# SYSTEMS ARCHITECTURES FOR FUTURE BATTLE SUITS – ENABLING SOLDIER SURVIVABILITY, SUSTAINABILITY AND VERSATILITY THROUGH SYNERGISTIC INTEGRATION OF NANOTECHNOLOGIES

Edwin L. Thomas* and William A. Peters
Massachusetts Institute of Technology
Institute for Soldier Nanotechnologies
Cambridge, MA 02139

Bruce Snider, Raytheon, Wayne Marsh, Dupont, Reuben Mezrich, Brigham and Women's Hospital, Jeffrey A. Gelfand, Massachusetts General Hospital, Jonathan J. Rosen, Center for Integration of Medicine and Innovative Technology

The US Army has recently established several initiatives to develop new technologies in support of the individual soldier's needs. As the Army transforms to the Objective Force, the individual soldier has become the centerpiece of Army war fighting. To fulfill the diverse missions of the Objective Force, new technologies must empower the soldier with dramatic increases in Responsiveness, Deployability, Agility, Versatility**,** Lethality, Survivability, and Sustainability, all further leveraged by an integral C4ISR capability. In response to these challenging requirements, the US Army's Land Warrior (LW), and Objective Force Warrior (OFW) development programs are focusing on providing significant improvements to the soldier's equipment in the near and mid-term time frames (up to about 2016). A major challenge for today's soldier is the need to carry too much weight with too little protection against a range of battlefield and environmental threats, e.g., ballistic, CB, weather, human health, etc. To help overcome this challenge, the Army has established the Institute for Soldier Nanotechnologies (ISN) at MIT to provide unprecedented survivability capabilities to the individual soldier through breakthrough research on nanotechnologies and through transitioning critical technologies for insertion in the LW, OFW and other Army programs such as the Future Warrior. ISN products are thus expected to benefit war fighters from 2005 to 2025 and beyond.

Realization of Army goals for soldier survivability requires revolutionary advances in the science and technology of individual protection. These advances must equip the soldier with a light weight, mission compatible uniform that provides multiple capabilities, without compromising comfort or freedom of movement. The systems architecture of such uniforms (battle suits), as well as the potential effects of battle dress on soldier physiology, mission performance, and post-mission readiness, are addressed in several previous and/or current Army and other programs. The present poster outlines a complementary ISN initiative to harvest, conceptualize, and apply battle suit systems architectures. This program has three major objectives: (1) inform the basic research of soldier system-of-system requirements; (2) facilitate transitioning of disruptive technologies into current and future fighting uniforms; (3) forecast potential challenges and benefits of new technologies and systems of technologies. The rationale for this program is understood by considering what the ISN will do.

The ISN mission is to perform basic research, technology transitioning, and outreach, in nanomaterials and nanotechnology to enable revolutionary advances in the protection and survivability of the dismounted infantry soldier. As part of this mission, the ISN will perform research on the synthesis and processing of nanomaterials and will develop methods to manufacture prototype products based on nanotechnology. Key capabilities for soldier survivability include detection and neutralization of multi-spectrum threats, far forward medical care, reduced logistical footprint, enhanced human performance, and total situational awareness. Technologies of ISN interest include novel nanomaterials for ballistic protection, mechanically active materials and devices to enhance human biomechanics and provide dynamic armor for ballistic and blast protection, materials and processes to protect against chemical and biological agents, innovative medical technologies to prevent injury and rapidly provide life-saving medical treatment in the battle space, advanced CB sensors, materials process engineering including novel nanofoundries for prototyping fibers, multilayers, devices, etc., and mathematical modeling and simulation to guide the design and synthesis of materials with novel properties as well as the engineering to affordably manufacture soldier products in quantity, and in time for significant impact on Army programs.

A core axiom of ISN operations is partnering of three complementary assets, the Army, MIT, and industrial partners. These assets will perform basic and applied research, inform and shape the research to capture Army requirements, and develop and transition ISN research products into practical and affordable technologies for the soldier. The ISN has founding partnerships with Raytheon and Dupont, and the medical community [Center for Integration of Medicine and Innovative Technology/Massachusetts General Hospital/Brigham and Women's Hospital (CIMIT/MGH/BWH)]. More industrial partners will be added over time. This poster will introduce a prototypical example of collaboration among these ISN assets, namely our initiative to harvest, conceptualize, and apply Nano-technology Rich Systems Architectures (NRSA) for infantry battle suits of the future. Rationale, needed capabilities, exploratory concepts for structure and integration, ISN mission applications, and soldier benefits will be presented.

To differentiate the present work from ongoing programs elsewhere, the poster will focus on how battle suit architectures will be used to shape and guide ISN research and to inform the transitioning process. We will describe ISN methods to identify battle suit requirements, and to assess how revolutionary technologies would interface with current and future architectures. For example, an important ISN strength is the ability to bring together Army, industry, and MIT to harvest key information, e.g., on battle suit architecture programs at Army research and development centers, and on soldier requirements from various Army centers including R&D, training, acquisition, testing, and operator communities. The poster will present examples of challenges and opportunities expected to be illuminated by this study of battle suit systems architectures. Among these are how best to enfold disruptive nanotechnologies in the uniform, hardware and software requirements for systems integration, enablement of previously unattainable functionalities, discovery of new platform configurations that better harmonize critical components and modules, and fusion of bio-, info- and nanotechnologies to impart novel capabilities while reducing weight and maintaining mobility. By forecasting possible pitfalls as well as system synergisms, this information is in turn expected to facilitate more rapid maturation of promising technologies to higher technology readiness levels culminating in fieldability.