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14. ABSTRACT The University of North Carolina (UNC) Defense Applications Group (DAG) aims to provide technical expertise and support to the U.S. Army Special Operations Command (USASOC). During the reporting period, the DAG completed a project with the U.S. Special Operations Command (USSOCOM), through which investigators at UNC Charlotte conducted research toward developing novel visual analytic tools to enable improved technology scouting and acquisition capabilities for Special Operations Forces (SOF). The DAG met with USASOC combat and participated in SOF focused technical discussions and industry conferences. The DAG facilitated introductions to					
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## Report Title

Final Report: Materiel Solutions for Special Operations Forces

### ABSTRACT

The University of North Carolina (UNC) Defense Applications Group (DAG) aims to provide technical expertise and support to the U.S. Army Special Operations Command (USASOC). During the reporting period, the DAG completed a project with the U.S. Special Operations Command (USSOCOM), through which investigators at UNC Charlotte conducted research toward developing novel visual analytic tools to enable improved technology scouting and acquisition capabilities for Special Operations Forces (SOF). The DAG met with USASOC combat and participated in SOF-focused technical discussions and industry conferences. The DAG facilitated introductions to UNC scientists and companies with core technologies to leverage against SOF capability gaps. The DAG hosted workshops on Advanced Protective Materials, C4ISR, Human Domain Analytics, Warfighter Performance, and UNC community outreach - all with academic, industry and USASOC/Army/DOD participation. The DAG facilitated UNC performance on STTR projects aimed at solving critical materiel capability gaps for SOF. UNC students participated in USASOC internships and delivered prototypes through engineering design courses. The DAG core group and broader support network were expanded to include wider coverage of cross disciplinary fields of expertise.

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**Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:**

**(a) Papers published in peer-reviewed journals (N/A for none)**

<u>Received</u>	<u>Paper</u>
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**TOTAL:**

**Number of Papers published in peer-reviewed journals:**

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**(b) Papers published in non-peer-reviewed journals (N/A for none)**

<u>Received</u>	<u>Paper</u>
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**TOTAL:**

**Number of Papers published in non peer-reviewed journals:**

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**(c) Presentations**

Number of Presentations: 0.00

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**Non Peer-Reviewed Conference Proceeding publications (other than abstracts):**

Received      Paper

**TOTAL:**

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

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**Peer-Reviewed Conference Proceeding publications (other than abstracts):**

Received      Paper

**TOTAL:**

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):

---

**(d) Manuscripts**

Received      Paper

**TOTAL:**

**Number of Manuscripts:**

---

**Books**

Received      Book

**TOTAL:**

Received      Book Chapter

**TOTAL:**

**Patents Submitted**

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**Patents Awarded**

---

**Awards**

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**Graduate Students**

<u>NAME</u>	<u>PERCENT SUPPORTED</u>	Discipline
Omar Eltayeb	0.50	
<b>FTE Equivalent:</b>	<b>0.50</b>	
<b>Total Number:</b>	<b>1</b>	

**Names of Post Doctorates**

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
<b>FTE Equivalent:</b>	
<b>Total Number:</b>	

**Names of Faculty Supported**

<u>NAME</u>	<u>PERCENT SUPPORTED</u>	National Academy Member
Wenwen Dou	0.20	
William J. Tolone	0.08	
<b>FTE Equivalent:</b>	<b>0.28</b>	
<b>Total Number:</b>	<b>2</b>	

**Names of Under Graduate students supported**

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
<b>FTE Equivalent:</b>	
<b>Total Number:</b>	

**Student Metrics**

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period: ..... 0.00

The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:..... 0.00

Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):..... 0.00

Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense ..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields:..... 0.00

**Names of Personnel receiving masters degrees**

<u>NAME</u>
<b>Total Number:</b>

**Names of personnel receiving PHDs**

<u>NAME</u>
<b>Total Number:</b>

**Names of other research staff**

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
<b>FTE Equivalent:</b>	
<b>Total Number:</b>	

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**Sub Contractors (DD882)**

1 a. University of North Carolina - Charlotte

1 b. 9201 University City Boulevard

Charlotte NC 282230001

**Sub Contractor Numbers (c):**

**Patent Clause Number (d-1):**

**Patent Date (d-2):**

**Work Description (e):** Conducted research toward developing novel visual analytic tools to enable improved tec

**Sub Contract Award Date (f-1):**

**Sub Contract Est Completion Date(f-2):** 12/31/14 12:00AM

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**Sub Contract Est Completion Date(f-2):** 12/31/14 12:00AM

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**Inventions (DD882)**

## Scientific Progress



## CORE MISSION: LEVERAGE UNC SYSTEM EXPERTISE TO ADDRESS SOF S&T GAPS

- In January-February 2011, recruited and organized core faculty, advisory and staff members of UNC Defense Applications Group (DAG), hired Defense Applications Engineer/ DAG technical coordinator, and stood up UNC DAG. Developed mission and concept of operations with USASOC and ARO input. Obtained SECRET clearances for DAG members by mid-2011
- From 2011 through 2014, expanded the DAG network to include:
  - Dr. Patrick Gardner (Western Carolina University), Mountaintop Endowed Professor of Engineering & Technology and Director of the Center for Rapid Product Realization
  - Dr. William J. Tolone (UNC-Charlotte), Professor of Software and Information Systems and Associate Dean for Research and Graduate Programs, College of Computing and Informatics
  - Dr. Jag Sankar (North Carolina A&T State University), Distinguished Professor of Mechanical and Chemical Engineering and Director of the Center for Advanced Materials and Smart Structures
  - Dr. Karl Ricanek Jr. (UNC-Wilmington), Professor of Computer Science and Director of the Institute for Interdisciplinary Studies in Identity Sciences (I2SIS)
  - Dr. Paul Dayton (UNC Chapel Hill), Associate Professor and Associate Chair of Biomedical Engineering (Joint UNC-NC State department)
  - Dr. Larry Silverberg (NC State University), Professor, Associate Head and Director of Undergraduate Programs, Mechanical and Aerospace Engineering
  - Dr. Stan Ahalt (UNC Chapel Hill), Professor of Computer Science, Director of the Renaissance Computing Institute (RENCI) and Director of Biomedical Informatics Service for North Carolina Translational and Clinical Sciences (NC TraCS) Institute
  - Dr. Rick Bunch (UNC Greensboro), Professor of Geography and Director of the Center for Geographic Information Science
  - Dr. Eric Elbogen (UNC Chapel Hill), Associate Professor of Psychiatry, School of Medicine
  - Dr. Bart Craig (NC State University), Associate Professor of Industrial-Organizational Psychology
  - Dr. Lori Foster Thompson (NC State University), Associate Professor of Industrial-Organizational Psychology
  - Dr. Chris Dwyer (Duke University), Associate Professor of Electrical & Computer Engineering and Computer Science
  - Kathy MacDonald (Contractor), Technical Consultant
  - Dr. Robert Spulak (Sandia National Laboratories), Manager of SOF & EO/IR Systems and SOF Innovation, Joint Special Operations University Associate Fellow
- Conducted outreach to UNC faculty and researchers about DoD, USASOC and SOF S&T needs and opportunities
- Facilitated discussions between UNC researchers and Army/DoD lab researchers and program managers to strengthen relationships and promote collaboration
- Visited more than a dozen university sites (UNC campuses, Duke University, and multi-institution research labs) with research programs relevant to defense/national security.
- Continually developed a repository of UNC System-wide defense research expertise and infrastructure resources to enable effective identification of UNC resources to be leveraged against SOF S&T needs
- Participated in SOF events at Ft. Bragg such as USASOC technology trade show (Feb 2011, 2012, 2013), USASOC Capabilities Exercise (May 2011, 2012), Joint Special Operations Command (JSOC) S&T Task Force Conference (Dec 2011), USASOC Tactical Ground Robotics Conference (Feb 2012).
- DAG members attended Program Manager Orientation Training events at Ft. AP Hill, VA (April 2012) and Quantico VA (2014), becoming more familiarized with S&T challenges for the Warfighter.
- DAG members and UNC faculty with expertise in rapid prototyping and textiles attended U.S. Special Operations Command (USSOCOM) events including: an Additive Manufacturing (3D printing) workshop in Dec 2013; a Tactical Assault Light Operator Suit (TALOS) Industry Day in August 2013; annual U.S. Special Operations Forces Industry Conference (Tampa, FL - May 2011, 2012, 2013, 2014); and USSOCOM Tactical Network Testbed (TNT) Experimentation Venue (Avon Park, FL, Feb 2012).
- Conducted interactive meetings with USASOC combat developers; met with commodity area leads (C4ISR, Visual Augmentation, Medical, CP/WMD, Human performance, Mobility, Signature management, Materials analysis, etc.) to discuss capability gaps and potential solutions or areas where UNC and partners might develop solutions
- Engaged USASOC Command S&T Advisor to explore UNC system support to USASOC G8
- Established new mechanisms for communicating opportunities for UNC experts to engage in defense research and applied S&T, including the development of a UNC Partnership for National Security website and the formation of a UNC Military Affairs Council with representatives from each UNC campus. Both the website and the council serve a broad range of functions aimed at connecting UNC resources and people with the research, educational and training needs of our military partners. Also created a weekly email notification -- which reaches over 120 UNC system faculty -- highlighting defense/security research opportunities.
- Created a Sharepoint site for internal DAG coordination and information sharing
- Developed handouts of UNC Defense Research Capabilities which are now used frequently for outreach and communication purposes.
- Facilitated discussions between USASOC and NC State University (NCSU)'s College of Veterinary Medicine on SOF Military Working Dog S&T. This led to a Memorandum of Agreement signed in May 2013 between USASOC and NCSU enabling joint opportunities and activities spanning research, continuing education, internship and streamlined access to emergency clinical services for military working dogs. NCSU also hosted an Army SOF Military Working Dog S&T workshop (June 2012) with 15 representatives from the SOF/military MWD community and leading academic experts from NCSU and five other U.S. universities. A follow-on workshop was hosted in Raleigh-Durham in 2014 with a similar audience. Additionally,

NCSU researchers have set up a canine blood bank and are pursuing canine genetics research that will benefit SOF MWD.

- Observed mission rehearsal training exercise at the JFK Special Warfare Center & School's Digital Mission Training Center. In consultation with the training center, UNC experts pursued development of modeling and simulation tools to reduce time and resources needed for simulating operational scenarios but no funding resources were ultimately identified to move forward on the project.
- In 2012, the DAG leveraged scientific expertise of UNC faculty and ARO program managers to support USASOC's review process for upcoming TNT experimentation on topics ranging from unmanned aerial systems to surveillance and decision making techniques.
- Hosted campus visits by LTG Patricia McQuisition, Army Materiel Command, and MG Nick Justice former Commanding General of RDECOM.
- Established relations with the NC National Guard, which now permits UNC DAG members access to secure facility and conference spaces.
- Attended a December 2013 session hosted by USASOC G9 on the command's strategic vision for developing concepts of operation in future environments. Discussions focused on how UNC regional and functional area experts can be a strong resource to support G9 development of operational scenarios and find creative approaches to operate in such scenarios.
- Fostered relationships with Navy and Marine Corps S&T components including the II Marine Expeditionary Force at Camp Lejeune, and hosted a UNC visit by the Chief of Naval Research, Admiral Matthew Klunder, to multiple UNC campuses.

#### USASOC/SOF VISITS TO UNC CAMPUSES

- The DAG has hosted multiple groups of USASOC and SOF community communications and signals experts for visits to NCSU to discuss emerging novel antenna research. At the invitation of USSOCOM, Professor Michael Dickey traveled to Tampa and provided a briefing to the Special Reconnaissance Surveillance and Exploitation program staff on his ground-breaking research to develop liquid (conformal) antennas. USSOCOM and USASOC remain interested in this technology. Prof. Dickey and his collaborator Prof. Adams continue to communicate with various stakeholders in DOD and SOF to further develop this technology for their needs, and are actively pursuing multiple R&D pathways.
- A DAG-facilitated visit to UNC Charlotte in October 2011 sparked USASOC-CDD interest in specific optics, tagging, tracking and locating (TTL), modeling & simulation, visualization, and analytic capabilities. As a result, follow-on briefings were arranged for other audiences within USASOC, USSOCOM and JSOC to hear more about UNC Charlotte efforts in these areas.
- UNC Charlotte's College of Computing & Informatics hosted Mr. James Geurts, deputy acquisition chief for USSOCOM, in July 2012 for lab tours and discussions on data analytics and visualization. Consequently, UNC Charlotte and USSOCOM have developed a strategic partnership to create and apply rigorous data analytic techniques to address business management needs of USSOCOM.
- USASOC-CDD visited UNC Wilmington (UNCW) in August 2012 to discuss capability gaps in biometrics and forensics. Since that time, Dr. Karl Ricanek at UNCW has been providing continuous SME support to the CDD lead in this area.
- Lisa Sanders, then Director of S&T for USSOCOM, visited NCSU and N.C. A&T State University (NCAT) in February 2013 as part of a new outreach effort for USSOCOM to better engage academia in pursuing revolutionary advances in technology. During this two-day visit, Ms. Sanders toured numerous research labs and met with more than 20 NCSU and NCAT faculty and staff to learn about research in electronics, tunable communication filters, advanced materials, ultra-thin protective films, electronic fabrics, body-powered sensors, biometrics and forensics, liquid antennas and more.
- Mr. Jim Geurts, USSOCOM Acquisition Executive, visited the campuses of UNC Chapel Hill and NCSU in March 2013. He met with researchers at Chapel Hill's Traumatic Brain Injury (TBI) center to hear about studies of TBI in elite athletes and SOF. Mr. Geurts was extremely interested in how this work could impact USSOCOM's Preservation of The Force & Family program focused on comprehensive rehabilitation strategies for SOF. As a result of these discussions, USSOCOM Biomedical program management staff are considering a UNC proposal for interdisciplinary research in this area. Discussions at NCSU centered on data analytics and digital game design for training scenarios.
- USASOC-CDD hosted UNC President Ross for a site tour in April 2013.

#### DEFENSE INDUSTRY OUTREACH AND PARTNERSHIPS

- Executed teaming agreements with K2 Solutions, Inc. and Boeing Phantom Works with specific regard to joint support of SOF projects.
- Further developed relations with Boeing; UNC Charlotte hosted a large Boeing group in March 2013 for campus tours and corporate level discussions of strategic university relations; collaborative research opportunities emerged in areas of computing, data analytics and visualization, and optics. Boeing continued discussions with UNC DAG through summer 2013 to identify a specific project (most likely analytics-oriented) in which Boeing can invest to close a USASOC-CDD gap. These discussions continue.
- Toured Charlotte area companies (Chemring Detection Systems, NLA Diagnostics, Entogenetics, Goodrich ISR, Tessera Digital Optics) to scout technologies for USASOC and establish long term relationships (Sept 2012)
- Worked with the NC Biotechnology Center on strategic plans to grow the state's Biodefense research and development efforts in areas such as battlefield medicine, combat casualty care, vaccines, and biological detection.
- Introduced USASOC to Morrisville-based company Porticos, which supplied a unique lightweight cooling vest that underwent testing by USASOC.

## EXTERNAL PARTNERSHIPS

The UNC DAG fostered broad University relations with external partners across the defense industry, non-profit, state/federal government, military and other academic institutions in North Carolina and beyond, jointly hosting and participating in events and activities such as:

- NC Defense Trade Show (Fayetteville, Aug 2011): A UNC DAG panel generated interest among local NC defense companies to partner with UNC system.
- NC Defense Business Association (NCDDBA) “Breakfast with a Prime” (Charlotte, October 2011): Continued building momentum for establishing defense industry partnerships.
- NC Defense Business Association (NCDDBA): DAG regularly participates in monthly S&T committee and medical committee meetings of NCDDBA, connecting UNC researchers with small business partners and federal funding opportunities to advance technology for warfighter needs.
- NC Military Foundation (NCFM) Board Meetings (Chapel Hill, December 2011, 2012, 2013, 2014): Raised visibility of UNC Partnership for National Security to external audiences; facilitated discussions on collaborative efforts between UNC system, NC defense industry, and USASOC; discussed strategic initiatives to boost research across the state in military medical and cybersecurity areas. Also participated in an NCFM hosted Cybersecurity Roundtable (March 2013): The DAG coordinated UNC faculty participation in this roundtable with over 30 NC-based companies and government agencies to map out local cyber research assets and chart the way forward for strategic collaborations.
- NC Federal Advanced Technologies Annual Symposium/Review (NCFATR) (Fayetteville - July 2012, Chapel Hill - 2013, Raleigh - June 2014): The UNC system has co-hosted this annual event with the NC Military Business Center, Office of Senator Burr, NC Military Foundation and the Institute for Defense & Business each year since 2012. This event attracts over 300 attendees from military, SOF, government, industry and academia. Each year, UNC system and Duke University faculty have participated in and chaired industry-academia R&D panels in areas such as advanced materials, manufacturing, biomedical, tactical energy, automotive & robotics, cyber and advanced analytics, and human/behavioral sciences. The DAG also participated in quarterly NCFATR meetings throughout 2012-2014 and identified UNC experts to speak about novel research of interest to military S&T audiences.
- Unmanned Aerial Systems (UAS) statewide initiative: The DAG has continuously worked with the NC State Next Generation Air Transport center to connect UNC-wide assets to state-wide efforts to establish a North Carolina UAS Center of Excellence with airspace and industry/academia technology partners to provide UAS solutions supporting defense and industry needs. North Carolina is a member of a consortium that has applied for Federal Aviation Administration (FAA) COE, with an award pending decision as of the submission of this report.
- NC Governor’s Gaming & Simulation cluster meeting (Raleigh, March 2012)
- Triangle region Defense Networking (“DEFNET”) events hosted bi-monthly by Wake County Chamber of Commerce with participation from more than 100 defense S&T companies in NC.
- Visited numerous defense companies and non-profit institutions across the state (including the Partnership for Defense Innovation/Defense Security Technology Accelerator, NC Wireless Research Center in Wake Forest, NC Biotechnology Center, RTI International, and many private sector firms); regularly coordinated with organizations such as the NC Military Foundation, NC Defense Business Association, NC Small Business Technology Development Center, NC Military Business Center and others to pair academic research efforts with technology development capabilities of defense industry companies in North Carolina; raised awareness of opportunities for UNC-industry collaborations in areas of SOF interest and promoted joint proposals to BAA and SBIR/STTR solicitations.

## WORKSHOPS

The UNC DAG hosted the following workshops (see Attachment pages 1-18):

- (1) Defense Research Funding & Collaboration Opportunities Workshop (N.C. A&T State University, Greensboro NC - August 2011): High level DoD program managers presented outreach and funding opportunities to an audience of over 100 UNC faculty and research staff. With DAG assistance, UNC faculty attendees began pursuing opportunities highlighted at this venue. USASOC Command S&T Advisor, Dr. John Morgan, participated in this event and shared perspectives on unconventional SOF missions—such as village stability, civil affairs, and military information support operations—where the academic community has low awareness but strong potential for impact.
- (2) Optimum Warfighter Performance Workshop (North Carolina Research Campus, Kannapolis - August 2011): UNC faculty had valuable interactions with USASOC and Marine Corps Special Operations Command (MARSOC) human performance staff and trainers in this forum. Building on connections made here, USASOC developed longer term relations with Appalachian State University and UNC-Chapel Hill in areas of human performance and athletic training. This ultimately led to graduate students from these programs serving as USASOC interns during summer 2012, 2013 and 2014. USASOC and MARSOC attendees provided positive feedback and have expressed strong interest in holding a follow-on workshop in this area.
- (3) C4ISR Workshop (UNC Charlotte, March 2012): This event attracted more than 75 attendees including 45 from academia (6 UNC institutions), 17 from federal/state government and DoD, and 16 from private/non-profit industry. USASOC Command S&T Advisor, USASOC G6 Technology Program Office, JSOC S&T staff and USSOCOM S&T Directorate staff participated in the workshop. Three technical panels including representatives from SOF, DoD, industry and academic communities presented and discussed technology gaps and ideas for solutions in areas of optics, analytics and awareness, and cyber assurance. UNC

faculty attendees gained valuable insight into unique challenges of the special operations and defense communities in these areas, and continue communications with military personnel to discuss research ideas. In addition to the main event, a closed session was held with USASOC S&T, JSOC S&T, and USSOCOM S&T representatives on optics and analytic/modeling projects at UNCC. These SOF participants expressed interest in the demonstrated research capabilities and the potential value of academic experts in identifying “good ideas” for solving hard SOF problems. A constructive discussion ensued regarding the concept of UNC DAG and how SOF can utilize the DAG network to identify SMEs and solutions.

(4) Defense Research Round Robin (Research Triangle Park, November 2012): This event was geared toward UNC faculty interested in pursuing defense research funding and opportunities to transition active research programs to military applications or customers. UNC faculty were invited to meet one-on-one with DAG faculty and technical advisors, spending 10-15 minutes with each pitching technology ideas and receiving feedback on potential DoD program matches and next steps. Twenty five faculty from eight UNC institutions attended. As a result, some of these faculty are pursuing new opportunities with the agencies such as the Defense Threat Reduction Agency and US Army Medical Research & Materiel Command.

(5) Human Domain Analysis Workshop (Fayetteville, November 2012): This workshop focused on quantitative social science methods and tools to support the needs of special operations forces. The event featured more than 20 experts, including 10 faculty from UNC campuses, six faculty from outside academic institutions, and industry technologists discussing their fields of study and how each applies to the study of the human domain. The presentations and panel discussions covered areas such as social media and social networking analysis, geospatial analysis, modeling and simulation, game theory, and political science. The goal of the workshop was to explore cutting edge techniques to measure the effectiveness of special operations through quantitative metrics derived from indicators such as levels of violence, sentiment, and other indicators and to use data-driven science to guide operational planning and strategic decision making. There were roughly 160 attendees from government, academia and industry. More than 85 were from USASOC, primarily from Civil Affairs, Military Information Support Operations, and Special Warfare Center & School commands. Academic participants included sixteen faculty from five UNC campuses and faculty from six non-UNC institutions.

(6) Advanced Protective Materials S&T Exchange (Raleigh-Durham, April 2014): Included participants from multiple UNC campuses, industry, USASOC and ARO. Topics discussed included next generation materials for operator worn armor, vehicle armor, signature management, and operation in extreme temperature environments. UNC faculty with expertise in materials science, chemistry, mechanical and aerospace engineering, optoelectronics, nanoengineering, and electrical and computer engineering attended from NC State University, UNC Charlotte and NC Agricultural and Technical State University. The discussions increased USASOC awareness of emerging and future technical innovations and informed the process of generating new S&T gaps.

## INTERNSHIPS

2011

Two WCU students participated in engineering internships at USASOC-CDD in summer 2011.

2012

Five UNC system students were selected for USASOC internships from May to August 2012 in fields of engineering (one from Western Carolina University, one from East Carolina University), human performance/athletic training (one from Appalachian State University, one from UNC-Chapel Hill), and graphic design (one from NC State University). All interns received positive and enthusiastic feedback from USASOC, and USASOC has indicated a desire to continue and grow the student internship program based on these successes.

2013

Seven UNC system students were selected for USASOC internships from May to August 2013. Three undergraduate students from Western Carolina University (WCU) in electrical engineering, mechanical engineering and engineering technology programs completed projects involving the design and fabrication of various electrical and mechanical devices as needed for constantly changing mission requirements, and supporting testing and evaluation of wireless communication hardware and software for battlefield situational awareness applications. Two graduate students from Appalachian State University (ASU) with strength and conditioning fields of concentration supported Human Performance programs aimed at optimizing operator performance through novel training, nutrition, recovery and education approaches. A graphic design student from NCSU produced historical and training videos and materials for the command. A mechanical engineering intern from NCSU surveyed and identified ongoing research projects at NCSU and other UNC campuses that can be leveraged against gaps in areas of unmanned and autonomous systems.

2014

Seven students from five UNC campuses were selected for USASOC internships from May to August 2014. These interns were financially supported through a separate ARO contract, but support the overall goals of this grant. Two undergraduate WCU students in electrical and mechanical engineering worked on projects to design and fabricate various electrical and mechanical devices including wireless communication and mobile power supply systems. Two graduate students and one undergraduate from ASU, UNC Greensboro and ECU supported Human Performance programs in areas of strength and conditioning, physical therapy, and performance nutrition. One graphic design student from NC State produced graphic and video materials for the command's training, evaluation and historical needs. A Psychology graduate student from NC State developed and applied statistical methods to assessment and selection efforts.

STUDENT DESIGN PROJECTS

2011-2012

Through WCU's Rapid Product Realization Center, two teams of undergraduate students, each led by a senior who served as an engineering intern with USASOC in summer 2011, completed USASOC projects as part of a senior capstone course spanning the fall 2011 and spring 2012 semesters.

(1) One team developed an illumination ball that will serve as a rugged, reusable, remote-controlled distraction device. The device uses light and sound to distract or disorient or cause threat force movement inside a room without aerosol and debris which are typical to a flash grenade. The device, made of a high strength composite plastic, uses a buzzer, white LEDs and near infrared LEDs. It is capable of being repeatedly thrown through windows and into concrete structures, completely submersible, and capable of operating between -31 and 125 degrees Fahrenheit. The student team completed a fully-functional prototype in May 2012; however, the prototype lacked some important access features. WCU hired an intern over the summer (at no cost to USASOC) to reconfigure some of the internal wiring and access points. USASOC took delivery of this prototype unit in July 2012. USASOC requested WCU conduct a "spiral 2" over the 2012-2013 academic year to integrate MILSPEC hardening and add some functionality improvements.

(2) The second team designed and demonstrated a mechanical lifting system for the USASOC airfield support vehicle. The objectives were to solve two primary challenges with the current model: making the platform concealable when not in operation and reducing the platform's weight by using lighter materials or a new design while maintaining structural integrity and strength. The team completed a system design which satisfied all requirements and built a scaled-down prototype to demonstrate functionality. USASOC took delivery of the scaled-down prototype in May 2012.

Through NCSU's Mechanical & Aerospace Engineering department Fall 2011 capstone design course, three teams (5-6 undergraduate and graduate students each) competed in developing Supacat half-shaft prototypes to address component failure challenges. All three teams were supported through a \$10K Short Term Innovation Research (STIR) grant from ARO. In December 2011, the teams demonstrated three distinct prototypes—which were provided to USASOC—including a modified COTS solution, a hybrid COTS design with new features, and a novel design created from scratch.

2012-2013

Two teams of undergraduate WCU students completed USASOC projects as part of a senior capstone course spanning the fall 2012 and spring 2013 semesters.

(1) One team developed an advanced prototype illumination ball to advance previous efforts from a 2011-2012 project. The team completed a fully-functional "spiral 2" prototype in May 2013 which improved the design, functionality and ruggedization of the first prototype completed by a student team the previous year. USASOC evaluated the second generation prototype and has discussed further development and commercialization steps with a potential industry partner.

(2) The second team designed and demonstrated a housing package for a dismounted or vehicle mounted USASOC camera system. The first objectives were to (a) design and prototype an environmental enclosure for the camera so that it could operate in extreme field conditions, and (b) add interoperability capability to the camera so that it could operate in the Army's "Terra-Harvest" architecture. The team delivered a prototype enclosure which satisfied the environmental requirements of the system. The team also collaborated closely with scientists at Army Research Lab to ensure compliance of the software with Army Terra-Harvest standards, demonstrated a proof-of-principle for a select number of operations, and delivered recommendations for future Terra-Harvest implementations. USASOC received the prototype in May 2013.

2013-2014

(1) A team of WCU undergraduate students completed a USASOC sponsored project as part of a senior capstone course spanning the fall 2013-spring 2014 semesters. The team was tasked to modify an existing scissor lift to better accommodate the needs of the operator. The goal was to create a control system that would redesign and modify the existing Zimmer HK1501A manual clamp to be electrically driven as well as weather proof. The new system was to include multiple distance sensors to determine both the current height of the lift as well as the proximity of the lift platform to any surrounding objects. These sensors would allow the lift system to move forwards and backwards in regards to the structure without collision. To better facilitate the operator, the newly designed system would have three locations from which the system would be controlled, intended to provide easy access to persons both inside the vehicle and outside. The new system would display the distances for both height and proximity sensors using a text based LCD screen. At the completion of the project, the team developed functioning IR sensors to measure height and proximity, a simulated clamp design, a control mechanism using Arduino Uno, and an LCD output display. The team prototyped multiple weatherproof enclosures and conducted weatherproof testing of all sections, accurate distance measurement testing, and reflective surface testing. The team was unable to complete the redesign of an electrically driven clamp and the development of multiple controllers due to time constraints. See Attachment 3 for the final capstone course poster.

(2) The DAG facilitated a new senior design project at the College of Textiles and College of Engineering at NC State University for the Fall 2013-Spring 2014 semester aimed at designing a realistic canine bite sleeve. The project was funded through a separate contract following the initial discussions and conceptualization efforts conducted under this grant.

#### SME SUPPORT:

- Dr. Lori Foster Thompson, Industrial-Organizational Psychologist at NCSU, supported a 10-day offsite assessment event for USASOC, providing valuable subject matter expertise and analysis on quantitative methods for personnel selection.
- The DAG participated in a non-lethal engagement workshop at Ft. Bragg and provided SME input on technical proposals in

this area.

#### DATA ANALYTICS RESEARCH AND DEVELOPMENT:

As a result of DAG-facilitated campus visits, USSOCOM sponsored a business analytics project at UNC Charlotte through a modification to this grant. The overall objectives were to develop and apply rigorous data analytic techniques to address technology scouting and business management needs of USSOCOM. The effort aimed to leverage intuitive, interactive visualizations and advances in data science and business analytics to facilitate better acquisition awareness and decision-making. The project researched capabilities for identifying emerging science and technology (S&T) topics and trends based on large corpora of structured and unstructured data. It was anticipated that the effort would complement and integrate with current USSOCOM initiatives aimed at developing a Virtual Collaboration Tool and technology “crawler” tools to enable forecasting of S&T breakthroughs that will impact USSOCOM’s mission and capabilities for special operations forces. Phase I of the UNCC analytics project was executed from August 2013 to January 2014. Phase II was executed from July through December 2014. Monthly progress reports were provided to the USSOCOM program point of contact, Mr. Howard Strahan.

The research results will contribute to the following long-range goals. First, the research strives to improve USSOCOM abilities for rapid innovation by advancing USSOCOM capabilities to: explore new technologies; identify those technologies that are most necessary and/or useful to USSOCOM warfighters; and, determine how best to integrate those technologies in the acquisition process. Second, the research strives to improve USSOCOM analysis and decision-making by advancing USSOCOM capabilities to: improve situational awareness across the range of acquisition processes and identify any pertinent dynamic or static data points necessary to maintain this awareness; identify meaningful/actionable events, trends and patterns from acquisition data; forecast plausible futures to enable prescriptive intervention; and, understand the process and provenance of data, analyses and decisions.

Phase I focused principally on the challenges of technology scouting in response to emerging USSOCOM requirements. The specific research challenge under exploration was threefold: i) to identify potential data science and business analytics techniques; ii) to couple these with intuitive, interactive visualizations that expose emerging topics and trends across research corpora – e.g., STTR/SBIR funding programs; and, iii) to connect these topics and trends to identified mission requirements in real-time.

During Phase I, UNC Charlotte acquired corpora of raw, open-source data and organized the structured and unstructured data for automatic analysis and subsequent visual exploration. The team collected abstracts from 112,877 funded STTR/SBIR proposals (104,858 SBIR and 8,019 STTR, respectively). These abstracts were organized using novel, data-driven topic modeling techniques designed to reveal latent knowledge (i.e., topics) within the corpus of abstracts. UNC Charlotte then developed novel techniques to explore these identified topics using intuitive, interactive visualizations. Research trend analytics at multiple temporal scales across varied operational scope was also performed.

In addition, through a case study, UNC Charlotte connected these topic modeling techniques to an emerging set of mission requirements – specifically those from the Tactical Assault Light Operator Suit (TALOS) Initiative. This enabled USSOCOM to identify over 6,000 TALOS related STTR/SBIR projects and to explore these projects using the same intuitive, interactive visualizations (see ‘Selected Phase I/ Phase II Screenshots in Attachment 1 pages 23-24). The delivery and deployment of a visual analytics pilot system to USSOCOM for evaluation marked the completion of Phase I.

- A capability demonstration and briefing of pilot research results was provided to USSOCOM’s Executive Acquisition Officer, who is the director of the Special Operations Research Development and Acquisition Center (SORDAC) on 24 OCT 2013
- Deployment of demonstration capability occurred in spring 2014.

Phase II focused on enhancing the analytic, exploratory and classification capabilities, and overcoming architectural limitations. The team developed a search-by-example proof-of-concept and a statistical/probabilistic approach to data organization and retrieval. The team conducted a comprehensive architectural refactoring of the analytical capability, transitioning the analytical capability from a desktop architecture to client-server architecture. UNC Charlotte also acquired a 3-4 TB data set of documents from the Defense Technical Information Center (DTIC) for rapid, scalable analysis. These data were used for validation of techniques against large-scale, noisy datasets. The team:

- Addressed technical limitations revealed in Phase I
- Demonstrated technical scalability of the approach
- Made significant advances toward enabling capability diffusion to other agencies
- Evaluated impact of data quality and demonstrated a data segmentation approach to mitigate impact
- Validated client-server architecture
- Prototyped several user interface enhancements to improve utility of the capability and the user experience.
- All research and development activities were completed prior to 31 December 2014, but due to scheduling conflicts the delivery of the Phase II analytical capability and supporting documentation occurred during a campus visit by the USSOCOM Program Manager on 22 January 2015.

ATTACHMENTS: Attachment 1\_Final tech report\_W911NF1010521

## Technology Transfer

## CORE MISSION: LEVERAGE UNC SYSTEM EXPERTISE TO ADDRESS SOF S&T GAPS

- UNC DAG members had regular interactions with Army Research Office (ARO) program managers, USASOC combat developers and individuals at Department of Defense (DoD) and Army R&D Laboratories to explore overlap in research goals and efforts. The DAG identified potential matches between UNC research efforts and Army/DoD research programs and facilitated communication between UNC faculty and appropriate DoD program managers. DAG core members and advisors mentored less experienced UNC faculty and researchers in the process and culture of working with DoD and applying for DoD research funding.
- Toward the goal of fostering a broad-reaching base of fundamental and applied research efforts that can be leveraged to address SOF science and technology (S&T) gaps, the DAG promoted various DoD funding opportunities throughout the UNC system and facilitated consultations between UNC researchers and DoD program managers and personnel regarding areas of technology interest. These discussions resulted in the submission of numerous white papers and proposals for new funding, including through solicitations from ARO, the U.S. Special Operations Command (USSOCOM), Army Medical Research and Materiel Command (MRMC), and other federal agencies. Several of these proposals were successfully awarded.

## STUDENT INTERNSHIPS

Five UNC student interns supported USASOC-CDD during May-August 2012, infusing new ideas and approaches for performance conditioning and physical therapy techniques; engineering design concepts for components such as vehicle mounting brackets and camera housing cases; and creative graphic design products and video presentations. Seven UNC student interns supported USASOC during May-August 2013, in areas of human performance conditioning and training; graphic arts design and videography; and mechanical and electrical engineering for fabrication design, technical surveillance, and wireless networking applications. Solutions developed by these interns have been fielded by USASOC.

An engineering student from East Carolina University (ECU) who served as an intern with USASOC in summer 2012 was hired by USASOC in a full time position at Ft. Bragg as an engineer in early 2013. An athletic training graduate student from Appalachian State University who worked as an intern at USASOC in summer 2012 was hired as a contractor to support USASOC Human Performance staff at Ft. Bragg in late 2012.

## STUDENT DESIGN PROJECTS

USASOC has taken possession of prototypes for multiple solutions developed through UNC senior design projects. One project at Western Carolina University (WCU) culminated in the demonstration of an illumination/acoustic ball for distraction/disorientation applications. An initial and second-generation prototype incorporating MILSPEC hardening and added functionality improvements were delivered to USASOC in 2012 and 2013 respectively. USASOC is exploring options for technology transition with an industry partner. A second WCU senior capstone team designed and demonstrated a mechanical lifting system (electrically controlled scissor lift) for a USASOC airfield support vehicle. A scaled-down prototype was delivered to USASOC in May 2012. Elements of this design have been transitioned to USASOC for implementation in the current lift platform. A third WCU capstone project resulted in the design and delivery of a ruggedized housing package for a camera system. This prototype was also delivered to USASOC in 2013. Through N.C. State University (NCSU)'s Mechanical & Aerospace Engineering capstone design course, three teams of undergraduate/graduate students completed feasibility and design studies on a half shaft component for a rough terrain vehicle. The teams delivered final presentations and studies, along with three different prototype half shafts -- ranging in design from de novo to modified commercial-off-the-shelf -- to USASOC in December 2011. These results helped facilitate USASOC engagement with vendors to find improved solutions.

## INDUSTRY PARTNERSHIPS, STTR PROJECTS

Through the networking activities of the DAG, three separate teams of investigators—including researchers at N.C. State University and Duke University, who teamed with local North Carolina small businesses—applied for and were selected in June 2012 for Phase I Small Business Technology Transfer (STTR) projects to develop methods for characterizing ultra-high strength concrete materials. DAG networking efforts also resulted in a Virginia-based team being awarded a phase I STTR project to develop battlefield ultrasound technology. These STTR teams conducted demonstrations for USASOC in April 2013, showing promising results and progress toward program objectives. Two of the projects were selected for Phase II awards. Those efforts are ongoing.

The DAG interacted frequently with defense industry businesses, associations, non-profit and governmental organizations across North Carolina—including the NC Military Foundation, NC Defense Business Association, NC Military Business Center, NC Department of Commerce, Office of the Governor, and many more—and participated in regional defense networking and trade show events to expand these valuable connections. We established stronger ties with industry to help transition technologies to the Warfighter and to provide the foundation for a range of future research, educational, training and scholarship opportunities for students and soldiers alike.

## ANALYTICS RESEARCH FOR USSOCOM

A UNC Charlotte team collaborated with locally based Taste Analytics, LLC to transition applied research and development results from a USSOCOM sponsored data analytics effort supported through this grant. Prototype analytic solutions were demonstrated and transition to a client-server architecture for USSOCOM.





**WORKSHOP TITLE: University of North Carolina Defense Opportunities Workshop**

**DATE: 3 August 2011**

**LOCATION: North Carolina Agricultural & Technical University Alumni center**

**TARGET AUDIENCE:** Faculty, students and staff across the University of North Carolina (UNC) system (encompassing all 16 baccalaureate-granting institutions) involved in research of potential interest and relevance to defense, security and intelligence applications.

**OBJECTIVES:**

- Raise awareness among UNC researchers about defense/security/intelligence community research collaboration and funding opportunities (BAAs, special announcements, university research initiatives, SBIR/STTRs, any other contract/grant vehicles, etc.);
- Raise awareness at UNC campuses of DoD S&T research organizations and technical needs;
- Share tips/best practices for staying alert to defense funding opportunities and submitting strong proposals;
- Motivate UNC researchers to contribute more to DoD mission and consider potential defense applications for ongoing or future research projects;
- Share examples of UNC partnerships with defense, homeland security and intelligence communities (research, training, education);
- Create networking opportunities for UNC researchers and innovators to meet representatives of defense/government S&T research and funding agencies and North Carolina-based defense businesses with similar R&D interests;
- Identify potential internships, collaborative research opportunities and future job opportunities.

**EXPECTED OUTCOMES:** Increased awareness among UNC research community of DoD research priorities and opportunities for funding and collaborative research projects; introductions of UNC researchers to potential DoD customers; and inter- and intra-campus networking on relevant DoD research topics.

**University of North Carolina Defense Opportunities Workshop  
August 3<sup>rd</sup>, 2011**

**North Carolina Agricultural & Technical University Alumni Center**

200 North Benbow Road  
Greensboro, NC 27411  
Phone (336) 433-5566



**Final Agenda**

- 0730-0830 Registration and continental breakfast**
- 0830 Welcome and Introductory Remarks**  
Dr. Mark Kiel, Vice Chancellor, University Advancement, NC A&T University  
Ms. Kimrey Rhinehardt, Vice President of Federal Relations, UNC General Administration
- 0835 Overview of UNC Partnership for National Security, Why DoD research?**  
Ms. Kathie Sidner, Defense Applications, UNC General Administration
- Invited speakers – Overviews of DoD basic and applied research programs; DoD R&D priorities; and opportunities for university research funding and collaborations with DoD:*
- 0845 Breaking the Code: DoD Research Funding**  
Dr. Pat Gardner, Adjunct Professor of Electrical Engineering, Western Carolina University, and Program Manager, Draper Laboratory
- 0900 Office of the Secretary of Defense (OSD) Basic Research Overview**  
Dr. Randy Avent, Professor of Computer Science, NC State University, and former Chief Scientist of Basic Research, ASD(R&E)
- 0920 Defense Advanced Research Projects Agency (DARPA)**  
CAPT Chris Warren, PhD, Program Manager, Defense Sciences Office (DARPA/DSO)
- 0940 Defense Threat Reduction Agency (DTRA)**  
Ms. Joan Ma Pierre, SES, Director, Basic and Applied Sciences Directorate

- 1000 Break
- 1020 **Army Research Office (ARL/ARO)**  
Dr. Stephen Lee, Chief Scientist; Dr. Dev Palmer, Program Manager
- 1040 **Air Force Office of Scientific Research (AFOSR)**  
Dr. Tom Hussey, Chief Scientist, and Dr. Van Blackwood, Assistant to Chief Scientist
- 1100 **Department of Health and Human Services' Biomedical Advanced Research and Development Authority (DHHS/BARDA)**  
Dr. Gary Disbrow, Deputy Director, Division of Chemical, Biological, Radiological, and Nuclear Countermeasures
- 1120 Break
- 1140 **DoD Small Business Innovative Research/Small Business Technology Transfer program (SBIR/STTR)**  
Mr. Michael Caccuitto, Chief, Technology Integration and Outreach Division, ARO
- 1200 **PANEL: UNC Research Engagement with DoD: Successes, Tips and Best Practices**  
**UNC faculty and staff panelists:**  
Dr. Michael Steer, NC State University; Dr. Pat Gardner, Western Carolina University; Dr. Barry Burks, UNC Charlotte; Dr. Randy Avent, NC State University; Dr. John Morgan, U.S. Army Special Operations Command
- 1245-1300 Wrap Up, Q&A
- 1300-1400 **Lunch** (on own, Williams Cafeteria)
- 1400-1530 **Campus tour** *\*for guest speakers*

2:00	2:15	2:30	2:45	3:00
IRC Lab 018	IRC Lab 105 Lab 122	IRC Lab 134	IRC Lab 222	Cherry Hall 132 McNair Hall 140
<i>Center for Advance Studies in Identity Sciences</i>	<i>Engineering Research Center</i>	<i>Center for Composite Material Research</i>	<i>Center for Human-Centric C2 Decision Making</i>	<i>Battlefield Center of Excellence</i>
<i>Dr. Gerry Dozier</i>	<i>Dr. Jag Sankar</i>	<i>Dr. Kunigal Shivakumar</i>	<i>Dr. Celestine Ntuen</i>	<i>Dr. Shanthi Iyer</i>

# Optimum Warfighter Performance Workshop August 30<sup>th</sup>, 2011

Hosted by the David H. Murdock Research Institute

**9:30am:** Arrive Coffee/social

**10:00:** Intro Welcome – UNC Partnership for National Security

**10:10:** Military Partners Speak on individual Human Performance Programs

USASOC Presenter 1

USASOC Presenter 2

MARSOC Presenter

**11:00:** Presentations: Nutrition and Supplements

**David Neiman, Ph.D.**, Professor, Appalachian State University

**Michael Perko, Ph.D., CHES, FAAHE**, Associate Professor, Dept. of Public Health Education,  
University of North Carolina at Greensboro

## Performance Enhancing Supplements

**11:30:** Discussion: Warfighter Nutrition and Supplements

**12:00pm:** Lunch

**12:45:** Presentations: Strength, Conditioning and Performance

**David Morris, Ph.D.**, Assistant Professor, Dept. Health, Leisure and Exercise Science,  
Appalachian State University

## High Altitude Training, Hyperoxia

**Brenda Bertrand, Ph.D.**, Associate Professor, Dept. of Nutrition Science,  
College of Human Ecology, East Carolina University

## Endurance Athlete Performance Factors

**1:15:** Discussion: Warfighter Strength, Conditioning and Performance

**1:45:** Presentations: Injury Prevention, Recognition, and Recovery

**Sandy Shultz, Ph.D., ATC, CSCS**, Associate Professor, Dept. of Kinesiology, School of Health &  
Human Sciences, University of North Carolina at Greensboro

Lower Extremity Injury

**Christopher Rhea, Ph.D.**, Assistant Professor, Dept. of Kinesiology, School of Health & Human Sciences, University of North Carolina at Greensboro

Assessment and Rehabilitation

**2:15:** Discussion: Warfighter Injury Prevention, Recognition, and Recovery

**2:45:** Closing Discussion and Remarks

**3:00:** Adjourn



# The University of North Carolina Partnership for National Security

*Support the Service Member.  
Contribute to the Mission.  
Grow North Carolina's Defense Economy.*

**NC Defense C4ISR Workshop  
University of North Carolina at Charlotte  
Thursday, March 29, 2012**

## Tentative - Agenda

- 9:00 Registration & Networking
- 10:00 Welcome - Kimrey Rhinehardt (UNC General Administration)
- 10:10 UNC Charlotte Overview - Dr. Bob Wilhelm (UNC Charlotte Vice Chancellor for Research and Economic Development)
- 10:40 Industry/NC Military Foundation - Lance DeSpain (Executive Director)
- 10:55 Break
- 11:00 **Panel 1: C4ISR – Optics**  
Moderator - Dr. Glenn Boreman (Director, UNC Charlotte Optoelectronics Center)
- 12:00 Working Lunch & Networking
- 12:30 **Panel 2: C4ISR - Analytics & Awareness**  
Moderator- Dr. Bill Ribarsky (Director, UNC Charlotte Visualization Center)
- 13:20 Break
- 13:30 **Panel 3: C4ISR - Cyberinfrastructure & Assurance**  
Moderator -Dr. William J. Tolone (Director, UNC Charlotte CCI Defense Computing Center)
- 14:30 Open Discussion - Questions for any Panelists  
Moderator - Dr. Bill Tolone
- 14:50 Tour Instructions
- 15:00 Adjourn (Main Session)
- 15:00 – 15:45 Tour Session 1 & Networking – Optics/Computing/Visualization Labs
- 15:45 - 16:30 Tour Session 2 & Networking-Optics/Computing/Visualization Labs



UNIVERSITY OF NORTH CAROLINA PRESENTS



# ROUND ROBIN

FOR

**DEFENSE RESEARCH**

F O C U S

1-on-1 mentoring sessions for UNC faculty interested in defense research funding and opportunities for transitioning active research programs to military applications.

W H E R E

Research Triangle Regional Partnership

1000 Trade Drive, Suite 124 at RDU Airport, RDU Center, Room 100-A

WHEN:

11.29.12

1:30-4:30 PM

SEE YOU THERE!

CONTACT JOHN JOHNSTON AT [JWJOHNSTON@NORTHCAROLINA.EDU](mailto:JWJOHNSTON@NORTHCAROLINA.EDU)

BY NOVEMBER 16 TO REGISTER

UNC FEDERAL AND MILITARY RELATIONS



## Human Domain Analysis Workshop

**Date: November 14, 2012**

**Location: Airborne & Special Operations Museum in Fayetteville, NC**

**Hosted by: The University of North Carolina system**



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What: The UNC system is hosting a workshop on “Human Domain Analysis” for the U.S. Army Special Operations Command (USASOC). This event is unclassified.

Who is invited:

- Selected academic and industry subject matter experts
- USASOC military and civilian personnel
- Other U.S. government experts and program managers

Summary: The overall focus of the workshop will be quantitative social sciences applied to the needs of special operations forces (SOF) across the spectrum of SOF missions including civil affairs, cultural engagement, stability operations, irregular warfare, etc. Leading experts will discuss cutting edge research, tools and approaches to improve understanding and modeling of human, social, cultural, and behavioral (HSCB) dynamics to inform SOF strategic and tactical planning, intelligence, operations, and assessment. Examples of specific topics include: social network analysis, internet and social media analysis, predictive analytics, and various computational methodologies and advanced analytic tools for understanding terrorist and insurgent networks, forecasting regional instability, course-of-action analysis, decision-making support, and more.

Agenda: A final agenda is forthcoming. The format will include a combination of presentations, panels and discussion sessions. A list of confirmed speakers and panelists is included below.

Examples of research and educational topics of interest:

- analytical methods and tools to support irregular/unconventional warfare operations, including Civil Affairs and Military Information Support Operations
- social network analysis (SNA): computational SNA, methodologies, and tools to analyze relationships among individuals and organizational risk, behavior and future actions
- developing sophisticated link analysis tools (Analyst Notebook is an example of a currently used tool)
- understanding covert networks and networks of terrorists, insurgents, and violent extremist organizations

- analysis of mainstream media and social media feeds such as Twitter, to forecast regional instability, violence, uprisings, etc. (i.e. Arab Spring)
- data mining from online sources (internet, social media, etc.) to assess societal perspectives in a region of interest
- simulations and related tools to gauge potential repercussions of military courses of action (how will local populations react if U.S. Special Operations Forces do X?)
- course of action decision making support tools to assist special warfare operational planners
- projects funded within the portfolio of the DoD Human, Social, Cultural, and Behavioral Modeling program (HSCB) managed by the Office of Naval Research
- agent-based simulations
- data analytics, visual analytics, visualization of complex/heterogeneous data
- civil information management
- strategic assessment models and methods
- simulation systems to improve cross-cultural interaction skills
- educational curricula for advanced analysis

**Confirmed Speakers and Panelists:**

COL	Greg	Wilson	Naval Postgraduate School	SOF Chair and Co-director, Common Operational Research Environment (CORE) Lab
Dr.	David	Sallach	University of Chicago	Senior Fellow, Computation Institute
Dr.	Steve	Chan	Massachusetts Inst. of Technology	Prince of Wales Senior Fellow, Chief Software Architect MIT Geospatial Data Center
Dr.	Colleen	McCue	GeoEye Analytics	Senior Director, Social Science & Quantitative Methods
Dr.	Randy	Avent	N.C. State University	Professor of Computer Science and Associate Vice Chancellor for Research (presenting on behalf of Dr. Christopher Healey, CS dept)
Dr.	Munindar	Singh	N.C. State University	Professor of Computer Science
Dr.	Tom	Carsey	UNC Chapel Hill	Director, Odum Institute for Research in Social Science; Thomas J. Pearsall Distinguished Professor of Political Science
Dr.	Mirsad	Hadzikadic	UNC Charlotte	Director, Complex Systems Institute and Professor of Software & Information Systems
Dr.	James	Walsh	UNC Charlotte	Professor of Political Science
Dr.	Justin	Conrad	UNC Charlotte	Department of Political Science and Public Administration
Dr.	Rick	Bunch	UNC Greensboro	Director, Center for Geographic Information Science, Professor of Geography
Dr.	Nick	Gessler	Duke University	Research Associate, Information Science & Information Studies Program
Mr.	Daniel	Kazmiersk	USAFRICOM	

Dr.	Margaret	Zahn	N.C. State University	Professor, Sociology and Anthropology
Dr.	Navin	Bapat	UNC Chapel Hill	Political Science
Dr.	Todd	BenDor	UNC Chapel Hill	City and Regional Planning
Mr.	Chris	Argenta	Applied Research Associates, Inc.	Mingle data routing platform



**Human Domain Analysis Workshop**  
**November 14<sup>th</sup>, 2012**  
Airborne & Special Operations Museum  
100 Bragg Blvd, Fayetteville, NC



**0745**

**Doors open and registration begins**

*Coffee and light refreshments available in Museum garden area*

**Introduction to Workshop Objectives and User Community**

- |             |  |  |
|-------------|--|--|
| <b>0850</b> | <b>Kathie Sidner</b> , University of North Carolina (UNC) General Administration   | Welcome & Admin                          |
| <b>0900</b> | <b>LTG Charles T. Cleveland</b> , USASOC Commanding General  | Opening Remarks                          |
| <b>0915</b> | <b>Dr. John Morgan</b> , US Army Special Operations Command (USASOC), Command Science Advisor                                      | Human Domain Analysis                    |
| <b>0925</b> | <b>COL Robert Warburg</b> , USASOC Commanding Officer, Military Information Support Operations Command                             | Briefing on current tools and needs      |
| <b>0935</b> | <b>COL Greg Wilson</b> , Naval Postgraduate School SOCOM Chair and Co-director, Common Operational Research Environment (CORE) Lab | CORE Lab Human Domain Advanced Analytics |
| <b>1005</b> | <b>Break</b>   |  |

**Asking The Right Questions: Framing Quantitative Social Science**

**1015**

**PANEL**

**Discussion moderated by: Dr. Lawrence Kuznar**, Indiana University – Purdue University, Fort Wayne, Professor of Anthropology  
**Panelists:**  
**Dr. Margaret Zahn**, N.C. State University, Professor of Sociology  
**Dr. Navin Bapat**, UNC Chapel Hill, Associate Professor of Political Science  
**Dr. James Walsh**, UNC Charlotte, Professor of Political Science  
**Dr. Andrew R. Binder**, N.C. State University, Assistant Professor of Communication  
**Dr. Justin Conrad**, UNC Charlotte, Assistant Professor of Political Science

**Socio-Cultural Modeling & Simulation, Forecasting & Decision Support**

*(Forecasting behaviors and outcomes, course of action analysis, tools to enhance decision making)*

- |             |   |   |
|-------------|---|---|
| <b>1110</b> | <b>Dr. David Sallach</b> , University of Chicago Senior Fellow, Computation Institute   | Multiscale Affect Strategy Analysis: Theory, Tools and Techniques   |
| <b>1125</b> | <b>Dr. Steve Chan</b> , Massachusetts Institute of Technology Prince of Wales Senior Fellow and Director of the MIT-IBM Network Science Research Center | Big Data to Big Insight Decision Engineering: The Art and Science of Human Domain Analysis for Infusing Latent Stability Amidst Dorian Gray Duality |
| <b>1140</b> | <b>Dr. Mirsad Hadzikadic</b> , UNC Charlotte Director, Complex Systems Institute, UNCC  | ACES: Actionable Capability for Social and Economics Systems  |

1155

**PANEL**

**Discussion moderated by: Dr. Nick Gessler**, Duke University  
Research Associate, Information Science & Information Studies Program  
**Panelists:** Sallach, Chan, Hadzikadic

1215

**LUNCH**

**Huske Hardware**

**Socio-Cultural Data Collection & Analysis**

*(Harvesting, analyzing, visualizing and making sense of diverse data sets to understand networks, threats and challenges)*

**1345 Daniel Kasmierski**, US Africa Command  
OSD Science & Technology Advisor      Information, Volume & Velocity (IV2) Joint  
Capability Technology Demonstration

**1400 Chris Argenta**, Applied Research  
Associates, Inc., Senior Scientist, Decision  
Systems Group      Irregular Warfare with Mingle: A platform for  
the automated discovery and distribution of  
operationally relevant information

**1415 Dr. Colleen McCue**, GeoEye Analytics  
Senior Director, Social Science &  
Quantitative Methods      Geospatial Predictive Analytics: Information-  
Based Approaches to Prevention, Thwarting,  
Mitigation and Response

1430

**PANEL**

**Discussion moderated by: MAJ Bull Holland, Ph.D.**, USASOC, S&T Division Chief  
**Panelists:** Kasmierski, Argenta, McCue

1450 **Break**

**1505 Andy Kowal**, Telum Protection Corp.  
Chief Operating Officer      The Gist Mill: Strategic Social Media  
Analytics

**1515 Dr. Randy Avent**, N.C. State University, Professor of  
Computer Science, Associate Vice Chancellor for  
Research *(presenting on behalf of Dr. Christopher  
Healey, Associate Professor of Computer Science)*      Human Perception for Visual  
Analytics

**1525 Dr. Rick Bunch**, UNC Greensboro  
Director and Professor, Center for Geographic  
Information Science      Space Analysis

1535

**PANEL**

**Discussion moderated by: Ed Petkovich**, President, Walsingham Group, Inc.  
**Panelists:** Kowal, Avent, Bunch

**Looking Ahead**

1550

**PANEL**

**Discussion moderated by: Dr. John Morgan**, USASOC Command Science Advisor  
**Panelists: Dr. Tom Carsey**, UNC Chapel Hill, Director, Odum Institute for Research in Social  
Science and Distinguished Professor of Political Science  
**Dr. Todd BenDor**, UNC Chapel Hill, Assistant Professor of City and Regional Planning  
**Dr. Munindar Singh**, N.C. State University, Professor of Computer Science

1630 **Adjourn**

# Advanced Protective Materials S&T Exchange

## April 9th, 2014

### Academic Subject Matter Expert Bios

#### **Donald Brenner**

Kobe Steel Distinguished Professor and Associate Department Head, Materials Science and Engineering  
NC State University

Prof. Brenner's research focuses on the development and characterization of new materials using atomic and mesoscale modeling methods. His recent research has focused on the dynamics of materials under extreme conditions, including shock loading of advanced aluminum alloys for light-weight vehicular armor applications, hot spot dynamics related to the initiation of energetic materials, the chemistry of metal-oxide deposits on fuel rods in nuclear reactors, and the design of stable nanostructured alloys for extreme temperatures and loading conditions. He has also worked extensively on carbon-based structures, including functionalized nanodiamonds and polymer-nanotube composites.

#### **Mohammed A. Zikry**

Zan Prevost Smith Distinguished Professor  
Mechanical and Aerospace Engineering  
North Carolina State University

Dr. Zikry's research interests are in the general areas of multiscale modeling, mechanics of materials, fracture mechanics, micromechanics, and computational mechanics. He is developing analytical, computational, and experimental methodologies that can be used to predict material and structural response at physical scales that range from the nano to the macro levels. These physically-based predictive tools are needed for universal scaling laws that can be used to understand how material behavior can be harnessed for new and significantly improved materials, devices, and systems. He received his Ph.D. from the University of California, San Diego, his M.S. from the Johns Hopkins University, and his B.S. from the University of Kansas. Amongst his recent awards, he has received the Jefferson Science Award (U.S. State Department), Senior Research Fulbright Award, the ALCOA Distinguished Research Award, the Research Excellence Award (NCSU) and the Ralph Teetor Research Award from the Society of Automotive Engineering. He has been awarded a Professeur, Premiere Classe, Strasbourg University, and he is also a Fellow of the American Society of Mechanical Engineering (ASME), the Editor in Chief of the ASME journal of the Engineering Materials and Technology, the Regional Editor for Mechanics of Materials, and was the Chair of the Executive Committee of ASME's National Material's Division. He has been a senior research advisor to the Army Research Office and the Department of Defense, and a consultant to numerous industries.

**Edward T. Samulski**

Cary C Boshamer Professor of Chemistry  
University of North Carolina - Chapel Hill

Dr. Samulski designs polymers for novel applications from solar energy to high performance materials for aerospace vehicles. At Carolina, he served as Chair of the Department of Chemistry and as Director of a NASA University Research Engineering and Technology Institute on Biologically Inspired Materials. He is also co-founder of Liquidia Technologies, a Research Triangle start-up company formed to bring to the marketplace a new technology for producing nanoparticles for drug/gene delivery and for enabling surface structures that enhance solar energy efficiency. Derived from his collaborative work with UNC colleague Joe DeSimone, Liquidia has raised \$50 million in venture financing and has won awards for its promising technology. In 2008 he founded Allotropica Technologies, a start-up commercializing high performance composites based on a new polymer system discovered at NASA. Last year he co-founded EiPI Systems, a start-up focused on rapid 3-D printing. From 2005 to 2006 he served as a Jefferson Science Fellow at the U. S. State Department, providing scientific and technical advice to policy makers in Washington. He has held visiting faculty positions at distinguished scientific laboratories including the Cavendish Laboratory at Cambridge University in England; the Weizmann Institute in Israel; and the Laboratory of Solid State Physics, University of Paris (Sud) in France. He was a Guggenheim Fellow in New Zealand, where he was a founding member of the MacDiarmid Institute for Advanced Materials and Nanotechnology, named for Nobel Prize winner Alan MacDiarmid, and he remains on the International Advisory board of the Institute. Samulski got his Ph.D. in chemistry from Princeton University, where he wrote the first dissertation in the field of polymeric liquid crystals. A fellow of both the American Physical Society and the American Association for the Advancement of Science, Samulski was the founding editor of the journal Liquid Crystals. He was recruited to Carolina to create the Polymer and Materials Science Program, recently ranked among the top three in the nation.

**Ajit D. Kelkar**

Professor and Chairman, Nanoengineering  
Joint School of Nanoscience and Nanoengineering  
University of North Carolina - Greensboro

Dr. Ajit D. Kelkar is a Professor and Chair of Nanoengineering department at the Joint School of Nanoscience and Nanoengineering. He also serves as an Associate Director for the Center for Advanced Materials and Smart Structures. For the past twenty five years he has been working in the area of performance evaluation and modeling of polymeric composites and ceramic matrix composites. He has worked with several federal laboratories in the area of fatigue, impact and finite element modeling of woven composites including US Army, US Air force, NASA-Langley Research Center, National science Foundation, Office of Naval Research, and Oak Ridge National Laboratory. In addition he has collaborated with Rice University, Texas A&M University, Tuskegee University, Air Force Institute of Technology, University of Dayton, Florida State University, Prairie View A&M University, University of Delaware, Texas State University, University of Minnesota, University of California, and San Diego. His expertise are in the area of low cost

fabrication and processing of woven composites using VARTM process, fatigue and impact testing of composites, analytical modeling of woven composites. Presently he is involved in the development of nano engineered multifunctional materials using XD CNTs and electro spun fiber materials. He is also involved in reengineering of helicopter components using out of autoclave processing. In the past he has worked on the one step processing of Composite Armored Vehicle using low cost VARTM. In the modeling area he is working on atomistic modeling of polymers embedded with CNTs and alumina nanoparticles. He is also involved in high velocity impact modeling of ceramic matrix composites and polymeric matrix composites embedded with electrospun nanofibers. He has published over two hundred papers in these areas. In addition he has edited a book in the area of Nano Engineered materials. He is member of several professional societies including ASME, SAMPE, AIAA, ASM, and ASEE.

### **Glenn D. Boreman**

Professor and Chair, Dept. of Physics & Optical Science  
Director, Center for Optoelectronics & Optical Communications  
University of North Carolina at Charlotte

Glenn Boreman, Chair of the Dept of Physics and Optical Science at UNC Charlotte, has a 30 year involvement in infrared technologies research. He has developed concepts for nanoscale surface treatments for control of infrared spectral emissivity as a function of wavelength, polarization state, and direction. Means for transitioning these approaches to practical size scales are under development, including production of metamaterial-based paints. Potential applications space includes signature management and tagging. Dr. Boreman is a fellow of the Military Sensing Symposium and of the Optical Society of America.

### **Michael B. Steer**

Lampe Distinguished Professor of Electrical and Computer Engineering  
North Carolina State University

Dr. Steer's interests are in RF and microwave engineering. Relevant to this meeting his expertise is in RF signature management and in absorbing/deflecting materials. He is also concerned about next generation armor and how it will impact RF signatures and co-site interference. One of the unfortunate lessons learnt over the last decade in the development of c-IED systems is the crippling interaction of IED jamming and detection systems with other electronics and the vehicle structure. Systems that had almost ideal performance when field tested in isolation failed when integrated on vehicle platforms. This resulted from RF signals interacting with other electronics and the vehicle structure itself to generate either spurious signals that masked the small signals reflected from targets, or they saturated blue force systems. We have learnt at enormous cost that a whole system approach is needed for the integrated design of vehicles including the design of electronic systems, of armor, and of signals. The same can also be said for personal protection systems. The challenge in this workshop is developing separable R&D topics that work with an integrated whole system approach. Dr. Steer is the author of a leading RF and microwave engineering textbook "Microwave and RF Design: A Systems Approach." He received numerous awards for his military contributions including an Army Medal, the



"Commander's Award For Public Service," from the MG Nick Justice, the CG of the U.S. Army Research, Development and Engineering Command (RDECOM), for his contributions to electronic warfare and in particular detecting and neutralizing improvised explosive devices. He has also received two Bronze Medallions from U.S. Army Research for Outstanding Scientific Accomplishment. He has been inducted into the Electronic Warfare Technology Hall of Fame sponsored by the Association of Old Crows.

**Roger L. Barker**

Burlington Distinguished Professor of Textiles  
North Carolina State University

Dr. Barker is an expert in advanced protective textiles and clothing systems. He is the Director of the Textile Protection and Comfort Center (TPACC), widely regarded as the most advanced academic laboratory for the development and testing of personal protective gear in the world. TPACC is home to the Pyroman™ and Man-In-Simulant-Test (MIST) research facilities can be found at no other U. S. university. The Pyroman System™ has been the first line of support for testing the ability of FR military gear to mitigate burn injuries associated with exposures to fire and intense heat. The MIST facility provides ability to evaluate the chemical vapor protection of full scale soldier CBRN ensembles. TPACC's environmental chambers and sweating manikins provide means of measuring the effects of clothing on human thermal comfort and heat stress over a range of hot and cold climatic conditions. These unique laboratory assets are used to develop advanced textile materials and gear for defense and security applications. TPACC research successfully developed next generation CB suit and CB boots, as well as thermally protective gloves with enhanced dexterity. Dr. Barker is currently leading a major DHS/FEMA AFG research project that is utilizing temperature reactive protective materials and advanced garment design concepts to develop a revolutionary suit prototype that provides protection with less weight and enhanced breathability for firefighters.



**University of North Carolina**  
*Partnership for National Security*



**US Army Research Office**

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## **Science & Technology Exchange Series**

### **Topic: Advanced Protective Materials**

**April 9th, 2014**

**Research Triangle Regional Partnership (RTRP)**  
**1000 Trade Drive, Morrisville NC**

The U.S. Army Research Office (ARO) and University of North Carolina (UNC) are hosting an exchange to bring together subject matter experts from the UNC system and local industry to explore futuristic protective materials for the U.S. Army Special Operations Command (USASOC).

**Outcome:** The intent of this meeting is to generate the information necessary to produce small business research (SBIR / STTR) and Broad Agency Announcements (BAA) inputs which will focus government investment on the advancement of science in specific areas of interest to USASOC. The method for producing these results will be to have members from Academia and Industry describe where investments are required to advance the state-of-the-science for their areas of expertise. USASOC participants will be responsible for determining how these advances in science may have military utility. This is the opposite of the traditional approach of telling the research community what USASOC's needs are; rather, this is asking the research community what is the next investment required to advance the field.

**Agenda:**

- 0830 Arrival and Coffee
- 0900 Discussion Topic #1: Operator worn armor
- 0940 Discussion Topic #2: Vehicle armor
- 1020 Break
- 1030 Discussion Topic #3: Signature management materials (infrared, RF, absorbing/deflecting materials)
- 1110 Discussion Topic #4: Reactive fibers that operate in extreme temperatures (-50 to 100F)
- 1150 Wrap Up Discussion
- 1215 Adjourn

Target participants include researchers with innovative ideas for future generation materials, design concepts, and ways to overcome current S&T challenges. UNC experts can provide significant knowledge on cutting edge research and emerging scientific discoveries, to inform future possible capabilities of which USASOC may not be aware. USASOC is looking for non-traditional input from scientists and engineers who may or may not have played a role in DoD projects in the past. Attendees will learn general information about Army SOF and gain a better understanding of user needs. Participation is by invite only.

## About USASOC



The U.S. Army Special Operations Command (USASOC) is the largest of the service components that make up U.S. Special Operations Command and provides about 70 percent of the special operations personnel in Central Command's theatre. On any given day, dozens of USASOC elements are deployed around the world. Made up of 26,000 personnel, USASOC combines a vast range of skills from raiding and airfield seizures, to human-terrain mapping and cultural analysts.

The mission of the Science and Technology (ST) is to coordinate Science and Technology (S&T) innovation for the United States Army Special Operations Command (USASOC) allowing Army Special Operations Forces (ARSOF) to extend its effectiveness into the future. ST is a warfighter-driven organization that coordinates and responds to short and long term S&T gaps of USASOC. It establishes programs and partnerships to direct resources to USASOC S&T gap areas within the special operations community, the Army, and external research and development agencies. ST identifies opportunities and facilitates the transition of new technologies with the subordinate commands and units of USASOC.

## About UNC



The University of North Carolina is a public, multi-campus university dedicated to the service of North Carolina and its people. Chartered in 1789, UNC was the first public university in the United States and the only one to graduate students in the eighteenth century. Today, UNC is a multi-campus university composed of all 16 of North Carolina's public institutions that grant baccalaureate degrees, as well as the NC School of Science and Mathematics, the nation's first public residential high school for gifted students. These diverse constituent institutions share the overall mission of the University to discover, create, transmit, and apply knowledge to address the needs of individuals and society. This mission is accomplished through instruction, research, scholarship, creative activities, and public service.

## UNC - USASOC Partnership

On November 12, 2009, LTG John F. Mulholland of the United States Army Special Operations Command (USASOC) and University President Erskine Bowles (UNC) signed a Memorandum of Agreement to establish a formal working partnership. On April 16, 2013, LTG Charles Cleveland and UNC President Tom Ross signed an updated version of the MOA. Select initiatives include:

- UNC National Security Fellowship for USASOC officers
- Agriculture and veterinary pre-deployment training for the 95<sup>th</sup> Civil Affairs Brigade
- Special Operations Medic Instructor residency rotations
- Foreign language and culture skills development support
- Specialized undergraduate and graduate degree tracks
- Warfighter performance enhancement
- Science and technology applications to enhance Warfighter capability on the battlefield

## Data-driven Methods for Identifying Emerging Topics and Trends

### *Final Technical Report*

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<b>Prime POC</b>	<b>UNC Charlotte POC</b>
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## Project Overview

This project researched capabilities for identifying emerging topics and trends based on large corpora of structured and unstructured data. It was anticipated that this effort would complement and integrate with current USSOCOM initiatives aimed at developing a Virtual Collaboration Tool and technology “crawler” tools to enable forecasting of science and technology breakthroughs that will impact USSOCOM’s mission and capabilities for special operations forces.

The project was organized into two phases under a single continuous contract. Phase I executed primarily from August 2013 to January 2014. Phase II executed primarily from July 2014 to December 31, 2014 (the contract end date).

## Phase I Task Summary

The Statement of Work for Phase I contained four (4) tasks:

- Data Development and Preparation

Data on federally funded research projects and their resulting publication are available online for several programs and agencies. During Phase I, the UNC Charlotte team:

1. Acquired corpora of raw, open-source data for analysis. Initial data development took about a month. Additional data development continued throughout the project as required.
2. Data preparation activities organized the structured and unstructured data for automatic analysis and subsequent visual exploration. Initial data preparation took 4-6 weeks. Additional data preparation occurred throughout Phase I as required.

- Research Design and Prototyping

Research design and prototyping was conducted iteratively using an agile research methodology that emphasized frequent customer communication.

1. The design of the analytical capability included both interaction and visualization design.
2. Analytical capability prototypes were generated. Paper-based (e.g., visual storyboards) were not employed; rather, only technology-based (e.g., technology mockups) were produced.

- Research Develop and Evaluation

Research development and evaluation was conducted iteratively using an agile research methodology.

1. Research on topic modeling and analytics – e.g., topic identification and characterization was performed.
2. Research trend analytics at multiple temporal scales across varied operational scope was also performed.

- Research Administration

Research administration covering all research reporting, scheduled communications and face-to-face meetings was performed.

## Summary Phase I Outcomes

The UNC Charlotte Team conducted research that produced intuitive, interactive visualizations that leveraged techniques for data science and business analytics. Outcomes included the following:

- A total of 112,877 federally funded STTR/SBIR project abstracts were collected – 104,858 SBIR and 8,019 STTR, respectively
- A capability demonstration and briefing of pilot research results was provided to USSOCOM's Executive Acquisition Officer, who is the director of the Special Operations Research Development and Acquisition Center (SORDAC) on 24 OCT 2013
- Due to weather events, scheduling conflicts and technical limitations at USSOCOM/SORDAC, deployment of demonstration capability occurred in spring 2014.
- The UNC Charlotte Team also conducted a case study evaluation to connect research results to the USSOCOM TALOS Initiative
  - System leveraged key terms from TALOS RFP as indicators
  - Over 6000 TALOS related SBIR/STTR proposals selected from corpus
  - Initial topic modeling analysis was completed and organized for fast investigation
  - Deeper analysis using intuitive, interactive visualizations was demonstrated
- The UNC Charlotte Team also developed a second corpus for rapid, scalable analysis. This corpus included 3-4TB of data from DTIC

## Phase II Task Summary

The Statement of Work for Phase II contained four (4) tasks:

- Advanced Data-driven Methods for Identifying Emerging Research Topics and Trends

The UNC Charlotte Team continued technology research and prototyping advanced topic modeling capabilities to identify technology trends and patterns relevant to USSOCOM mission requirements.

- Business Modeling for Data Fusion and Projections

The UNC Charlotte Team continued to develop data sources to support technology scouting research question.

- Context-driven Business Analytics

The UNC Charlotte Team performed limited task analysis (at the sponsor's direct) to understand the technology scouting activity.

- Research Administration

Research administration covering all research reporting, scheduled communications and face-to-face meetings was performed.

## Summary Phase II Outcomes

The UNC Charlotte Team received the following specific guidance from the sponsor for Phase II:

- Conduct the research necessary to move the analytical capability forward
- Execute research and development to overcome architectural limitations
- Conduct research to expand exploratory capabilities
- Conduct research to enhance classification capabilities
- Defer most task integration/transformation research – i.e., context-driven business analytics – until subsequent research engagement

The following this guidance, the UNC Charlotte Team conducted research that advanced the intuitive, interactive visualizations and analytical techniques to support technology scouting. Specific outcomes included the following:

- The UNC Charlotte Team research and developed a search-by-example proof-of-concept research and validation. The team also researched and developed statistical/probabilistic approach to data organization and retrieval. The impacts of this effort are:
  - Expands capabilities for exploratory analyses
    - Enables the retrieval other documents that are statistically similar to a given example
  - Provides a data-driven approach to document classification – e.g.,
    - Enables the classification of TILO submissions – similarity to previous submissions and other efforts
    - Facilitates the identification of evaluators
- The UNC Charlotte Team conducted a comprehensive architectural refactoring of the analytical capability. This effort transformed the analytical capability from a desktop architecture to client-server architecture. The impacts of this effort are:
  - Overcomes several technical limitations revealed during Phase I
  - Demonstrates technical scalability of the approach
  - Makes a significant advance on the pathway toward enabling capability diffusion to other agencies
- The UNC Charlotte Team conducted large-scale, noisy data validation. To conduct this effort the team demonstrated ingestion of a noisy 3-4 TB data set. The impacts of this effort are:
  - Evaluates the impact of data quality relative to the approach.
  - Demonstrates a data segmentation approach to data quality mitigation
  - Validates client-server architecture
- The UNC Charlotte Team research and prototyped several user interface enhancements. The primary impact of this effort was to improve the utility of the capability as well as the user experience

All research and development was completed prior to 31 December 2014. However, due to scheduling conflicts the delivery of the Phase II analytical capability and supporting documentation occurred during a campus visit by the USSOCOM Program Manager on 22 January 2015.

## Selected Phase I / Phase II Screenshots

The following contains illustrative screenshots of the analytical capability that resulted from the Phase I and Phase II research effort.





