interface and functioning of the container in the autohandler mechanism. The contractor shall also deliver a final report detailing the work done in Phase II.

Potential Commercial Market: The technology developed by this study may benefit any industrial process in which components of assembly must be removed from a shipping or storage container and introduced into an automated system. This includes the manufacture of virtually any medium and large size equipment such as automobiles, trucks, appliances, machinery, etc.

OSCR: Automation friendly packaging will allow faster and safer production of the end item. By considering automation interface in the design of the packaging, problems associated with interfacing may be reduced or eliminated. Operating and support cost savings with respect to associated labor, safety, operating efficiency, and waste disposal may be realized.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-067TITLE: Non Destructive Inspection By Infrared Imaging Spectroscopy

CATEGORY: Advanced Development

OBJECTIVE: Develop, build and test a prototype multi-spectral infrared imaging detector system for non-destructive inspection.

DESCRIPTION: Non-destructive inspection (NDI) techniques using infrared can be categorized into two broad areas: detection of material composition from the infrared signature and detection of part or defect geometry from thermal imaging. The former involves measuring the intensity of the spectral components and the lagger involves measuring the energy distribution over a surface. Advances in the technology make it possible to measure the energy distribution of multiple spectral elements over a surface (infrared imaging spectroscopy). This technology is used to determine geological compositional differences. This solicitation is for the development and application of infrared imaging spectroscopy to the field of NDI.

Phase I: The contractor shall demonstrate multiple practical NDI applications for multi-spectral infrared imaging on a laboratory scale. The contractor shall design a prototype industrial grade multi-spectral automated infrared imaging system with broad and significant NDI applications to the military. The contractor shall find potential sources of venture capital for developing the 'SBIR Phase III' market.

Phase II: The contractor shall build and deliver the prototype system designed in Phase I, test it, document its operational characteristics, validate its worth with real NDI applications, and design a production version.

Potential Commercial Market: Commercial and military applications are bountiful. The results will augment our work in data fusion of NDI signals. Applications include imaging variations in material composition of composites, ceramics, plastics, propellants, and gases. Army specific applications range from inspection of printed circuit boards in various munition items for delamination and good solder joints, to determination of contents of foreign unexploded rounds, to bench testing of rocket motor delay assemblies. Three dimensional imaging applications are possible if the sensors are configured for thermal tomography.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-090TITLE: Microscale Sensors and Actuators

CATEGORY: Exploratory Development

OBJECTIVE: Design, fabricate, and test microelectromechanical (MEM) devices for use as microscale sensors and actuators in military and civilian applications.

DESCRIPTION: General - The U.S. Army has identified the need for miniature, low cost, and reliable sensors and actuators for use in tactical military equipment. Recent developments in micromachining technology have made it feasible to design and fabricate microelectromechanical systems using standard semiconductor integrated circuit processing techniques. These microscale sensors/actuators offer significant reductions in the size, cost, and power requirements of conventional sensors/actuators while providing the desired capabilities to the soldier on the battlefield. Collaboration with EPSD and use of EPSD microfabrication facilities for device development are possible. Examples of specific devices of interest are high "g" gyroscopes for smart munitions guidance systems, vibrational sensors for failure prognosis of ground and airborne structures and propulsion systems.

Phase I: Phase I will identify the type of sensor/actuator device to be fabricated and the intended military application. A device design and theory of operation will be presented. Demonstration of the device processing steps required for fabrication must be detailed. A structurally complete prototype device will be fabricated to determine the feasibility of the design and process integration.

Phase II: Phase II will encompass device design and process refinements. Initial device testing should demonstrate the operation of the device. Data must support the concept of operation for use in military environments. Complete fabricated devices will be delivered to conduct initial testing for use in military systems.

Potential Commercial Market: Applications for microelectromechanical sensors and actuators cover both military and commercial systems in areas such as munition guidance systems, failure prognosis of vehicular structures and propulsion systems, automated control and navigation of ground and airborne vehicles, hazardous chemical/biological materials warning and identification, robotic positioning systems, medical drug monitoring, micro surgery, and medical diagnosis sensors.

TECHNOLOGY CLUSTER: A-10

TOPIC: A93-151TITLE: Helicopter Rotor Blade Trailing Edge Control Surface

CATEGORY: Exploratory Development

OBJECTIVE: Develop practical design concept for controlling deflection of a helicopter rotor blade trailing edge control surface.

DESCRIPTION: Rotor blades of modern production helicopters are controlled by changing the pitch of the entire blade at the blade root pitch bearing. Such blades typically do not contain movable trailing edge control surfaces. However, new opportunities for providing flight control and reducing vibratory loads will be possible if a practical capability for controlling the rotor blade trailing edge can be developed. This may be a discrete flap segment or an integral flexible segment of the trailing edge. One approach currently receiving attention is to apply exotic smart materials such as piezoelectric, magnetostrictive, or shape memory alloys. The present topic is specifically addressed toward more conventional approaches, based on exploiting recent technology advances to tailor electromechanical or related devices to the unique requirements of helicopter rotor blades. Such approaches will require small, light weight, efficient, highly reliable, rugged, and rapid response actuation devices for incorporation within the rotor blade airfoil structure. These requirements mitigate against conventional electro-hydraulic actuators, reduction-geared electric motors, and conventional mechanical components such as hinges, bearings, and pushrods to move the trailing edge control surface.

Phase I: Develop and analyze candidate concepts for trailing edge control devices. Evaluate physical and performance characteristics. Select optimum approaches.

Phase II: Carry out engineering design of candidate control device, fabricate and bench test prototype system on a typical rotor blade structure.

Potential Commercial Market: This technology is applicable to commercial helicopters as well as military.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-152TITLE: Damperless Helicopter Rotor Blade

CATEGORY: Exploratory Development

OBJECTIVE: Develop helicopter rotor blade concepts that do not require hinges, bearings, or lead-lag dampers.

DESCRIPTION: Reliability, cost, and performance of helicopters are all improved by advanced rotor systems having fewer parts, especially hinges, bearings, and lead-lag dampers. These components require maintenance, lubrication, and in the event of failure may result in instability or failure of the rotor system. Recent advances in rotor technology have produced bearingless rotor systems that no longer contain blade motion hinges and bearings, but these rotors still retain lead-lag dampers to suppress potential air and ground resonance of soft inplane configurations. Aeroelastic couplings hold the potential to tailor aerodynamic and structural properties to provide inherent stability without need for auxiliary lead-lag dampers.

Phase I: Use analytical methods to identify design concepts and approaches based on optimal aeroelastic and structural design that satisfy air and ground resonance stability requirements.

Phase II: Confirm design concepts by conducting small-scale model rotor testing.

Potential Commercial Market: This technology would have direct application to the commercial rotorcraft market. Commercial benefits include improved affordability through reduced development and operating costs.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-153TITLE: Helicopter Rotor Blade One/Rev Vibration Reduction

CATEGORY: Exploratory Development

OBJECTIVE: Identify methods and techniques for reducing helicopter rotor one/rev vibration.

DESCRIPTION: One component of helicopter vibration is produced by non-identical mass and aerodynamic properties of the rotor blades. These variations between blades result in helicopter vibrations at a frequency equal to the rotational frequency of the rotor. Current techniques for minimizing such vibrations are to minimize blade-to- blade mass imbalance and to maintain quality control of blade aerodynamic contours in the manufacturing process. Innovative research and development may identify additional complementary approaches to reduce this component of helicopter vibration.

Phase I: Explore concepts and conduct analysis of potential candidates to identify and assess effectiveness.

Phase II: Implement engineering approaches, including possible hardware development, and conduct appropriate model or full-scale tests.

Potential Commercial Market: Vibration reduction improves both ride quality as well as reliability. There is direct application to the civil rotorcraft market.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-154TITLE: Composite Rotor Blade Sectional Analysis

CATEGORY: Basic Research

OBJECTIVE: To develop a computational tool which can decrease analysis costs by determining equivalent beam properties for three-dimensional composite rotor blades.

DESCRIPTION: Sophisticated comprehensive analyses of helicopter aerodynamics and structural dynamics phenomena that are beginning to be available have the potential to revolutionize the design process and significantly improve the performance of Army rotary wing aircraft. However, detailed modeling of nonlinear anisotropic rotor blades places an increasing burden on the analyst to prepare input data. The finite element analysis of a composite rotor blade structure would normally require costly three-dimensional methods. However, orders of magnitude less expensive beam methods can be used by first performing sectional analysis to determine beam properties. The sectional analysis of a complicated beam-like rotor blade need only be done once if the blade is spanwise uniform, or only a few times to accommodate typical mild spanwise nonuniformity. Sectional analysis is a two-dimensional problem, the domain of which is a local cross section. The sectional characteristics of a closed cross-section beam are in the form of a symmetric six-by-six stiffness matrix. The sectional analysis also provides a set of displacement and strain influence matrices which, when multiplied by beam strain measures, yield warping displacement and strain over the cross section, yielding an approximation to the three-dimensional solution.

Phase I: Prepare a research code to provide sectional analysis including the recently enhanced theory which incorporates initial twist and curvature. Demonstrate functioning of the code on a suite of test cases.

Phase II: Develop a production level code including a graphical pre-processor providing on-screen view of the cross section coupled with CAD capabilities and with a mesh generator (also viewed on screen), a graphical post-processor providing graphical representation of stress and strain at selected axial positions (as determined in the beam theory solution).

Potential Commercial Market: This technology is applicable to the design of commercial helicopters as well as military helicopters.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-158TITLE: Electronically Survivable Composite Airframe Primary Structures

CATEGORY: Exploratory Development

OBJECTIVE: To design and demonstrate innovative organic composite primary (flight load carrying) structural concepts that satisfy a variety of electrical and electronic threats and design constraints, without imposing unreasonable acquisition, operational or support costs.

DESCRIPTION: Because of exceptional strength to weight performance and certain producibility characteristics, advanced composite materials will be used almost exclusively for the primary structure of the Army's next generation/future systems (NG/FS) air vehicles. Although carbon and graphite fibers have some electrically conductive properties, advanced composite structures can be characterized as empirically non-conductive in the lightning strike, high-frequency, and some other radio frequency environments. Graphite composites can be considered conductive in the ultrahigh and radar frequency ranges. Prior research and development programs have demonstrated that composite structures may inherently provide sufficient electrical shielding and conductivity to satisfy certain avionic shielding and detectability constraints, but require additional metalization or dielectric treatment to provide adequate antenna ground planes, lighting strike protection, or stealth levels. These often conflicting design solutions add considerable weight, manufacturing difficulty and cost to the system.

Phase I: Investigate the current and projected performance requirements and integrated system design solutions for advanced composite airframe structures in the future electrical/electronic environment. Characterize the tradeoffs and penalties in the designs in terms of cost, producibility, weight, strength, and electrical performance for the various solutions. Develop and evaluate innovative design solutions to satisfy the future operational requirements with emphasis on reducing weight and cost impact to primary NG/FS air vehicle structures.

Phase II: Using innovative material system design and processing techniques, fabricate and evaluate through test candidate coupon and test panel structures that would satisfy the requirements identified in phase I. Select and further develop the most promising primary structural concepts for demonstration in generic airframe subsystem components. Evaluate these components in terms of weight and cost, and structural and electrical performance.

Potential Commercial Market: Lightning strike protection, avionic and electrical system shielding and grounding, and antenna performance are all additional cost drivers for composite airframe designs. This technology will enhance use of composite materials in civilian airframes.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-169TITLE: Remotely Piloted Rotorcraft for Cargo Delivery

CATEGORY: Exploratory Development

OBJECTIVE: Define a required aircraft subsystem to accomplish a remotely piloted rotorcraft cargo delivery mission.

DESCRIPTION: Define the Mission Equipment Package (MEP) and aircraft control systems required to allow a remotely piloted rotorcraft to deliver cargo in a warfighting environment. The rotorcraft systems must be able to handle such unexpected eventualities as terrain, obstacles and threats and still reach destination. The MEP will require systems to provide obstacle avoidance, position/location of aircraft, route planning communication/navigation, threat warning, etc. to accomplish the mission.

Phase I: The objective of Phase I is to define the required sensors and aircraft subsystems to allow a rotorcraft to be operated remotely to travel to a designated position, land/deliver cargo, and return to a designated position. Decision aiding or expert systems may also be required. The mission would cover day and night operations throughout the entire battlefield.

Phase II: The objective of Phase II is to define the required sensors and aircraft subsystems to allow a rotorcraft to autonomously perform the cargo delivery mission of Phase I.

Potential Commercial Market: The results of Phase II could be applied to commercial delivery systems, within warehouses or possibly within town/cities.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-175TITLE: Helicopter Weapons Deployability, Operability, and Supportability

This topic is CANCELLED.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-178TITLE: Affordable Technology for Magnetic Signature Duplication

CATEGORY: Advanced Development

OBJECTIVE: To develop affordable technologies for defeating magnetic fuzed mines to support a Milestone II decision.

DESCRIPTION: Magnetic-Influence-Fized (MIF) landmines are in the inventory of many nations throughout the world and have become a significant threat to maneuver forces. These mines target the magnetic signature of vehicles allowing precision full vehicle-width attack. The Vehicle Magnetic Signature Duplicator (VEMASID) system was designed to defeat these mines by projecting a magnetic signature ahead of the vehicle. VEMASID was Type Classified for Low Rate Production in Feb 91; however, the user subsequently decided that the cost of the system was too high and terminated the program. The intent of this effort is to demonstrate more affordable techniques and technologies to protect vehicles from MIF mines using magnetic signature duplication. The system will be required to actuate at least 95% of MIF mines in a path 1.2 times the width of the vehicle in the battlefield operational environment. The requirements of the VEMASID ROC (Required Operational Capability), 19 Feb 86, apply. The ability to defeat multi-axis magnetic influence fuzes is desired.

Phase I: This effort would result in a brassboard system suitable for testing on an M109 Howitzer and data sufficient to support a conclusion that the system could be made affordably.

Phase II: This would extend the development to fabricate engineering prototypes for environmental, reliability and performance testing and to more fully develop affordability data.

Potential Commercial Market: Phase III would encompass preparation of program documentation for presentation to the PM for Mines, Countermine and Demolitions and to TRADOC in support of Milestone decisions leading to production and fielding. This effort addresses S&T Thrust in Advanced Land Combat and the Star 21 focal values for affordability and casualty reduction.

OSCR: 1 & 4 Field Diagnostics/Prognostics. Predict a failure before it happens, thus preventing premature failure and unnecessary maintenance actions. Power saving technologies that can reduce overall power usage and improved battery systems.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-181TITLE: Diesel and JP-8 Homogeneous Mixture Fueled Rotary Engine

CATEGORY: Advanced Development

OBJECTIVE: Develop Diesel and JP-8 homogeneous mixture fueled rotary engines.

DESCRIPTION: The Army needs light-weight, quiet and high power/weight ratio Diesel and JP-8 fueled engines.

Phase I: Develop the necessary design changes and predict the diesel fueled engine performance based on combustion analysis and the gasoline engine manufacturer's published data. Demonstrate the predicted performance with breadboard testing.

Phase II: Fabricate two prototypes of the diesel/JP fueled hardware using production gasoline rotary engine cores. Potential Commercial Market: The diesel rotary could be used in any of the gasoline applications where the weight, size and vibrations of the reciprocating Diesel engines of comparable powers are prohibitive. This effort addresses S&T Thrusts in advanced land combat and the Star 21 focal values for electric drive technology.

OSCR: #6 Technologies which significantly reduce fuel consumption (e.g. new engines, reduced vehicle weights, improved fuel/lubricants, new vehicle types (electric drive)) or improved fuel distribution is important to this topic.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-213TITLE: Programmable Logic Controller Energy Management Programs

CATEGORY: Exploratory Development

OBJECTIVE: Develop application programs for Programmable Logic Controllers related to energy management.

DESCRIPTION: Programmable Logic Controllers (PLCs) have been proven by USACERL in the laboratory to have the capability to be used in a cost effective way to control Heating, Ventilating, and Air Conditioning (HVAC) processes. There do not exist however any application programs for energy management functions such as demand limiting, night setback, and optimum start stop. PLCs have many advantages over current HVAC control hardware, but will not be considered for Army wide use until the capability to perform energy management functions is proven. The use of such devices would greatly impact creature comfort and operating/support cost reduction.

Phase I: Determine at what level in a networked system of PLCs application programs can be best implemented and develop some prototypes. It is expected that some will be found to be most easily implemented at the PLC level while others would be best implemented at a centralized location. The capability to perform energy management functions will be evaluated and the advantages/disadvantages of PLCs over the currently used hardware in a networked system will be assessed. The results of this assessment will be used to determine the benefits of pursuing the development of a full range of energy management programs

Phase II: Develop and implement a foul range of application programs for PLCs. The application programs will be heavily oriented towards energy management functions such as demand limiting.

Potential Commercial Market: Installers of HVAC control systems would initially be the major purchaser of this product. This includes end users who install their own equipment and control contractors who do this for a living. The successful implementation of this product would open up an entirely new market for the PLC manufacturers and thus it is expected that they would purchase such a product or enter into a licensing agreement in order to sell their PLCs along with it as one integrated package. Another consumer of this product would be the so called system integrators. These firms specialize in the integration of computers, control equipment, and machinery. This product would allow them to integrate Heating, Ventilation, and Air Conditioning (HVAC) systems with PLCs which already control other types of machinery. The potential of this portion of the market is enormous due to the large number of existing PLCs.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-216TITLE: Sensors for Intelligent Low-Maintenance Corrosion Control in Industrial Water Systems
CATEGORY: Exploratory Development

OBJECTIVE: Develop a low-maintenance sensing package which is capable of accurate, automated measurement of key water chemistry parameters in boiler water and cooling tower systems.

DESCRIPTION: Lack of manpower resources has made it increasingly difficult for US Army installations to maintain water treatment programs for corrosion and scale control,particularly for boilers and cooling towers. Recommended periodic testing, evaluation, and analysis of problems is not done, therefore necessary adjustments to the water treatment program are not made. This results in a greatly shortened service life and reduced energy efficiency of such equipment. At some installations, boilers which are designed to last for 30 years routinely fail due to corrosion in 5 or 6 years. The heat loss due to a 1/16 inch buildup of scale on the tubes of an 80% efficient boiler which generates 50,000lbs/hr of steam results in an excess annual fuel cost of approximately $180,000. The solution is a low maintenance, automated, self-diagnostic and self-adjusting treatment system for boiler and cooling tower water. Such a system would perform water chemistry testing at the required intervals, diagnose problems, and adjust chemical feed rates accordingly or sound an alarm if it cannot correct the problem itself. The focus of this work is the development of a low-maintenance sensing package to perform testing of key water chemistry parameters and to provide electronic input for the control system.

Phase I: Identify key boiler water and cooling water parameters related to corrosion control. Identify and evaluate candidate low-maintenance sensing techniques for automated measurements of these parameters.

Phase II: Fabricate a prototype low-maintenance sensing package for automated measurement of the parameters identified in Phase I.

Potential Commercial Market: This device would have many commercial applications and would be valuable for almost any user who is responsible for the operation and maintenance of boilers and cooling towers. Industrial plants, power plants, military/government installations (particularly those at remote locations), and universities are examples of potential users.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-217TITLE: Development of Operating and Support Cost Reduction Processes in Building Construction
CATEGORY: Exploratory Development

OBJECTIVE: Develop products to enable Army facility engineers to more efficiently maintain the buildings, utilities, grounds, and supporting environmental systems. The objective is to produce products that have wide application in the building maintenance industry and that have significant impacts on reducing the cost of maintenance.

DESCRIPTION: The US Army is currently undergoing budget restraints that require drastic measures if facilities are going to be maintained in a manner to ensure a continued READY Army. The Army inventory of roads, buildings, underground piping, bridges, railroads, electrical and fluid distribution systems, heating/air conditioning systems, etc. is extensive. Budgetary constrains dictate that a better way of maintenance must be found. The Army and the nation is looking to the research community to provide new (and use existing) technologies to help get the job done with less.

Phase I: Develop and prove the concept of an innovative approach continued (or increased) quality of service.

Phase II: Develop a marketable product that is affordable and that greatly reduces maintenance costs on one or more aspects of facility maintenance. Provide a working model to USACERL at the end of the Phase II development.

Potential Commercial Market: Facility maintenance is not unique to the US Army. State and local governments and private industry all spend large amounts of money in maintaining facilities of varied size and type. The impact of a new and extremely high market potential.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-228TITLE: Development of Crashworthy W-Beam Guardrail Manufactured from Light-Weight Fiber Reinforced Plastics (FRP)

CATEGORY: Engineering Development

OBJECTIVE: This project is to evaluate the feasibility of using lightweight FRP for guardrails. The goal of this project is to produce FRP guardrails that have been tested for environmental durability and highway safety performance and are ready to be marketed.

DESCRIPTION: Highway and roadside safety is an ever-increasing concern for the Army, other DoD Agencies, the Federal Highway Administration, and state highway departments. Highway guardrails are presently manufactured from common materials such as aluminum, steel, and concrete. The use of a new engineering material, Fiber Reinforced Plastics (FRP), has been proposed for applications where a standard W-Beam guardrail has previously been installed. Because of improved crash worthiness, light weight, and corrosion resistance, application of FRP in the construction of guardrails is attractive for higher safety and lower costs in erection and maintenance. Since many thousands of miles of W-beam located along roadways exists both nationally and internationally, there exists significant potential for widespread use of FRP guardrails for infrastructure rehabilitation.

Phase I: The contractor will investigate current manufacturing processes and develop new techniques to produce FRP W-beam-profile guardrails. Required physical properties include a minimum tensile strength of 70,000 psi and Young's modulus of 3,000,000 psi. Results of this work will be documented in a report. Samples of the prototype FRP W-beam guardrail totaling 100 ft. in length will be provided.

Phase II: The contractor will conduct laboratory testing and analysis to evaluate mechanical performance of the produce including effects of cold weather, ultrviolet light degradation, water resistance and flammability. The product will be subjected to full-scale vehicle crash testing at a Federal Highway Administration (FHWA) test facility, and after a successful testing, approval of the FHWA will be solicited to install the experimental guardrail on highways. As a minimum, six locations in the United States will be selected covering different climatic zones, from the very hot and humid environment of the south to the severe cold climates of Alaska. The installed guardrails will be monitored for a year for indication of any degradation, or if any accidental crash has happened, the modes of failures. The results of FHWA crash test and field tests will be documented in the final report.

Potential Commercial Market: If the results prove to be commercially attractive, the research team will quickly transfer the technology and market the product. As a constructor and owner of roadway systems, the Corps of Engineers and the rest of the Army will be a user of this advanced guardrail technology. State DOT's and other local governments will also find applications in highways and local roads. This technology will have direct relevance to many infrastructure rehabilitation applications.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-232TITLE: Development of an Asset Oriented Approach for Facility Lightning Protection

CATEGORY: Exploratory Development

OBJECTIVE: There is currently no generally accepted single methodology or approach for the evaluation of the vulnerability of systems to the effects of lightning or for the protection of systems from lightning. Such an assessment method could be used for design verification, maintenance, protection evaluation, or as a support tool for writing specifications. For example, one might hope that there would be some approved standard for such an approach, but none presently exists. The methodology currently accepted for lightning protection design occurs by default and is varied. In some cases, installing a lightning protection system (LPS) according to a standard, for example, the National Fire Protection Association (NFPA) 78, Lightning Protection Code, is adequate for insurance companies to provide insurance against lightning damage. In some cases, specialized companies using semi-quantitative methods but relying mainly on engineering judgment, survey a system and make recommendations of the LPS. Often such assessment are performed by people who are selling LPS hardware and for whom there is a conflict of interest. In some cases, an assessment might be a back-of-the-envelope type of assessment such as the one defined in the NFPA 78, Appendix I. Assests normally being protected can include the facility structure, the safety of personnel, equipment, wiring and electronic circuits, and sensitive materials such as explosives. The threats from a lightning strike can include: 1. Direct effects--where the asset is damaged by being in a direct path of all or part of the lightning current. 2. Indirect effects--where the asset is damaged by electric or magnetic fields generated by nearby lightning current. Existing manuals and specifications provide a list of things to do for lightning protection without consideration of a system's peculiar susceptibilities. The susceptibilities of assets depend on various operational configurations such as an explosive being stored in a closed container or exposed for maintenance. Closed containers usually have seams or cable penetrations which can allow the entrance or lightning energy. Those effects need to be evaluated. The objective

of the effort is to develop an asset oriented evaluation and protection design methodology. This methodology will be packaged in a user friendly PC based expert system, which will be oriented towards project engineering staff.

DESCRIPTION: There are several problem areas to be addressed in this effort: 1. The usual LPS design specifications are concerned mostly with preventing side flashes: that is keeping the lightning current confined to the rods and cables comprising the LPS plus all the other metal and electrical grounding circuits which are electrically connected to the LPS. This design criteria favors the protection of building structure and the prevention of fires in combustible structural elements or the presence of flammable vapors. The criteria can compromise personnel and equipment safety in some cases and does not consider the effects of the electric and magnetic fields or internal objects connected to the LPS, nor the proximity of assets to any of the elements of the LPS. The geometrical arrangement of the LPS and the connected metals and electrical grounds will dictate the vulnerable geometrical locations of the assets, because electric and magnetic field intensities have a spatial dependence in and around the LPS. 2. The vulnerability of assets to direct or indirect effects may not be known precisely enough to judge the "safe" areas within a facility-LPS system. Conversely, the facility-LPS system may exist or be built without knowing the vulnerability of assets it may need to protect in the future. However, an existing facility may be "rated" at a particular "safety level" and statistically "safe locations" within the facility may be declared. It may then be determined whether or not a particular asset is "safe" within that environment. 3. Any asset oriented approach needs to be easily available and understandable to a non-lightning expert.

Phase I: 1. Categorize the threat tolerance of typical assets to both direct and indirect effects. (There may be several operational configurations of a particular asset with varying degrees of exposure to threat). 2. Determine safety levels within the working volume of typical existing facilities using testing and mathematical modeling of typical facilities. 3. Determine optimum geometries for LPS design in future facilities given a set of typical assets which need protecting. 4. Obtaining generic sensitivities to electrostatic discharge (ESD) will require analysis i.e., primary explosives, pyrotechnics, propellants, high explosives, and vapors, dust and gases evolving for specific operations. 5. Develop a PC-based expert system which can perform lightning protection design and evaluation of facilities and collocated assets.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-264TITLE: Innovative Annular Motorcase Shell Designs

CATEGORY: Exploratory Development

OBJECTIVE: Innovative filament wound annular motorcase shell designs are desirable that will eliminate current difficulties in the strain rates of the inner and outer cases, discontinuity forces at end closure and body intersections, and compressive instability of the inner shell.

DESCRIPTION: During the burn cycle of annular motorcases, the inner and outer shells are thermo-mechanically loaded as a result of the burning propellent. These loads cause the inner and outer shell to strain at different rates in the current designs. This difference in strain rates creates loads in the propellent that can threaten the integrity of the motorcase. These motor-mechanical loads can also cause discontinuity forces at the end closure and end body intersections which can lead to premature failure in this region. These thermo-mechanical loads also cause the inner shell to be in a highly compressive state of stress that typically leads to a compressive instability in the shell.

Phase I: Develop an innovative annular motorcase design that features inner and outer sheels that strain at simular rates under thermo-mechanical loading, end closure and end body intersections with minimal discontinuity forces, and a stiffened inner shell.

Phase II: Fabricate a prototype annular motorcase with the features developed in Phase I. Experimentally evaluate the performance the motorcase and the features developed in Phase I in improving the integrity of the motorcase.

Potential Commercial Market: There is a potential commercial market in numerous areas that utilize or will utilized advanced composites structures on a broad range from advanced missile weaponry to airplanes and swimming pools.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-276TITLE: Non Eroding Nozzle Material Development

CATEGORY: Exploratory Development

OBJECTIVE: Missile control nozzles require precise and predictable performance. Current nozzle materials erode during service and in systems containing a number of control nozzles, the differences in erosion in the nozzle throats results in control compensations being required. A non-eroding nozzle material system is sought which will provide either no erosion, or small and reproducible erosion, of the nozzle throat. Multiple material systems should be considered to include carbon-carbon, metal and phenolic. Multiple material nozzles present material incompatibilities during processing which must be understood and provided for in the overall design.

DESCRIPTION: Co-processing of metal or carbon-carbon inserts are being considered for a non-eroding nozzle assembly. These multimaterial configurations induce thermal stresses, and hence the possibility of cracking between materials either during processing or firing.

Phase I: The Phase I effort will require analytical modeling of conceptual nozzles to define the magnitude of the thermal stresses developed, residual stresses after processing, and methods of reducing those residual stresses. Multiple material nozzle designs should be considered, with composite materials being designed to minimize the residual thermal stresses.

Phase II: A Phase II effort will demonstrate the design concepts by fabricating several components. Analytical tools must be demonstrated to be capable of predicting the nozzle residual stress states. Combined material and configuration optimization will be sought in the Phase II effort.

Potential Commercial Market: There is a potential commercial market in numerous areas that utilize or will utilize advanced composite structures on a broad range from advanced missile weaponry to airplanes and swimming pools.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-280TITLE: Unstructured Grids for Computational Fluid Dynamics Applications

CATEGORY: Exploratory Development

OBJECTIVE: To develop revolutionary and innovative techniques for the application of unstructured grids in computational fluid dynamics to viscous dominated problems.

DESCRIPTION: Unstructured grids for computational fluid dynamics (CFD) applications offer a great potential for the improved design of any missile component that is governed by aerodynamic considerations. Unstructured grids have been used for many years in the area of structural analysis using finite element methods. It has only been in the past few years that this gridding technique has been applied to the coupled set of partial differential equations of fluid dynamics as opposed to the set of ordinary differential equations used in finite element structural analyses. In particular, these grids have been used very successfully for stage separation problems in multi-stage missiles. However, these solutions have been obtained only for the Euler formulation of the governing set of partial differential equations. To date, there has been no truly successful application of unstructured grids to viscous problems; yet, a successful application of these techniques to a viscous problem would revolutionize computational fluid dynamics by providing a method to solve problems with complex geometries and strong viscous dominated characteristics. To overcome this limitation, research is required in the following areas: 1. Non-orthogonal grids - The use of non-orthogonal grids have led to unstable solutions which become more unstable in direct proportion to the non-orthogonality of the grid. Algorithms are sought which do not exhibit this trend. 2. Numerical turbelence - The generation of numerical turbulence in a CFD solution is affected to a great extent by the skewness of the grid. This trend needs to be investigated to determine what factors are important in the algorithm that enhances or suppresses this numerical turbulence. 3. Turbulence model/Grid Interaction - Depending on the turbulence model used, e.g. algebraic or TKE, the CFD solution becomes more or less stable. This phenomena needs to be understood such that less sensitive solution algorithms can be developed.

Phase I: Technical approaches will be formulated for research into each of the above problem areas. At least one innovative approach will be executed through numerical experiments to assess the feasibility for improvement.

Phase II: The additional approaches formulated in Phase I will be finalized, executed, and documented leading to the incorporation of an unstructured grid capability not an existing Government computational fluid

dynamics model. The advanced CFD model will be run for a series of test cases which can demonstrate the ability of the unstructured grid methodology to treat viscous dominated problems.

Potential Commercial Market: The past few years has seen an enormous growth in both the development and application of the computational fluid dynamics throughout commercial industry. The revolutionary and innovative application of unstructured grids to viscous dominated problems would open a vast new area to the application of computational fluid dynamics.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-283TITLE: Atomization of Diesel Fuel for Combustion

CATEGORY: Exploratory Development

OBJECTIVE: Develop a laboratory prototype of a field burner operating on the principles of atomization.

DESCRIPTION: Fuel burners currently in use in field feeding equipment use vaporizing technology, requiring pressurization to achieve cold starting. For safety reasons, the burners must be fueled and preheated away from the cooking area and transported, while lit, back to the food preparation area. Advances in technology applied to atomization of fuel, such as lasers to break up fuel into fine droplets for more complete combustion and thermolectrics to more efficiently power the system, suggest the potential for designing a field burner that is clean burning, low in power consumption, with variable firing rates of from 1-3 lbs/hr. Additional goals are to produce a field burner that is rugged, lightweight, easy to maintain, and burns cleanly enough for the product of combustion to be in contact with food.

Phase I: Phase I will investigate and define the best design approach to allow atomization to occur at low firing rates now required for use with existing field equipment. Power requirements will be defines and addressed through the use of the latest technology and trade-offs identified between function, weight, volume, safety, and reduced cost (both initial procurement and O&S). Based on the results, a model will be presented for approval by the funding agency.

Phase II: Phase II will provide a working prototype to demonstrate the practical application of the new design with existing field feeding equipment.

Potential Commercial Market: Advances in burner atomization will increase the efficiency of fuel-fired home heating units.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-288TITLE: Development of an Immersion Water Heater for Field Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop Immersion Water Heater for multiple applications.

DESCRIPTION: Hot water for general use in the field is obtained by heating water in an open corrugated can using a liquid fuel-fired immersion heater. The heater and fuel tank are clamped to the side of the can such that the enclosed burner is immersed in the hot water. Fuel from the tank is introduced into the burner and a diffusion flame is established with the required draft provided by a tall stack. The heater is designed to operate with gasoline as the normal fuel and diesel as an emergency fuel. The overall requirements of this project shall include the development of new technology in terms of novel concepts for combustion and heat transfer that will result in a new immersion water heater design which provides clean, reliable and safe operation using a wide range of fuels, including diesel (primary), JP8 and gasoline. The new immersion water heater shall have a nominal rating of 35,000 BTU.

Phase I: The contractor shall conduct an evaluation of all requirements, an evaluation of the engineering and scientific feasibility of the project and development of an initial prototype design with supporting data and engineering sketches (level I).

Phase II: The contractor shall fabricate the prototype immersion water heater as presented in Phase I and as accepted by the Government.

Potential Commercial Market: Product of potential use in camping, outdoors recreation market. Also of potential use in disaster relief.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-291TITLE: Closed-cycle Regenerative Field Refrigeration (CRFR)

CATEGORY: Exploratory Development

OBJECTIVE: To develop a nonpowered (nonelectric) closed-cycle solid-gas sorption refrigeration system for storage of perishable subsistence.

DESCRIPTION: Conventional field refrigeration systems require electric power, which is historically not available for field food service. The mechanical vapor compression systems are prone to failure, especially in harsh desert environments. Moreover, they use environmentally destructive CFC refrigerants. Other nonpowered refrigeration systems based on the Electrolux-Servel ammonia/water cycle are limited by size due to the use of a bubble pump. For smaller applications, ice chests require the availability of ice and are only effective for a short time. Accordingly, the CRFR should be designed with an adsorption material that can be cycled to absorb and desorb a working fluid/vapor such as ammonia or alcohol by alternating cooling and heating with either a reversible heat transfer oil loop or low grade combustion exhaust. There should be no mechanical parts other than a reversible control valve. Weight and bulk should be minimized for transportability. There are two desired regrigerator capacities. A small CRFR (8 cubic feet) with one adsorption bed for one or two day missions that could be regenerated at a central location. A large CRFR (150 cubic feet) with at least two adsorption beds for constant refrigeration.

Phase I: In Phase I the basic operative principles shall be investigated through the design and development of a proof-of-principle 8 cubic foot prototype, and the overall feasibility of the concepts shall be evaluated.

Phase II: A practical 150 cubic foot prototype shall be developed in the second phase to be used for preliminary field demonstration (6.3A).

Potential Commercial Market: Disaster relief, emergencies, remote areas, third world countries, recreation, recreation vehicles (vans and yachts).

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-292TITLE: Diesel-Fired and JP8-Fired Lantern for Field Use

CATEGORY: Exploratory Development

OBJECTIVE: Development of a compact, portable, cleanburning, efficient field lantern fueled by diesel and JP8.

DESCRIPTION: With the current plan for a single fuel Army, there is a need to replace the current gasoline-fired lantern with one capable of burning diesel or JP8 fuels. Current lantern designs do not efficiently burn diesel fuel, particularly at low temperatures. The overall requirement of this project shall include the development of a compact, easily portable lantern capable of operating cleanly and efficiently on diesel or JP8 fuel. The lantern shall be capable of operation in temperature extremes ranging from -40 to 120 F. The lantern shall be durable enough for field use and transport and shall require no external power source. The lantern shall provide a minimum output of 250 Candle Power.

Phase I: Phase I shall include evaluation of all requirements, evaluation of the engineering and scientific feasibility of the project, and development of an initial prototype with supporting data to prove the concept.

Phase II: Phase II shall include the development of a portable diesel/JP8-fired prototype lantern suitable for field evaluation.

Potential Commercial Market: Product is of potential use for the camping and outdoors recreation industry.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-298TITLE: Modular Microclimate Conditioning System

CATEGORY: Exploratory Development

OBJECTIVE: Develop a man-portable, lightweight, compact and modular cooling, heating and air purification system for the Individual Soldier.

DESCRIPTION: A modular cooling, heating and air purification system must be provided to protect the combat soldier in all environments, including NBC environment. The microclimate conditioning system must weigh 10 or less pounds and must provide the encapsulated soldier with the ability to conduct missions of up to 12 hours in duration regardless of ambient temperatures and humidity with the actual duration being dependent on the work rate.

Phase I: Investigate the feasibility of potential conditioning technologies and identify those that show high potential in meeting the stated objective.

Phase II: Develop a working prototype of one or more of the technologies identified in Phase I and demonstrate the effectiveness of the system against performance criteria.

Potential Commercial Market: Use in the entertainment industry by those in full body costumes, use in humanitarian relief efforts i.e. Somalia.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-351TITLE: Concurrent Engineering (CE) Tool for Diagnostics

CATEGORY: Exploratory Development

OBJECTIVE: The Concurrent Engineering (CE) tool for diagnostics will help automate the testability/support aspects of a system design and implementation.

DESCRIPTION: The tool will use automated preliminary design criteria (i.e., BHDL, CAD models, etc.), for early models and be refined as the system design matures. The CE tool will supply a cost benefits analysis of the system, and supply necessary documentation for design reviews.

Phase I: This phase will evaluate the technology and propose a development of necessary software. A demonstration of feasibility is highly desirable.

Phase II: This phase will deliver a working prototype to prove the proposed benefits.

Potential Commercial Market: The purpose of this SBIR is to encourage the incorporation of "testability" in the system design process so design for testability has the same weight as other system design criteria.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-352TITLE: Prognostic Methodologies for Electronics or Mechanical Systems

CATEGORY: Exploratory Development

OBJECTIVE: Investigate new technologies which can be used in the evaluation of a system or equipment for potential or impending malfunctions.

DESCRIPTION: Currently we have no field usable tool that can predict whether a weapon system can accomplish a required mission. We have mathematical algorithms to perform prediction/forecasting analyses, however, these require manpower intensive actions to input data necessary for predictions and forecast. In addition there is little information available on the kinds of information that would provide the best input elements for prognostics. This task is to develop a usable real time prognostics tool to supply usable information to the field mechanic on potential or impending malfunctions on his system and to investigate the types of input data that should be used in such a tool.

Phase I: This phase will consist of a feasibility study and proposal. A demonstration of feasibility is highly desirable.

Phase II: This phase will deliver a working prototype to prove the proposed benefits.

Potential Commercial Market: These prognostic technologies will be able to predict the health of a system and would be applicable to such areas as system safety, supply and mission planning.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-364TITLE: Equipment and Procedures for Placement of Dowel Bars in Hardened Concrete

CATEGORY: Exploratory Development

OBJECTIVE: Develop equipment and procedures for the insertion and proper alignment of dowel bars for load transfer in hardened concrete.

DESCRIPTION: The procedures and equipment developed should provide for the placement of dowel bars in the proper alignment. It is assumed that the holes shall be pre drilled to a diameter just slightly greater than that of the dowel to be inserted and with proper orientation and spacing. It is desirable that the majority of equipment selected or modified be commercially available from several manufacturers. Detailed construction procedures and equipment are required covering hole preparation and insertion to assure requirements for placement and orientation are satisfied.

Phase I: Possible procedures and equipment should be evaluated for proper placement of the dowel bars. The most promising procedures and equipment should be selected for initial testing and evaluation. Information should be obtained concerning ease of installation, costs, and effectiveness. Final procedures and equipment should be detailed in a specification format.

Phase II: Demonstrate the procedures and equipment in the field for proper placement of dowel bars. Verify proper orientation and that all void areas around the dowel have been filled with the bonding epoxy cement.

Potential Commercial Market: Concrete pavement rehabilitation (load transfer between slabs is crucial for long term pavement performance).

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-365TITLE: Ground Penetrating Radar for Pavement Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop an instrumentation system, based on ground-penetrating short-pulse radar (GPR), that is capable of producing a continuous readout of pavement layer thicknesses and depth to bedrock.

DESCRIPTION: The GPR system should be micro-computer controlled and should contain all electronics, interface equipment, and software necessary for data acquisition and interpretation. The system should be adaptable to standard vehicles or nondestructive test (NDT) equipment such as the falling weight deflectometer. The system should be capable of operating in a continuous mode with color graphical and digital output. The system must be rugged and well suited for field use. Instruments exposed to the elements shall be operable in the temperature range of minus 10 to plus 50 degrees Celsius and shall tolerate relatively high humidity, rain or spray, and all other adverse conditions such as dust, shock, and vibrations that may normally be encountered. Instruments not exposed to the elements shall be operable in the temperature range of 5 to 40 degrees Celsius. The system should contain multiple antennae capable of continuously resolving surface, base, and subbase layer thicknesses within 3 feet of the pavement surface while simultaneously searching for bedrock to a depth of 20 feet.

Phase I: Design a prototype test configuration with associated software that is self calibrating and capable of providing a continuous readout of pavement layer thicknesses and depth to bedrock. Include laboratory and field tests to validate antennae design and frequency requirements. Submit results to Army sponsor for design review. Include data flow diagram, software development plan, equipment layout and interconnect diagram, system specifications, and test results.

Phase II: Finalize the approved design and fabricate a GPR system in accordance project requirements for continuous pavement layer thickness measurement and simultaneous detection of depth to bedrock. Test and validate the performance of the system under controlled lab conditions and with a range of actual pavements. Furnish the results and working system to the Army sponsor for evaluation.

Potential Commercial Market: This system will be directly applicable to all types of pavements, including airfields, roads, streets, parking lots and building floors with a wide range of DOD, DOT, State, and commercial applications.

TECHNOLOGY CLUSTER: A-10
TOPIC: A93-366TITLE: Laser Range Sensor for Pavement Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop a laser sensor and associated test interface equipment necessary for continuous measurement of pavement profile and deflection under loading.

DESCRIPTION: The laser device should be micro-computer controlled and should contain all electronics, interface equipment, and software necessary for data acquisition. The system should be adaptable to a variety of test vehicles and capable of operating in both continuous and static modes. The system should be capable of accurately measuring the deflected profile for a moving wheel load. A deflection basin defined continuously from the load axis radially outward to a minimum distance of 72 inches is required. The system must be rugged and well suited for field use. Instruments exposed to the elements shall be operable in the temperature range of minus 10 to 50 degrees Celsius and shall tolerate relatively high humidity, rain or spray, and all other adverse conditions such as dust, shock, and vibrations that may normally be encountered. Instruments not exposed to the elements shall be operable in the temperature range of 5 to 40 degrees Celsius. The system should be capable of continuously measuring vertical movement of a pavement with an accuracy of +/- 2 percent or +/- .08 mils, whichever is greater; and if recorded, the minimum resolution shall not be more that .04 mils.

Phase I: Design a prototype sensor to evaluate the feasibility of meeting project requirements using laser technology. This should include laboratory tests on pavement samples to validate optical system model calculations concerning all critical parameters of a laser range sensor including precision, bandwidth, and laser power. At this point a design review will be held. The system design will be furnished to the Army sponsor. Include sensor design, top-level functional block diagram, data flow diagram, software development plan, equipment layout and interconnect diagram.

Phase II: Finalize the approved design and fabricate a laser sensor system in accordance with project requirements for continuous surface profile and pavement deflection measurements. Test and validate the performance of the system under controlled static lab conditions and dynamically with actual pavements. Furnish the results and working system to the Army sponsor for evaluation.

Potential Commercial Market: This technology represents a new generation of pavement measurement equipment and can be used to advance and improve analytical and performance prediction capabilities. This system will be directly applicable to all types of pavements and railroads with a wide range of DOD, DOT, State, and commercial applications.