Center for Soldier Innovation (CSI)

Enhancing Human Performance for the Warfighter and Homeland Defender/Emergency Responder Communities

A new business opportunity through strategic collaboration with Natick Soldier Systems Center, MA companies and Universities

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Table of Contents

1 Executive Summary

Draper Laboratory (Draper), working with representatives of the Natick Research, Development and Engineering Center (RDEC) / Natick Soldier Systems Center (NSSC)[1] Science and Technology Board, proposes a Center for Soldier Innovation (CSI) in the Metro-West Region of Massachusetts. The CSI will establish and grow an economic engine that will align the capabilities and focus of Massachusetts companies and universities with key mission areas of the Natick Soldier System Center. The objectives for this enterprise include:

- Enable close cooperation between Massachusetts organizations and the NSSC,
- Increase Massachusetts development and manufacture jobs,
- Stimulate new company creation and
- Enhance Massachusetts STEM workforce development.

The goals of the CSI are as follows:

- Capture $29 million in federal and commercial funding the first five years of operation
- Transition products initially developed and demonstrated for military applications to broader commercial markets
- Spin-out multiple start-up organizations ready to seek venture funding.

The CSI will specifically address the critical and unmet needs for the *Soldier*, where *Soldier* is defined as those men and women that protect, serve and defend us; the *warfighter* in the Army, Navy, Air Force and National Guard, and *homeland defender* e.g., fire fighters, law enforcement, Coast Guard, Border Patrol agents and emergency medical staff. The process for selecting program initiatives will include determining the potential for broad adoption in commercial markets, providing a pathway to high volume manufacture and low unit cost for the warfighter and homeland defender.

1.1 Problem Statements

(A) Customer Need - Recent world-conflicts, hurricanes and transportation accidents have demonstrated the ***critical need for enhancing the endurance and capability of the individual warfighter***, homeland defender, and those in occupations where vigilance and alert action is required to maintain public safety. These same technologies transfer to a broad range of commercial applications, including home care and sports performance.

(B) Growing Jobs - Massachusetts ranks #1 in the nation in its ability to attract federal, industry and academic funding[2]. World-renowned education and specialized cutting-edge firms fuel our economy. And yet, technology and manufacture companies continue to exit

Massachusetts. This significant funding helps draw many of the highest capability students in the world to Massachusetts; however, the large majority of these students leave Massachusetts when their training is completed. A key reason – we do not have sufficient technology and manufacture jobs here in Massachusetts to retain these future leaders[3]. With the exception of MIT, Massachusetts universities do not produce significant numbers of new start-up companies (a major driver for technology and manufacture job growth). Also, Research and Development (R&D) funding directed toward commercial companies is typically applied to strengthening existing product areas; it is difficult to justify the long-term investments in basic research and prototype development needed for companies to establish themselves in new emerging product areas – investors push for rapid return on investment.

The strong Massachusetts technology economy has established an important benchmark in the nation for others to follow. In response, other progressive States are working hard to attract technology companies to their State***. Florida, Virginia, Ohio, North Carolina, Pennsylvania are aggressively working to promote the creation of new technology/manufacture companies and building sustainable industry clusters***[4]. We must act now – Massachusetts must continue to innovate to maintain its edge as the national and international leader for science and technology.

(C) Retaining Military Leadership in Massachusetts - The ***Natick Soldier Systems Center needs an industrial and university community that truly understands soldier needs and environments*** and that can be called upon for rapid reaction solutions and to assist in developing the programs which address the emerging future warfighter and homeland defender needs. Lack of a strong external support community and available workers, diminishes the capability of the NSSC. The US Army Aberdeen Proving Ground (APG) for example benefits from a community support infrastructure. As a direct result of the supporting cluster groups around APG, the mission of the APG continues to expand. Jobs (both for APG and local community) have dramatically increased[5]. In addition, the availability of new workers with Science, Technology, Engineering, and Math (STEM) skills is critical for DoD laboratories to be successful in developing the leading edge technologies for our warfighters. STEM-based jobs are growing at twice the rate of other jobs, yet the number of STEM-based degrees has remained flat nationally for the past 10 years[6]. This disparity creates a significant competition between the DoD laboratories and industry.

1.2 Basic Proposal

We propose to form a Center, administered by Draper that, with NSSC, will seek to understand the critical and unmet DoD soldier-centric and homeland defender problems, and build teams with Massachusetts organizations to solve these problems under government and commercial contracts. By bringing together multiple teams working to address different problem sets, we will be nucleating new Massachusetts technology clusters groups. DoD and Department of Homeland Security (DHS) development programs will demonstrate new core technologies that transfer to much larger commercial applications. Cluster groups will broaden and strengthen as

they access new commercial markets using the demonstrated technologies. Unique discoveries and concepts are also expected when addressing difficult customer-focused problems; the resulting Intellectual Property (IP) will become the cornerstone for new spin-out companies.

The Center for Soldier Innovation (CSI) will:

- Work to establish a clear picture of near and long-term needs for the warfighter and homeland defenders. The CSI will share these needs with Massachusetts organizations to encourage focus on these critical customer needs (including realignment of R&D, customer interactions, and government support).

- Build teams to: (1) address rapid fielding/response to warfighter and homeland defender requirements, (2) respond to open competitions and (3) establish new programs to address emerging requirements. The CSI will bring manufacture organizations into these teams early in the development process to ensure successful manufacture deployment after the basic products are demonstrated in relevant environments – quickly putting the new capabilities in the hands that need it most.

- Mentor university partners in converting their ideas into new companies.

- Work to ensure that intellectual property generated by the teams during contract execution will benefit all team members and Massachusetts.

1.3 Implementation Considerations

- Successful Center Model – The proposed Center for Soldier Innovation is based on the successful implementation of three similar Centers by Stanford Research Institute (SRI) and Draper; National Center for Maritime and Port Security (FL), Center for Advanced Drug Research (CADRE) (VA), and the Center for Bio MEMS (FL). See Appendix A.

- The Center is Needed – This proposal was prepared in collaboration with the representatives of the Natick RDEC/NSSC Science and Technology Board (http://stb.natick.army.mil/) members; Natick Soldier Systems Center, Mass Executive Office of Housing and Economic Development, Mass Executive Office of Public Safety and Security, Mass Technology Collaborative, Mass Development, University of Massachusetts, Mass Technology Defense Initiative, Metro West Chamber of Commerce, Draper Laboratory. The aforementioned organizations are in agreement that the CSI will provide a valuable new capability for Massachusetts.

- Initial User Community – Warfighters and Homeland Defenders: 4 million Americans.

- Sources of Revenue – The Center for Soldier Innovation, teamed with NSSC and Massachusetts companies and universities will compete for contracts and grants from multiple government and commercial entities. For the proposed initial topic, *enhancing human performance*, in excess of $7 billion has been identified in the GFY 2009 Federal

budget. Clearly, not all of these budgets are addressable, however, it is indicative that there is significant interest in enhancing human performance, and that it is a priority for the US government.

- Financial Analysis – The Center for Soldier Innovation will generate $29 million revenue over the first 5 years of operation. The net impact to the local economy will be $64 to $96 million, based on the MetroWest Chamber of Commerce[7] and SRI analysis, respectively. CSI will break even in year four, and be self-sustaining in year five. The CSI plans to subcontract approximately 40% of revenues realized to university and industrial partner organizations.

  Massachusetts is being asked to provide $5 million seed funding over a 4-year period to establish the CSI. The CSI requires $1.5 million in the first year of operation.

- Lead Organization Characteristics – The Natick RDEC/NSSC Science and Technology Board members are specifically seeking to establish a Massachusetts economic engine, working as a catalyst to promote job growth by building up Massachusetts organizations, providing research opportunities and promoting start-up opportunities. The lead organization must possess key capabilities and characteristics to encourage Massachusetts partners to readily participate with the lead organization in developing ideas, proposing solutions and executing programs, these attributes include:

  - Knowledge of the soldier environments and needs
  - Knowledge of the government funding/proposal process
  - Track record in establishing a working relationship with NSSC
  - Complementary capabilities and interests to NSSC
  - Experience in building and leading research and development teams
  - Independence– ability to choose the optimal technology path
  - Does not manufacture (does not compete with small companies)
  - Significant IR&D available for critical concept development
  - Long time horizon, allows for addressing long-term problems
  - Education charter, specifically focused on building STEM skills and addressing military challenges, and experienced with funding University faculty and students
  - Support building entrepreneurs, included in CSI charter
  - Willingness to invest in important Natick S&T Board goals. Commitment to share sponsor funding with universities and industrial companies

2 Background

2.1 The Successful Center Model - Key Innovation

We have modeled the Center for Soldier Innovation (CSI) on previous successful centers established in Florida and Virginia by SRI and Draper (see Appendix A). Key founding principles include:

- Each center focuses on important customer needs – Core to success.
- It is recognized that universities do not naturally focus their efforts on real customer needs, and so conversion of research to practical products is limited. The universities will cooperate with the center to: (1) connect their research to important customer needs; (2) work together with the center to realize new funding sources and growth; (3) enhance the university profile – to attract a more diverse student base; (4) create the jobs that can enable the students to remain local and join in building the local technology cluster; (5) build and strengthen an entrepreneurial culture; and (6) enhance revenues from university intellectual property.
- Each center promises to obtain new funding and jobs for the local economies. Job growth is realized in the center, company team partners, university team partners, and new spinout companies. Each center possesses an advisory board that provides oversight and determines if predetermined milestones are met each year; subsequent funding is based on achieving milestones.
- Combinations of state, local and university support are provided to establish the center. The first cadre of new hires focuses on defining the customer need, preparing proposals and developing data to support proposals. Subsequent hires execute the sponsored research and development.
- The centers become self-sufficient in 3-4 years.

2.2 Customer Need

The recent US experience in Afghanistan and Iraq has underscored the importance of the individual warfighter, and the critical need to properly equip and protect this asset. A key lesson learned by the US military over the past five years has been the importance of, and need for, having *boots on the ground* for extended periods. As the focus of operations for the combat soldier has shifted from high intensity conflict to stabilization and security operations, we have witnessed:

- A marked increase in the breadth of tasks that the soldier is expected to perform
- Recognition of the importance of maintaining optimum human performance in harsh conditions for longer periods

- A clear need to provide the tools for these forward emissaries to win the hearts and minds of the people in these liberated countries

Focusing the resources and mindshare of Massachusetts companies and universities on the critical soldier needs will materially enhance the survival and health of these warfighters.

The warfighter is called upon to work under difficult conditions. Their performance can be affected by the equipment they carry (weight, complexity, communication with peers, situational awareness), the environment (extreme temperatures, humidity, altitude, weather), and their resulting physiological state (stress, cognitive load, sleep deprivation, hunger, thirst). These same factors are important for homeland defenders and many occupations where vigilance and alert action is required to maintain public safety. The very human nature of combat operations, peacekeeping missions and first responder events requires a focused effort to best prepare the "soldier" for dealing with both the stress of the environment on mind, body and spirit as well as working effectively in the civilian population.

2.3 Natick Soldier Systems Center (NSSC)

NSSC, located in Natick, Massachusetts employs ~2000 (military, civilian and contractors) personnel. Their mission is *RDT&E to maximize the Warfighter's Survivability, Sustainability, Mobility, Combat Effectiveness and Field Quality of Life by treating the Warfighter as a System*. Their Research and Development (R&D) result in products for the DoD and a broad variety of other government agencies, including the Department of Homeland Security, Department of Justice and NASA. Moreover, NSSC is responsible for the research, development, engineering of all food, clothing and individual equipment (less weapon), shelters (hard and soft), canopies (personnel and cargo), integration on the warfighter of all systems worn or carried by the soldier, and medical research to improve and sustain soldier performance.

The NSSC has deep knowledge of soldier requirements and unique facilities that are available to Massachusetts organizations, including: man-rated environmental chambers that permit testing equipment under all environmental conditions to which the soldier may be exposed;, a soldier biomechanics laboratory; 3-D anthropometric laboratory; bone health laboratory; DoD combat feeding laboratory; thermal test facility; fiber production and research facility; textile testing facilities; and rapid prototyping capabilities for expedient transfer to solders in the theatre of operations.

The NSSC creates a $400M annual impact on the local Massachusetts community[8]. Moreover, NSSC is responsible for the technology development leading to $24 billion in soldier equipment purchased by the Army from Massachusetts companies[9]. The NSSC is an important asset for Massachusetts and New England.

The CSI and resulting new technology clusters can materially increase the funding for NSSC technology areas, and increase NSSC capabilities by:

- Accessing new government and commercial funding sources,
- Permitting new NSSC hires from these new additional funding sources (increased number of researchers and contract monitors) and
- The number of organizations that understand the warfighter/homeland defender requirements, needs and operational environment will dramatically increase.

The CSI will work closely with the NSSC to:

- Identify the emerging critical and unmet needs for the warfighter and homeland defender
- Establish teams of organizations focused on these requirements
- Utilize the NSSC facilities and capabilities in the development of new products
- Ensure that the needs of our defenders are prominent in the minds of our elected officials

Finally, the Natick Soldier Systems Center is the only remaining active component Army military base in New England.

2.4 Draper Laboratory – CSI Lead Organization

The Charles Stark Draper Laboratory, Inc. (Draper) is an independent, not-for-profit corporation located in Cambridge, Massachusetts. They are a full capability laboratory, performing research, development, test and integration, fabrication of fieldable prototypes, demonstration of fieldable prototypes in relevant military environments and low rate production. Draper transitions technology with detailed designs to industrial partners for those programs requiring higher rates of production. With approximately 1270 employees, 60% are technical staff and 10% are technicians contributing directly to the technical work. In 2008, total revenue was $400 million. The Draper technical staff, facilities and support functions will be available to the CSI. The significant Draper infrastructure will provide assurance for early customers that the CSI has available the staff and tools to accomplish the proposed programs.

Draper Laboratory specifically offers the CSI and partner Massachusetts organizations the following:

- Draper is a successful government contractor. Their process for obtaining government programs is the same process proposed for obtaining CSI funding; identify critical and important problems, elicit customer needs and build relationships, identify solutions, build teams, write proposals, successfully execute the programs, identify unmet needs for the new customer, etc. This process is a core Draper competency. An important aspect of the CSI collaborations will be the transfer of these skill sets to start-up firms and university partners.

- Draper has a working knowledge of the Army and NSSC operational environments and needs. Draper has a working relationship with many of the groups within NSSC. The CSI funding will by charter apply significant resources toward identifying the critical needs for the soldier, identifying potential funding sources (military and non- military), and disseminate this information to the MA community.

- Draper has experience building teams. Much more can be done to promote the NSSC mission with additional resources. CSI will align companies and university researchers with the NSSC mission (focused on the most critical problems and introducing non-military sources of funding).

- Draper is a not-for-profit company –
    - Draper develops technology and demonstrates this technology in relevant environment. They then typically transfer this technology to other companies for manufacture. This permits Draper to choose the best technology for an application (vs. promoting their own manufacturing interests).
    - Because Draper is not a manufacturing company, smaller companies are more willing to partner with Draper, because there is significantly less concern that the larger company will compete with the smaller company's technology. This trust factor is critical to forming effective collaborations.
    - Draper funds internal IR&D programs. The CSI will be able to compete directly for these funds (~$18 million per year). As part of the Draper commitment to CSI, at least one IR&D program/year will be directed toward a CSI program, more if the IR&D proposals warrant.
    - Draper can have a longer time horizon for developing a technology; they are focused on maximizing the greater good of the Nation.
- Draper has an education charter – Draper funds ~$2 million/year in University IR&D and invests in ~70 graduate students, Draper Lab Fellows (DLF), per year (where the student works on real world problems at Draper for their thesis). Several of the Draper engineering managers are also adjunct professors and have the ability to monitor and serve as thesis advisers. The CSI will provide a new location for these DLF's to serve,

where the DLF can work at CSI and conveniently attend classes at their host university. At least one DLF is expected to be part of the CSI mission. The new CSI location will permit Draper to draw candidates for the DLF program from more universities.

- The core of the Draper Mission is to solve problems of national importance. This means solving the problem, demonstrating the solution in relevant environment and then putting these solutions into the hands of the user. There are many ways to get product into the hands of the user, including manufacturing and start-up companies. Similar to Draper's interest in mentoring students, the CSI, will assist the entrepreneurs within the focus teams.

- Draper is already investing in CSI. Going forward, Draper has committed to provide facility, IT, finance, and contract management support for the CSI. In addition, the CSI will have access to Draper engineering resources. The CSI can correctly claim the resources of a substantial engineering and manufacturing organization.

- Commitment to building a Massachusetts economic engine – The CSI has committed to spend on average 40% of contract revenues with university and industrial partners.

2.5 Massachusetts Understanding Of The Need

Lessons learned continue to emerge from the on-going overseas military as well as homeland-bound national response experiences. A broad range of user groups, including military, federal, state, and local governments, hospitals, and laboratories are identifying capability gaps for equipment, training and human endurance. Industry and academia may well be developing important solutions that could directly benefit our defenders, but they are often unaware of the military and emergency response capability gaps. Today, it is very difficult for Massachusetts companies and universities to sort through the large volumes of data and then identify willing and capable teammates to work together to fill these needs quickly. The result is that few organizations can apply the resources needed to effectively research and understand the warfighter and homeland defender problems, and if they do, most work toward solutions alone – and progress is minimal.

The CSI will work closely with the NSSC to establish a description of the most critical and unmet warfighter and homeland defender needs, leveraging the full experience and capabilities of the NSSC. The CSI will then reach out to provide these findings to Massachusetts commercial and university research communities. This approach will build strong collaborative teams and programs to respond to these needs.

3 Center for Soldier Innovation (CSI)

3.1 Unique Massachusetts Center for Soldier Innovation Elements

The CSI will achieve the benefits outlined in Section 2.1; solving important problems, establishing high technology cluster groups, increasing university and local company funding, and new high tech jobs for the community. Nevertheless, the CSI mission focus is far more important to the greater good. The Natick Soldier Systems Center (NSSC) is responsible for developing, fielding, and managing food, clothing, shelters, airdrop systems, and integrating everything the soldier carries.

Creation of the CSI can be an important element in increasing focus on the warfighter and homeland defender. The CSI teams will work to obtain funding from traditional military and non-military government organizations (going beyond the funding vehicles available to NSSC), but the justification and the need will be validated by the warfighter and homeland defender communities.

Unique elements of the Massachusetts-based CSI:

- The CSI will define the warfighter and homeland defender needs. The CSI will share this information with Massachusetts companies and universities. This information is not easily available to these organizations. This will enable organizations to focus on these needs as an individual company/school or in collaboration with CSI. Access to warfighter and homeland defender needs enhances opportunities for universities, existing companies and new start-up companies.

- The CSI center will provide a research and development facility where students and faculty from partner colleges/universities can come to participate in idea brainstorming, proposal preparation and conduct research. For some organizations, such as Framingham State College, the CSI can afford the first opportunity for undergraduate and graduate students to conduct research. For other organizations that have excellent facilities, such as UMass Lowell, the CSI can provide real-world science and engineering experience, working closely with commercial scientists and engineers on important warfighter problems. This type of collaboration is an important vehicle for building-up the STEM workforce. These CSI college/university collaborations will be presented to High School teachers and students – showing them early where STEM academic focus can take them in their future careers.

- The CSI Business Plan contributors have worked to reduce the state and local financial investment for establishing the CSI from the typical $10-20 million to only $5 million over the first four years of operation.

3.2 Establishing the Center for Soldier Innovation

In partnership with Natick Soldier Systems Center and Massachusetts companies and universities, the CSI's objective is to establish a center of excellence focused on enhancing human performance.

The process for establishing the CSI and building the Massachusetts cluster teams is as follows:

3.2.1 Establish the Advisory Board

Includes one appointment each for each stakeholder; Draper, University, each funding organization (i.e. Mass Development, Mass Technology Collaborative and Mass Life Sciences Center) and one non-government subject matter expert to be named by the governor of Massachusetts. The Advisory Board will include a liaison member from the NSSC. This advisory board will provide oversight and determine if predetermined milestones are met each year; subsequent funding is based on achieving milestones. The advisory board will participate in the selection of the CSI Director.

3.2.2 Establish CSI

The CSI Director is the first key hire – the director will set the direction to achieve the Center's defined objective. Objective qualifications will include strong technical background, experience with the warfighter or homeland defender community, a proven track record and extensive experience in working with research and development teams and transitioning applied research into systems, experience leading multi-disciplinary and multi-institutional teams, demonstrated experience in securing commercial, government, and foundation funding for applied research and technology development. An example CSI Director job description is provided in Appendix B.

The cost model includes five core staff (including the Director) to write proposals to federal agencies and other sponsors, conduct the initial research necessary to get data for proposal submissions and establish the facility. Detailed operating procedures, topic selection criteria, IP terms and teaming responsibilities will be prepared.

The initial five-person team will possess the following capabilities:

- Director – Leadership name recognition with at least one major funding agency.
- Research Leader – technical name recognition, based on work impacting the soldier, first responder and/or medical communities.
- Knowledge of small business operation, growth, mentoring
- Knowledge of all engineering/facility assets available to CSI from Draper Laboratory
- Skills building and leading interdisciplinary research and development teams (including university and commercial companies)
- Working knowledge of the Army requirements and funding process, ability to determine emerging needs, validate future requirement, initiate programs

- Working knowledge of government contract and grant funding opportunities, shaping new programs, building alliances to leverage non-military spending for related military applications.

Nominally, the core staff will include; Director, Programs and Small Business Development Manager, Draper engineering interface, and two researchers.

Draper Laboratory will provide the following support (this level of investment is disproportionate with the expected early income from the operation, but is necessary to develop the CSI):

- Facility, IT, Finance, and Contract Management support
- Access to all Draper engineering and manufacturing resources
- During the first year, the CSI core team will be located at the Draper Cambridge facility
- CSI will pursue internal Draper IR&D funds through the existing Draper internal process (~$18 million available annually). Because of the importance of initiating the CSI name and capability recognition, one or more CSI IR&D proposals are expected to be funded in each of the first four years of operation
- CSI university partners will be able to compete for Draper University IR&D funds through the existing Draper process (~$2 million available annually). One or more CSI Draper University IR&D proposals are expected to be funded in each of the first four years of operation

3.2.3 Define the Critical Problems to Be Addressed

In partnership with the Natick Soldier Systems Center, the CSI will develop an understanding of the most pressing and unmet problem areas affecting the soldier. This will include assessing requirements information from the following: TRADOC Schools, PEO Soldier, the U.S. Army Research, Development and Engineering Command, Walter Reed Army Medical Center, Army Knowledge Online (AKO) Lessons Learned. Concurrently work with other government agency partners such as Department of Homeland Security and Department of Justice, to review homeland defender and emergency responder critical areas of interest.

The emerging needs will be correlated with related federal spending, including; Army, DARPA, DHS, FAA, NSF, EPA, NIH, NIST, NASA. Where possible, the CSI will select topics that can be impactful for several government agencies.

Only large government contractors can afford to allocate significant resources toward understanding the broad, emerging needs for the aforementioned communities. When these investigations are undertaken, the result is held as proprietary information for that company. This information is not generally available to MA companies and universities. *A specific responsibility of the CSI will be to develop an understanding of the emerging needs of these communities and to communicate these emerging opportunities to MA companies and universities, permitting the interested organizations to meet with stakeholders early in the decision process; enabling programs to be shaped around MA capabilities.* This proactive (pre-solicitation) market development will augment existing MA State initiatives, including the Mass Technology Transfer Center (which can provide information for current solicitations).

3.2.4 Exchange Information

The CSI will bring Army, industry, and academic technologists into structured discussions around the application of advanced technologies to meet the identified critical soldier problem areas.

The CSI will use forums to disseminate this information, including recommendations by the Advisory Board, and appropriate industrial groups, e.g., DTI. The key objective will be to present the information to interested MA organizations.

The intent of the information exchange is as follows:

(1) Provide insight into the needs of the soldier community. Companies and professors can assess how their capabilities and interests match the defined need. Customer contacts will be provided to the interested parties to permit them to develop concepts and work toward shaping programs or establishing credibility early in the procurement process. Experience tells us that establishing a relationship with the customer early, dramatically enhances the probability of success in obtaining funds.

(2) Provide a mechanism for likeminded organizations to self identify their interest in the topic area and define what their organization offers to solve the challenge. Experience suggests that individual companies or professors do not have all of the resources/capabilities to provide the “total solutions” that users need. These information exchange meetings provide the forum for bringing together potential teams, which can together, provide the full solution focus on demonstrating capability in relevant environments, and transition to manufacturing.

3.2.5 Form Focus Teams

These organizations may align their internal R&D to focus on the problem area and bolster subsequent proposal efforts. Funded research supporting proposals may be accomplished by the CSI or focus team members, as appropriate. Teams will include Natick Soldier Systems Center, companies, universities, and other entities as may be needed to accomplish the objective.

Each focus team will enter into a formal teaming relationship. Members of the team will share in any revenues for IP generated during the performance of any team contract.

By combining the capabilities of universities (typically basic and applied research), small businesses (typically a component of the solution), CSI (typically system integration, prototype, and testing), and small/large business for subsequent manufacture, the CSI team can provide novel solutions to the customer at a potentially significantly lower cost.

Potential team members will be self-identified based on the information exchanges. The invitation to join a CSI team will be based on the experience and capability of the individual applicant. We are seeking the best value for the sponsor. Best value may be time/cost to demonstration or for long-term challenges, a credible path to solution.

CSI, as a not-for-profit, can devote more time to developing long-term partnerships – initiating technology clusters around the most challenging problems.

3.2.6 Develop R&D Proposals

Focus teams will prepare responses to solicitations with the objective of demonstrating solutions to the identified problems. By combining organizational resources, the perceived and actual capability, credibility, and financial stability of the team will be significantly enhanced.

The focus team may also shape a new program; this can include obtaining validation and support from Army organizations. Focus teams will also work with the NSRDEC's National Protection Center to determine if the technologies are appropriate for homeland defender applications. Proposal decisions will include consideration of manufacturing and the potential for commercial applications.

One of the benefits of having representation from basic and applied development organizations, NSSC advocacy, and a view toward production from the beginning of a project, is that one can address the needs of several users at the same time. By parsing the problem into elements, the CSI led team can seek funds from multiple government sources (where members of the team have a relationship with these potential sources of

funds). The soldier applications can be used as examples of broader systemic problems that need to be addressed, in the context of work for the "greater good". There is power in this approach, resulting in successful proposals.

As an example: Portable Power is a significant challenge for the dismounted soldier. Celltech Power located in Westborough, MA, manufactures SOFC fuel cell components, the company claims to be able to use any hydrocarbon fuel, including JP8 containing sulfur. However, until a full system can be demonstrated, there is little interest from the Army or possible fuel cell manufacturers. Here is an opportunity for universities, CSI, NSSC and fuel cell system manufacturers to partner with Celltech Power to work together to obtain funding and build the solution and refine the product. With a working system in hand, the product can be considered seriously by the military and large-scale manufacturers.

The combined credibility and resources of a multidisciplinary team will enhance the probability of project funding and rapid technical success.

3.2.7 Execute Programs

Research and development programs shall be directed toward prototype manufacturing and demonstration of the new technology in a relevant operational environment.

Potential manufacturers will be brought in early to initiate interest, provide manufacturability guidance, and provide a roadmap to high-volume production.

3.2.8 Showcase Technology

Demonstrate new capabilities for the military and homeland defenders.

3.2.9 Transition Demonstrated Solutions

Focus teams will seek out spiral insertion opportunities into DoD programs of record. Products will be included in future programs of record for subsequent acquisition by the user communities.

Commercial Manufacture – CSI will plan for commercialization early in the development and demonstration activities, with preference given to team members and small Massachusetts companies.

The CSI will encourage/mentor/support university members interested in creating new. Draper technology spin-out examples are provided in Appendix C.

Mentorship can come in many forms within the CSI; from gathering the soldier critical needs to transitioning the final technology to a volume manufacturer. In all phases of this process, relationships are being built and partners are being trained to identify opportunities, seek relationships with potential customers, build teams, write proposals, and execute on programs. This is the core process that Draper Laboratory executes to win work and later continue winning future work from government customers. The partners learn from each other. This is not a lecture that gets forgotten tomorrow, it takes time, and the learning becomes ingrained into how people succeed in the future.

One or more of the CSI core team members will have expertise in developing small businesses. This will include germinating ideas, obtaining funding, spin-out opportunities, and IP. This person will work to help small business and university partners in developing and executing their plans to start or build new businesses. The process of building technology clusters is really one of building interdependent relationships – this is what CSI seeks to accomplish.

3.3 Initial Topic Area Thrust

Natick Soldier Systems Center has identified the area of "Human Dimension" as a key unmet challenge facing the soldier. This is consistent with the TRADOC "Big Five" challenge, where TRADOC (responsible for writing the requirements for the Army) has identified Human Dimension as one of the top five challenges for the Army[10].

TRADOC has defined the human dimension challenge as: "Provide Soldiers and leaders the ability to excel in a challenging and increasingly complex future operating environment by developing tools and technologies that enhance Soldier cognitive performance in order to function efficiently as an integral component of a network. Soldiers must be able to interface with multiple unmanned systems, conduct multi-modal human computer interface, and multitask across a wide spectrum of information input while mitigating the proportional increase in physiological and psychological stress".

The Human Dimension encompasses many of the NSSC product areas, working to improve the human performance under all environmental conditions. Human performance is affected by the gear they carry (weight, complexity, communication with peers, situational awareness), the environment (extreme temperatures, humidity, altitude, weather), and their resulting physiology (stress, cognitive load, sleep deprivation, hunger, thirst).

After significant discussion with the NSSC staff and scientists, it was determined that the first CSI topic to be investigated should be a subset of Human Dimension: Cognition and Stress in Operational Environments.

Example topics in Cognition and Stress in Operational Environments:

- Soldier Availability - There is currently no adequate method for quantifying the real-time stressors and assessing the resulting cognitive and physical state of the individual. Soldiers in Iraq and Afghanistan are constantly facing a broad spectrum of stressors (physical and psychological): the impact to the individual from sleep, water and food deprivation, dehydration, multiple traumas, temperature extremes, and observing senseless death to name a few. These stressors affect each soldier differently; nevertheless the commander needs to know who is best able to accomplish the next patrol/mission.

- Soldier Injury - If a soldier should become injured or otherwise impaired, it is critical to assess the extent of their injuries and their physiologic state as quickly as possible. On the battlefield, this would help protect both the injured soldier's life and the lives of those trying to save them.

Cognition and Stress in Operational Environments is also important to the First Responder and individuals in roles that can impact public safety, e.g.

- Firefighters are faced with stress. One-half of today's fire fighter deaths are attributed to stress related heart attacks[11].

- The train or truck driver, who may be tired or otherwise impaired, and falls asleep, and crashes the vehicle.

Each of these examples could have an improved outcome if a monitoring system were available to measure human cognitive and or physical performance readiness. This tool could then be used directly to make decisions regarding the fitness of the individual or used to develop new methods, innovations and equipment improvements to avoid individual injury and protect the community.

The CSI, in collaboration with Natick Soldier Systems Center, industry, and universities, will have the capability to develop such monitoring systems. The system would include the development and integration of existing and novel sensors, the algorithms to interpret the data and infer cognitive and physical state of the individual, and a central repository to store the data and provide quantitative lessons learned to improve individual job tasks. Collectively, this will lead to increased understanding of human performance limitations and establishing processes and equipment to maximize human effectiveness. Development of this system will require interdisciplinary resources for basic and applied research, prototyping, and human testing and manufacture – it will take true collaboration to achieve this ambitious goal.

Possible spin-off products may include small and lightweight sensors patients can wear in home care, hospital patients, and sports enthusiasts. The condition of the individual can be measured and necessary corrective action can be implemented to realize optimum performance outcomes. Another example would be in-cab sensors for locomotive engineers and long-haul truckers that could be installed to improve vigilance and prevent sleep-related accidents.

The development example below provides an illustration of how multiple programs might be directed toward a single theme, each building on the results of the related, but different multiple

projects. Also, there is a maturing process for the product, the products increase in capability with time – offering increased benefits to broader numbers of users with each passing year.

Development Example:

Cognition and Stress Sensor System

Year 1	System requirements for NSSC soldier nutrient testing (CSI, NSSC) Breadboard soldier system (CSI) Develop algorithms to infer cognition and stress from sensors Preliminary lab testing (blood O2, sugar, hydration, cognition test) (NSSC) Initiate basic research for non-electrode EEG sensor (university) Investigate application for Fire Fighter (National Protection Center, university) Investigate application for home care monitoring (medical instrument co.)
Year 2	Brass board (form fit function), field test soldier nutrient testing Algorithms correlate measurements with inferred cognition and stress Bread board Fire Fighter stress system, lab test Initiate basic research for special Fire Fighter stress monitor sensor Initiate basic research for special home care monitor sensor
Year 3	NSSC adopts soldier system and applies to nutrient, food, and clothing testing Brass board Fire Fighter stress monitor, field test Bread board home care system lab test Soldier system adopted for training application – Brigade
Year 4	Soldier system modified for medic application Soldier system used in testing taken to theater – Brigade Soldier and fire fighter System transitioned to commercial manufacture co. Brass board homecare system, field test – shown as non-invasive insulin test
Year 5	NSSC incorporates soldier system in clothing, field demonstration Army includes soldier system in Ground Soldier Equipment spiral insertion (program of record) System Initial soldier and fire fighter systems license revenues Spin-out company forms to explore home care application Clinical testing of home care system

Army adoption = >1-200,000 units
Fire fighter = >1-200,000 units
Home care = >2-6 million units[12].

A discussion of the emerging Remote Patient Monitoring for Home Healthcare Market is provided in Appendix E.

3.4 The End Users

The CSI will first focus on the needs of the warfighter and homeland defender population. The CSI can affect the lives of over four million people that have placed their lives in harm's way to protect Americans. Technologies developed for these warfighters and homeland defenders will

then be applied to broader commercial populations. By expanding the population of ultimate customers, increased economies of scale during manufacture (lower unit cost) can be expected, reducing the unit cost for all users.

Warfighters

• Army Active Component:	518,000
• Army National Guard:	353,000
• Army Reserve:	190,000
• Marines	194,000
• Air Force	316,600
• Navy	325,300

Homeland Defenders

• US Customs & Border Protection	44,414
• US Immigration & Customs Enforcement	16,854
• Federal Emergency Management Agency	6,409
• US Secret Service	6,409
• Coast Guard	47,798
• Law Enforcement	861,000
• Fire Services	
○ Career	317,000
○ Volunteer	824,000
• Emergency Medical Services	201,000

3.5 Sources of Revenue

Virtually every government agency has funded programs and contract R&D related to enhancing human performance; this includes how we can anticipate and mitigate injury, how to sustain optimum human mental and physical acuity, and/or enhance human capability and effectiveness. US Government human performance-related funding in FY09 budgets include:

Army	$70M[13]
Navy	$183M[14]
Air Force	$97M[15]
NASA	$161M[16]
DARPA	$185M[17]
DHS	$65M[18]
FAA	$2M[19]
NSF	$326M[20]
EPA	$1,205M[21]
NIH	$4,887M[22]

As the CSI focus teams consider proposal topics, CSI technology focus areas will be compared to the solicitations associated with the above federal budgets. The Center will seek to use both military and non-military revenue funds to support the objectives of the CSI. (Note: much of the potential funding defined above is not currently being sought by the NSSC or Massachusetts industry or universities).

Draper has worked closely with the Natick Soldier Research, Development and Engineering Center (NSDREC) and Army Research Institute of Environmental Medical (ARIEM) to define a first project for the CSI. It was determined that there is a current critical need for a physiological monitoring system specifically for the U.S. Army, the Civil Support Teams that search for Weapons of Mass Destruction (CST-WMD) and first responders (fire and EOD) using heavy and encapsulating or semi-encapsulating protective gear. These groups of users are highly susceptible to thermal-work strain related heat illness. Working with NSRDEC and ARIEM, this program will develop a networked physiological monitoring system capable of monitoring location and thermal-work strain and other metrics of medical state for these responders, communicate these parameters to local commanders, and enable early corrective actions - prior to becoming symptomatic and result in a medical emergency/"man-down" scenario.

3.6 Financial Analysis

The business model for the CSI will be essentially the same model that Draper (as an independent, non-profit company) employs for government contracts. The CSI will execute contract R&D for the federal government.

In order to implement this proposal, Massachusetts is requested to provide grant funding over the first four years of the Center's operation. The State support will enable the CSI to hire the staff necessary to organize the CSI, write proposals, and conduct the necessary research to obtain data for proposal submissions. The CSI will also commit to partner with Massachusetts companies and universities; it is expect that approximately 40% of the proposed work effort to be performed by these team partners.

$2.35M in capital has been budgeted for special equipment (not resident at NSSC or Draper facilities) to get the operation started during the first four years of operation. $1M has been included in year two of the budget for build-out and occupation of the state-supplied building.

The Massachusetts support will cover the short fall between revenues and expenses during the first four years of operation. It is estimated that the operation will be break even in year 4, and be self-sustaining in year five.

The work done at the CSI center will complement, not compete with, the work performed at the Natick Soldier Systems Center.

The CSI is projected to receive $29 million revenue cumulatively in the first five years of operation, including $11.6 million to be subcontracted to team partner organizations.

3.6.1 Financial Projections

	Year 1	Year 2	Year 3	Year 4	Year 5
Total CSI Revenue ($M)	-	$1.00	$4.00	$9.00	$15.00
CSI Realized Revenue ($M)	-	$0.60	$2.40	$5.40	$9.00
Partner Subcontract Revenue ($M)	-	$0.40	$1.60	$3.60	$6.00
CSI Revenue ($M)	$0.00	$0.60	$2.40	$5.40	$9.00
Expenses					
CSI Cost of Operations					
Labor ($M)	$0.70	$1.10	$2.14	$4.21	$6.92
Non-Labor ($M)	$0.50	$0.56	$0.85	$1.10	$1.42
Capital Expenditures, less Depreciation ($M)	$ 0.315	$ 1.280	$ 0.530		
	$1.51	$2.93	$3.51	$5.31	$8.34
CSI Cash Flow ($M)	($1.51)	($2.33)	($1.11)	$0.09	$0.66
MA State Investment (M)	1.51	2.33	1.11		
CSI Staff (FTE end year)	5	8	12	23	30

3.6.2 Assumptions

Cost Containment:

- Draper will provide facility, IT, finance, and contract management support.
- During the first year, the CSI core team will be located at the Draper Cambridge facility.
- During the second year, the CSI will build out and occupy the 10,000 sq. ft. facility supplied by Mass Development in the proximity of NSSC. Build out cost is approximately $1M, to be leased at no-cost for 10 years.
- CSI will be able to compete for internal Draper IR&D funds through the existing Draper internal process (~$18 million available annually).
- CSI university partners will be able to compete for internal Draper University grant funds through the existing Draper internal process (~$2 million available annually).

Shared Benefit:

- Income from Intellectual Property (IP) licenses will be shared equally by the organizations that teamed on the associated project. Massachusetts will receive an equal share of all license revenues and/or equity derived from venture spinout opportunities. Specifically, financial benefit from IP developed in association with

a project will be divided on an equal basis between participating member in the project plus one equal share provided to Massachusetts.

Governance:

- The CSI will be part of Draper Laboratory, a 501(C)(3) non-profit organization
- The CSI Director will be hired to start the CSI, the balance of the Center's initial cadre (four additional staff) will be new hires or transfers from Draper's Cambridge campus, thereafter, additional staffing will be added as contracts are won to support the additional hires.
- The Advisory Board will include one appointment for each stakeholder; Draper, University, each funding organization (i.e. Mass Development, Mass Technology Collaborative and Mass Life Sciences Center) and one non-government subject matter expert to be named by the governor of Massachusetts. An NSSC representative will also participate on the Advisory Board as a customer liaison. This advisory board will provide oversight and determine if predetermined milestones are met each year; subsequent funding is based on achieving milestones. The advisory board will participate in the selection of the CSI Director.
- The CSI, led by the Director, will integrate the needs for the army, homeland defender and related special human performance challenges that impact the Nation.
- The Director will coordinate information exchange opportunities/discussions around the application of advanced technologies to meet the defined critical soldier problem areas. Such opportunities will include direct university contact and the Defense Technology Initiative (DTI) collaboration. Interest and capabilities will be sought from universities and industry. The Director will organize proposal teams. The order of priority for information exchange is as follows: 1) MA organizations; 2) New England organizations; 3) companies that possess unique capabilities to provide solutions to the critical problem.

Organization Interaction:

- Proposals will complement the Natick Soldier Systems Center (NSSC)
- Contract and grant funding is intended to increase the total funding for all focus team members; all members are to derive benefit.
- Preference for focus teams will be given to New England organizations.
- NSSC staff may be temporarily assigned to the CSI under a federal government Interagency Personnel Agreement (IPA) to develop concepts, perform research,

and collaborate on strategies for integrating solutions onto the soldier. Such decisions will be determined on a case-by-case basis by CSI and NSSC management.

- The CSI will offer sponsored graduate research assistant opportunities to both civilian and military Masters and PhD candidate students. A portion of the Massachusetts seed funding for the CSI will be applied toward Science, Technology, Engineering and Mathematics (STEM) initiatives.

3.7 Risk Mitigation

The primary risks to success of this business plan are twofold: 1) that the CSI will not be able to hire and retain key staff; and 2) that the projected revenue volume will not be achieved. The CSI will mitigate these risks as follows:

1) If availability of key hires becomes an issue, Draper will commit to allocate personnel to the CSI to bridge the temporary shortfall.

2) To ensure the cost reduction steps listed in the financial section (above), including;

- Draper will provide facility, IT, finance and contract management support.
- During the first year, the CSI core team will be located at the Draper Cambridge facility.
- CSI will be able to compete for internal Draper IR&D funds through the existing Draper internal process (~$18 million available annually).
- CSI university partners will be able to compete for internal Draper University grant funds through the existing Draper internal process (~$2 million available annually).

3) A CSI Advisory Board of Directors will be established to determine if predetermined milestones are met each year, subsequent funding is based on achieving milestones. Annual mid-year review of the CSI in the early years will allow business plans to be modified, based on the emerging environment.

4) After the first five CSI staff are in-place (necessary to write proposals to federal agencies, conduct the initial research necessary to get data for proposal submissions and establish the facility), incremental additional staff will be hired based on the CSI success in developing opportunities. Facilities and resources will be matched to task, with new capabilities added when needed. The CSI Advisory Board will ensure that the CSI is staffed at the appropriate level throughout its growth phase.

5) The CSI will present target opportunities to the NSSC/NSRDEC Science and Technology Board for advice and to confirm that target customer needs are being addressed.

3.8 Potential Sources of Funding

The State of Massachusetts is being asked to provide $5 million seed grant funding over a four-year period to establish the Center for Soldier Innovation. $1.5 million is required in the first year of operation.

During the preparation of this Business Plan, there was much discussion concerning the magnitude and sources of the CSI seed funding. Alternatives considered included seeking funding from other New England states and paid corporate membership. These alternatives are not attractive because the significant CSI benefits would no longer be focused on Massachusetts organizations. Moreover, there are significant risks associated with the potential change in the CSI focus from a not-for-profit to a for-profit. The best alternative would be for the funding to come from Massachusetts directly. Possible alternative funding sources may include; no interest loans, matching funds, charitable contributions from commercial companies.

4 Appendix A: Successful Center Model

The proposed Center for Soldier Innovation is based on the successful implementation of three similar Centers by SRI and Draper; National Center for Maritime and Port Security (St. Petersburg, FL), Center for Advanced Drug Research (CADRE) (Harrisonburg, VA), Center for Bio MEMS (Tampa, FL) and MCM Pilot Facility (Tampa, FL).

The goals for the three centers are similar in that they have annual requirements for jobs created and grant proposals submitted. When an annual goal is achieved, the next tranche of financing is provided for the subsequent year activities. For all four centers, each has met or exceeded its goals after 2 years, 1 year, 5 months and 5 months, respectively.

Background Information:

National Center for Maritime and Port Security
http://www.seagrantfish.lsu.edu/pdfs/biloxi_07/GaryBrown.pdf
Funding sources: $20M State, $20 Local Community match (includes land and building)
Contact: former Gov. Jeb Bush

Center for Advanced Drug Research
http://www.sri.com/biosciences/cadre/
Funding sources: $22M State, Local Community provide building
Contact: Gov. Tim Kaine

Center for Bio MEMS
Funding sources: $10M State, $6M Local Community, $4M University
Contact: Gov. Charlie Crist

MCM Pilot Facility
Funding sources: $5M State, $4M Local Community

5 Appendix B: Example CSI Director Job Description

Responsibilities

The Center Director will lead all of the CSI efforts toward enhancing the performance of the warfighter and homeland defender, working in partnership with Natick Soldier Systems Center. The Director will play the lead role in the identification of warfighter and homeland defender needs, presentation of these needs to the Massachusetts community, and development of business and marketing plans to address defined markets. The Director will then establish the teams (combining the resources of CSI, NSSC, and Massachusetts commercial and university organizations) capable of addressing the defined challenges, and propose new solutions to government and commercial sponsors. The Center will demonstrate the defined technology in relevant operational environments and work to transition the technology to a production manufacturer. In this latter role, the Center will coordinate a process that will connect companies to supporting resources (state and federal opportunities) to support expanded output.

The principal responsibility of the Director is to grow the CSI by leading collaborative teams that successfully win funded research contracts and subsequently demonstrate new products and capabilities that address critical soldier applications. These soldier application areas include: increasing soldier cognitive and physical performance under operational and environmental conditions, increase survivability against ballistic, chemical biological, environmental (flame, thermal, concussive, blast, etc) and developing materials and products that enhance soldier sustainability and mobility.

Qualifications

Requirements:

- Broad and diverse experience in multiple technical fields (i.e. chemistry, physics, biology, neuroscience, polymer science, textile science, engineering, nanotechnology, physiology).
- Demonstrated experience for successfully establishing and leading collaborative-based research, development and/or production/manufacturing teams.
- Demonstrated experience in securing commercial and government funding for applied research and technology development in areas applicable to the CSI, including a wide range of established contacts with potential CSI sponsors.
- A minimum of ten years of experience leading multi-disciplinary and multi-institutional teams toward the successful development of advanced system solutions.
- Strong technical qualifications in medicine, biomedical engineering and/or soldier-focused product development/transition, with a MS or higher (MD/PhD preferred). Strong written and verbal communication skills.

- Strong internal and external team building skills.
- Applicants selected will be subject to a government security investigation and must meet eligibility requirements for access to classified information. U.S. Citizenship is required.

Desired:

- Experience working with the warfighter or homeland defender community, including knowledge of requirements, operations and equipment.
- Demonstrated experience in successful technology development from conception to production/manufacturing
- Experience building and/or supporting start-up companies.
- Prior military combat experience or extensive experience with battle field scenarios and/or combat medical requirements (battlefield triage, trauma, and point of care)

6 Appendix C: Draper Technology Spin-out Examples

A key element of the Center for Soldier Innovation is the transition of new technology developed within the Center to a broader marketplace, thereby creating larger manufacture volumes which will lower costs to DoD and state and local government adopters of the technology and provide growth opportunities for industry. As a not-for-profit R&D laboratory, Draper has a long history of transitioning its technology developments to industry for both military and commercial applications. Without a manufacturing capability at the Lab, it is only through technology transition to industry that Draper has maintained its relevance over more than fifty years of operation in a rapidly changing technology environment. Technology transition occurs in a numbers of ways at Draper including, licensing to existing and start-up companies, spin-out companies, a liberal publishing policy, and the movement of Draper employees and students to industry and start-up companies. A few specific examples, including some in the healthcare area, include;

Technology Licensing:

1. Best in class MEMS inertial instrument intellectual property developed at Draper was licensed to Rockwell International (now Honeywell Inc., after Boeing's acquisition of Rockwell) for military applications. Honeywell is currently producing more than 10,000 navigation systems per year based on this licensed technology.

2. Draper was contacted by the Boston based start-up company Bioscale, Inc. seeking to license Draper MEMS intellectual property associated with a chemical and biological detector for both biodefense, environmental monitoring, and biomedical applications. Bioscale is now supplying product to the market.

3. Draper was contacted by a west coast start-up company seeking license to optical measurement technology developed at Draper with application to the diagnostics for non-centralized healthcare. This company is now in initial product development with product roll-out scheduled for 2010.

Spin-out Companies:

1. In 2001 Sionex Corp, Woburn, Ma, was established as a spin-out company from Draper. Sionex is active in the chemical and explosives detection business, producing a highly sensitive and broadly applicable spectrometer based chemical and biological sensor.

2. In 2006 MTPV Incorporated, Boston, MA was established as a spin-out company from Draper. With technology aimed at converting waste heat into electricity, MTPV is an alternative energy company which has raised its second round of funding, established beta test sites with large manufacturing companies, and is currently developing a prototype for field testing.

Each year up to 60 graduate students, who have been instrumental in technology innovations during their residency at Draper, graduate and transition their knowledge and ability to industry. In addition a number of Draper employees have followed their desire and entrepreneurial spirit, transitioning innovations they have developed at Draper to successful start-up companies, again, often in the Massachusetts community. Two examples include SRU Biosystems, Inc, Woburn, MA, and SatCon, Inc., a Massachusetts company based on flywheel technology developed at Draper which is now being employed in the alternative energy market.

Draper has experience in technology transition via a number of channels to both defense and commercial industries. Most recently Draper's technology transition has grown to include more of a focus on technologies related to healthcare. Draper has the experience needed to transition the CSI innovations for soldier applications to not only suppliers for the DoD, but also to industry dedicated to commercial healthcare applications.

7 Appendix D: Local Economy Impact Analysis

Prepared by: MetroWest Economic Research Center (MERC) at Framingham State College

Why MetroWest?

The MetroWest Cohesive Commercial Statistical Area (CCSA), a leading center of research and development activities in Massachusetts, includes the town of Natick, home of the U.S. Army Soldier System Center. The addition of over 100 new professional positions at the Center for Soldier Innovation (CSI) would certainly benefit the MetroWest economy by increasing regional employment and payroll. Even more importantly, siting the CSI in the MetroWest region would offer the Center numerous strategic advantages: a vibrant leading edge regional economy, a striking variety of firms engaged in research and development in many different industries, a highly skilled workforce, and easy access to the many internationally known hospitals and universities located in the Boston MSA. The proximity of such resources will enable the CSI to carry out its mission to meet critical soldier needs by leveraging the experience and capabilities of the Soldier System Center with MetroWest and Boston/Cambridge industry, medical, university and research communities.

Regional economy:

Located 20 miles west of Boston and served by Interstate 90, Route 9 and commuter rail, the MetroWest CCSA economy generated 107,600 jobs with a total payroll of $6.8 billion in 2007. Over 6,600 establishments provided an average annual wage of $63,000, 13.9% higher than the Massachusetts average annual wage of $55,300. The region's strong and diversified industrial base in Professional and Business Services, Trade, Education & Health, and Manufacturing attracts firms and contributes significantly to the Massachusetts economy. In addition, MetroWest enjoys a well earned reputation as a center for research and development. Locating in MetroWest offers the CSI the opportunity to gain synergy from the very firms with which the CSI plans to build relationships and seek federal grants.

Previous MERC research has documented both the concentration of a highly educated management and professional resident labor force and the concentration of research and development establishments. When compared to state residents, MetroWest resident workers are more likely to be employed in industries characterized as professional, scientific, and management services, and information. They are also far more likely than state residents to be in such occupations as those in management, business operations and financial specialties, computer and mathematical areas, engineering, and life, physical and social sciences.

Building on this exceptionally highly educated and highly skilled labor force, the region has attracted firms such as Boston Scientific (medical products), Bose (acoustical engineering), Genzyme (biotechnology), EMC (computer), The MathWorks (computing), Raytheon (defense), Computer Associates (software), NMS Communications (telecommunications), as well as

hundreds of smaller entrepreneurial establishments. The North American Industry Classification System (NAICS) typically classifies such establishments engaged in scientific research and product development in the Professional, Scientific and Technical Services (PSTS) sector or Manufacturing supersector depending on the processes used. It is important to note that MetroWest manufacturing establishments typically do not engage in traditional line manufacturing, but instead concentrate on research, development and prototype design in science and engineering. Production is located elsewhere. In 2007 the average annual wage in the combined Professional, Scientific, and Technical Services and Manufacturing sectors of $95,400 exceeded the regional average annual wage by 51% and the Massachusetts average annual wage by 73%.

These two sectors, Professional, Scientific and Technical Services and Manufacturing as well as the Information sector, form a high technology cluster with a disproportionate number of high technology jobs concentrated in the MetroWest region. In 2007 over 1,100 Professional, Scientific and Technical Services establishments, 220 Manufacturing establishments and 150 Information establishments generated 28,200 jobs in MetroWest, one quarter of the region's total employment. In 2007 MetroWest provided an 11% larger share of Professional, Scientific and Technical Services jobs, a 42% larger share of Manufacturing, and a 52% higher share of Information jobs than these sectors provided statewide. Thus, in the immediate locale of the Natick Soldier Systems Center and CSI, MetroWest offers high technology cluster groups within which to identify firms that will stimulate innovation and deliver soldier technology breakthroughs. Moreover, within 20 miles of the Natick Soldier System Center lie the internationally known industry/university/medical institutions of Boston/Cambridge. The new establishment, CSI, would both benefit from and add to the Professional, Scientific, Technical Services, Manufacturing, and Information cluster already located in the MetroWest region.

Direct Impact of CSI on MetroWest:

Using the output multiplier of 1.61 as developed in the January 2008 UMass Donahue Institute report, *The MA Defense Industry: Characteristics and Economic Impact*, an increase of $20-25 million in new contracts results in additional downstream benefits of $12.2 - $15.25 million. This gives a total estimated output benefit of $32.2 - $40.25 million.

Using the employment multiplier of 2.2 as developed in the January 2008 UMass Donahue Institute report, *The MA Defense Industry: Characteristics and Economic Impact*, a gain of 100 jobs will result in an additional 120 jobs. Assessing each of the initial 100 jobs at an average combined wage of $95,400 gives an estimated direct payroll increase of $10 million annually.

8 Appendix E: Remote Patient Monitoring for Home Healthcare Market

Remote patient monitoring for centralized healthcare is mature; however, in the non-centralized setting, including the home setting, remote patient monitoring is still an emerging business with significant room for innovation based on new technology solutions and new provider models. In this home setting, remote monitoring is an important tool for preventive care, chronically ill care, and continuity of care, leading to better health outcomes and overall cost savings. The tools required for remote monitoring in the home setting are analogous to the monitoring devices for warfighters and emergency responders as described earlier in the CSI business plan. For example, typical sensors needed for home remote monitoring include blood pressure, glucose meter, weight scale, pulse oxidation, peak flow, ECG, medication use, and digital camera, as well as others. Also needed for home health monitoring is the communications and information technology infrastructure required to collect and transmit this vital data to care givers. All the basic elements needed for soldier monitoring systems as will be developed by CSI are applicable to the non-centralized healthcare application.

Remote patient monitoring in the non-centralized setting, including the home setting, is an emerging business with a demand trend that will continue to grow well past mid-century and the worldwide population continues to age. This growth will only be fueled by innovation in basic physiology and cognitive monitoring systems. The sensor, communications, and information technologies developed by CSI for soldier systems will be directly applicable to remote patient monitoring in a home healthcare setting, further leveraging the developments of the Center.

Remote patient monitoring today in both centralized and non-centralized healthcare settings (including the home setting) is about a $9B business worldwide, projected to grow to about $16B by 2012. Approximately three fourths of this growth will be in the non-centralized healthcare market which is projected to grow at a 15% CAGR rate over this time period while the centralized healthcare market will grow at 6% CAGR.

There are a variety of factors driving this emerging market in non-centralized health care, and remote monitoring in particular. First and foremost is the worldwide aging population. In the U.S. alone the population over 65 years of age will grow over 40% by the year 2025 to almost 65 million people. Or stated another way, the over 65 demographics of the entire U.S. will be equal to that of the state of Florida today where just under 18% of the population over 65. A second driver is the trend among “baby boomers”, who make up this growing retirement population, to actively take charge of their own healthcare through use of both home diagnostic kits and monitoring of vital signs, and to do so in their own home in non-critical care situations. Added to this is the concern that in the relatively near future there will be a significant shortage of primary care physicians. While past projections of physician populations have been somewhat problematic, a recent GAO study concluded that there will be a significant gap between supply and demand of primary care physicians by about 2018. This shortage of primary care physicians can only be made up through wider spread use on non-centralized healthcare, starting in a home setting.

9 Appendix F: Physiological Monitoring Telemetry System Proposal

Applying the CSI Process to a Current Proposal

A. Define the Critical Problems to Be Addressed

In partnership with the Natick Soldier Systems Center, ARIEM and MA National Guard, CSI has identified and confirmed the following critical need:

BACKGROUND:

The U.S. Army, the 20th support command (CBRNE), the Civil Support Teams for Weapons of Mass Destruction (CST-WMD) and first responders (fire and EOD) using heavy and encapsulating or semi-encapsulating protective gear are highly susceptible to thermal-work strain related heat illness. Today, all of these groups commonly experience heat casualties after a few hours of active work. In the event of a sustained chemical/biological attack many of the responders would be unable to perform their missions due to dehydration and heat illness.

The NEED

It is difficult to assess the physical status of responders through verbal radio communication. Yet, most casualties demonstrate physiologic changes in vital signs and core temperature prior to collapse or loss of consciousness/death. Proactive monitoring can decrease serious injuries and loss of operational strength/readiness by tracking changes and trends in vital signs/core temperatures and taking action before they become symptomatic and result in a medical emergency/"man-down" scenario.

B. Exchange Information

The CSI will bring Army, industry, and academic technologists into structured discussions around the application of advanced technologies to meet the identified critical soldier problem areas. These discussions will be conducted in conjunction with DTI, UMass Lowell, and other bodies recommended by the Advisory Board.

The individual university professors and companies may choose to address self nominate themselves for a position on the CSI Focus Team.

C. Form Focus Teams

The CSI Director will review the candidate organization for building the Focus Team and will initiate collaboration discussions. Potential team members will be encouraged to align their internal R&D to focus on the problem area to bolster subsequent proposal efforts. Teams will include Natick Soldier Systems Center, companies, universities, and other entities as may be needed to accomplish the objective. Each focus team will enter into a formal teaming relationship. Members of the team will share in any revenues for IP generated during the performance of any team contract.

Team members will be selected based on capability and relationship with the user community. For this program, knowledge of the user environment, limitations of existing technologies, understanding of physiological impact of dehydration, potential sensors, and low cost RF systems will all be considered.

Approximately 40% of the proposed revenues would be subcontracted to CSI team members.

D. Develop R&D Proposals

Focus team will prepare responses to solicitations with the objective of demonstrating solutions to the problems. By combining organizational resources, the perceived and actual capability, credibility and financial stability of the team will be significantly enhanced.

APPROACH

Working with NSRDEC and ARIEM, develop a networked physiological monitoring system capable of monitoring location and thermal-work strain and other metrics of medical state for these responders, communicate these parameters to local commanders, and enable early corrective actions - prior to becoming symptomatic. The system will be built compatible with the protective equipment and where feasible, incorporated as a functional part of the equipment set, capable of operation in the hostile environments of interest and require minimal operator attention during deployment.

During the proposal process the CSI will make sure that current technology does not meet the mission and validate this understanding with users.

ALTERNATIVE

There is no existing COTS technology for networked physiological monitoring consistent with the needs of these responders. Absent this essential funding, this important system solution will be delayed until funding is available.

The base proposal may be submitted to multiple agencies, modified to address their specific understanding of the problem.

E. Execute Programs

Build the needed near-term capability. Develop objective long-term capability (may include new sensors, algorithms, size and power reduction).

Potential manufacturers will be brought in early in the process to initiate interests, provide manufacturability guidance and provide a roadmap to fielding the subject capability.

F. Showcase Technology

Demonstrate new capabilities for all potential user groups. Give credit to funding sources. Work to extend technology to additional potential funding sources.

G. Transition Demonstrated Solutions

Focus teams will seek out spiral insertion opportunities into programs of record. Products will be included in future programs of record for subsequent acquisition by the user communities.

The CSI will encourage/mentor/support university members interested in creating new small companies.

10 References

[1] NCCS is a composite of resident organizations located at the Natick, MA campus, including; U.S. Army Natick Soldier Research, Development and Engineering Center (RDEC), U.S. Army Institute of Environmental Medicine (USARIEM), U.S. Army Integrated Logistics Support Center – Soldier, Biological, Chemical (ILSC-SBC), U.S. Army Installation Management Command (IMCOM), U.S. Army Product Manager Clothing and Individual Equipment (PM CIE), U.A. Army Product Manager Force Sustainment Systems (PN FSS), RDECOM Acquisition Center Natick, U.S. Coast Guard Clothing Design and technical Office, U.S. Navy Clothing Design and Textile Research Facility

[2] Milken Institute June 2008 Report …..

[3] Boston Globe, Mass Exodus, Jan 15, 2006

[4] Milken Institute June 2008 Report …

[5] APG Army Alliance - http://www.armyalliance.org/

[6] S Army RDECOM presentation Building Strength in Massachusetts for Science Technology, Engineering, and Math, presented November 20, 2008 to the Natick S&T Board

[7] Appendix D, MetroWest Economic Research Center Analysis

[8] Natick RD&E Center - http://www.natick.army.mil/soldier/index.htm

[9] PEO Soldier, Ft. Belvoir, VA

[10] TRADOC Warfighter Outcomes Presentation, “The Big Five”

[11] Jalal Mapar (S&T Directorate, Dept of Homeland Security) presentation, Mar 18, 2000

[12] US Dept. of Health and Human Services – http://www.pueblo.gas.gov/cic text/family/aging/lovedones.htm

[13] Army RDT&E Budget FY 2009; Mapping and Remote sensing, Human Engineering, Persons Performance and Training, SCI BS/CBT Care, BS/Army Op Med Research, Human Factors Engineering Technology, Manpower Personnel and Training Advanced Technology, Combat Feeding Clothing and Equipment, Ground Combat Identification, Automatic Target Recognition

[14] Navy RDT&E Budget FY 2009; Human Performance Sciences, Human Systems, Common Picture Applied Research, Warfighter Sustainment Applied Research

[15] Air Force RDT&E Budget FY 2009; Human Performance, Human Effectiveness Applied Research

[16] NASA FY 09 Budget Request Details; Human Research Program, Crew Health and Safety

[17] DARPA RDT&E FY 2009 Budget; Bio Interfaces, Human Assisted Neural Devices, Computer Exploitation and Human Collaboration, Personalized Assistant that Learns, Collaborative Cognition, Unconventional Therapeutics, Advanced Diagnostics, Integrated Crisis Early Warning System, Novel Power Sources, Very High Efficiency Solar Cell, Robust Surface and Sub-surface Navigation, Navigation-Grade MEMS Inertial Measurement Unit

[18] Department of Homeland Security FY 2009 Congressional Justification Overview; System Studies and Decision Tools Program, Border Technologies Program, Response and Restoration Program, Response and Recovery Program, Incident Management Enterprise, First Responder Technologies Program, Integrated Modeling Mapping and Simulation Program

[19] DOT FY09 Budget in Brief; Safety and Operations

[20] NSF 2009 Budget Request to Congress; Research on Learning in formal and Informal Settings, Behavioral and Cognitive Sciences, Polar Environment safety and Health

[21] EPA Budget Clean Air and Global Climate Change; Healthier Indoor Air, Clean and Safe Water – Protect Human Health

[22] NIH Estimates of Funding for Various Diseases Conditions Research Areas; Behavioral Research and Social Science Research, Traumatic Brain Injury, Biodefense