

# VACCINE

Visual Analytics for Command, Control and Interoperability Environments  
A U.S. Department of Homeland Security  
Science and Technology Center of Excellence

## VACCINE ANNUAL REPORT – YEAR 3

April 1, 2011 – March 31, 2012

Cooperative Agreement No. 2009-ST-061-CI0001

# PURDUE

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HOMELAND SECURITY UNIVERSITY PROGRAMS  
TODAY'S RESEARCH & EDUCATION, TOMORROW'S SECURITY

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## I. Summary

### A. Overview

Established in July of 2009, the Visual Analytics for Command, Control, and Interoperability Environments Center (VACCINE), along with its co-lead, Rutgers University, has served as the Department of Homeland Security's (DHS) Center of Excellence in Command, Control and Interoperability. VACCINE's mission continues to focus on creating methods and tools to analyze and manage vast amounts of information for all mission areas of homeland security. VACCINE accomplishes its mission through an integrated program of research, education and outreach, spanning the disciplines of visualization and computer graphics, engineering, computer science, geographic information systems, cognitive psychology, information technology, and emergency management and public safety. VACCINE is an international center with overall management and the lead research component handled by Purdue University. The education/MSI mission is directed by the University of Houston-Downtown with Georgia Tech providing an advisory role. VACCINE now has five official MSI partners, and we are currently working with Tennessee State University and Fayetteville State University on individual projects. The VACCINE team is currently comprised of the following 26 universities with the associated Principal Investigator listed for each school:

<i>University</i>	<i>PI</i>
Arizona State University	Dr. Ross Maciejewski
California State Univ, Dominguez Hills(MSI)	Dr. Mohsen Beheshti
Carleton University, CA	Dr. Jim Davies
Dalhousie University, CA	Dr. Kirstie Hawkey
Florida International University (MSI)	Dr. Shu-Ching Chen
Georgia Institute of Technology	Dr. John Stasko
Indiana University	Dr. Shaun Grannis
Justice Institute of British Columbia, CA	Dr. John Dill
Morgan State University (MSI)	Dr. Timothy Akers
Navajo Technical College (MSI)	Mr. Tom Davis
Ontario Institute of Technology, CA	Dr. Christopher Collins
Pennsylvania State University	Dr. Alan MacEachren
Purdue University	Dr. David Ebert
Simon Fraser University, CA	Dr. Brian Fisher
Stanford University	Dr. Pat Hanrahan
Swansea University, Wales	Dr. Min Chen
University of British Columbia, CA	Dr. John Dill
University of Calgary, CA	Dr. Sheelagh Carpenter
University of Houston, Downtown (MSI)	Dr. Richard Alo

<b>University</b>	<b>PI</b>
University of Manitoba, CA	Dr. Pourang Irani
University of North Carolina, Charlotte	Dr. William Ribarsky
University of Oxford, UK	Dr. Min Chen
University of Stuttgart, Germany	Dr. Tom Ertl
University of Texas at Austin	Dr. Kelly Gaither
University of Victoria, CA	Dr. Evert Lindquist
University of Washington	Dr. Mark Haselkorn
Virginia Tech	Dr. Chris North

Figure 1: University Partners and Principal Investigators

VACCINE is strategically positioned to support the Department of Homeland Security in confronting the challenges of safeguarding our nation in preventing, responding to, and recovering from events in applications including criminal investigation, health surveillance, fraud detection, emergency response, natural disasters, and border and infrastructure security. VACCINE focuses on the research, development, and deployment of interactive visual analytic environments for communicating and disseminating information and deriving insight from the massive homeland security data deluge. VACCINE is developing tools to help homeland security personnel, responders, and decision makers make sense of the sea of text, sensor, audio, and video data by developing powerful analytical tools and interactive visual decision making environments that enable quick, effective decisions as well as effective action and response based on available resources. VACCINE integrates data and analysis into interactive visual displays to enable users to make discoveries, decisions, and plan action. Applications include public safety, public health, and emergency response. Turning massive data into actionable knowledge through visual analytic techniques is vital to the mission of the Infrastructure Protection & Disaster Management Division of The Department of Homeland Security, as well as all of the mission areas of DHS.



Figure 2: VACCINE International Team Members and Partners

## B. Accomplishments

During Year 3, the VACCINE team worked diligently to create a robust portfolio of research and academic projects as well as make significant progress in our outreach and overall marketing activities. Highlights of our team’s efforts include the data in Figure 3 as well as these activities:

- VACCINE continued building our **multi-agency public safety consortium** with organizations within the state of Indiana and developing new relationships with organizations such as the Indiana Intelligence Fusion Center. A Memorandum of Understanding was also negotiated with the Ohio Department of Public Safety, which includes the Ohio Dept. of Homeland Security and the Ohio State Highway Patrol. We also have public safety partners in other states such as the Charlotte-Mecklenberg Police, UNC Charlotte Police and UNC Public Safety Department in North Carolina; the Harrisburg Police in Pennsylvania; and the Miami-Dade County Department of Emergency Management in Florida, who work with our partner institutions.
- As part of the COE **marketing plan initiative** through DHS and in conjunction with CCICADA, we have developed a new brochure featuring the research and educational activities of VACCINE which will be distributed to partner schools and organizations, our DHS contacts, Congressional representatives, other COE’s, and prospective organizations and agencies with whom we hope to work in the future. We are awaiting the delivery of a two-minute video, professionally produced through the information technology area at Purdue, which will also be used to market VACCINE’s activities.

- Our **Visual Analytic Law Enforcement Toolkit (VALET)** continues to be used in the Lafayette, West Lafayette, and Purdue Police Departments, Indianapolis Police Department, and the Tippecanoe County Sheriff's Office. We continue to receive input and feedback and make adjustments to the technology. Steve Hawthorne, crime analyst for the Lafayette Police Department, presented VALET at the International Association of Crime Analysts Conference in September, 2011. The mobile version of VALET (iVALET) was delivered to the Purdue and West Lafayette Police Departments in October, 2011. The Ohio State Highway Patrol and TSA have also expressed an interest in utilizing VALET within their organizations.
- **VALET** was also used for analysis and presentation of high-risk alcohol behavior in the Purdue campus area, working with Purdue Student Health, Housing, EMS/Fire, and Police members. A presentation was given to campus representatives at the annual Alcohol Summit held at Purdue University. The resulting findings and analysis are being integrated into educational and enforcement programs at Purdue.
- **VACCINE** was awarded the **Commander Atlantic Area's Excellence Coin**, a prestigious award presented by the US Coast Guard, in recognition of our work with District 9 in search and rescue/resource allocation and District 1 in conjunction with the PROTECT project and the CREATE Center.
- **Jigsaw** is being used by the Indianapolis Police Department, the West Lafayette Police Department, the Rock Hill Police Department (SC), and the Lafayette Police Department. Purdue has an undergraduate student working part-time in the West Lafayette Police Department to assist them in solving cold cases utilizing Jigsaw. Currently, over 150 people and organizations have downloaded the system, including Air Force Intelligence, AFRL Wright Patterson, Army Counterintelligence, Boeing, Deloitte, Naval Research Lab, NCIC, PayPal, Thomson Reuters, United Nations Investigators Office, US Attorney's Office Organized Crime Taskforce, as well as numerous newspapers and police departments.
- **Motorola Solutions, Inc.** renewed its membership in **VACCINE's Limited Liability Corporation**, VACCINE, LLC, with a gift of \$40,000 for a second year. We continue to talk with corporations who may be interested in joining this organization, including Northrop Grumman and Eli Lilly.
- **GARI (Gang Graffiti Recognition and Analysis)** is being used by the Indianapolis Metropolitan Police, the Indiana Intelligence Fusion Center Gang Task Force and gang detectives across Indiana (fall 2011). We are working with the Indiana State Police to handle the distribution of the tool to law enforcement personnel because identification verification is required for use. There are currently approximately 30 users and nearly 700 graffiti images within the GARI database.
- Penn State has received complementary funding from the National Geospatial-Information Agency and the US Army Corps of Engineers to continue development of **SensePlace2** involving social media data. The research team continues to work actively with personnel in the Harrisburg Bureau of Police to refine the **CrimeViz** web-mapping software for their use and distribute the tool more broadly. In addition, Penn State launched a public-facing **SymbolStore** and is collaborating with SBIR partners at

Charles River and Physical Optics, along with PNNL, to begin to transition the tool to a larger audience.

- **COE Explorer** continues to be a joint project between VACCINE and CCICADA and has received accolades from DHS for its usefulness with investigators, program officers and policymakers. Current and future improvements to the tool include social network analysis, improved quality and contents of the dataset being visualized, and providing textual content.
- We continue to develop our relationship with the **US Coast Guard and expand use of the Coast Guard Search And Rescue Visual Analytics (cgSARVA)** technology to other areas of the Coast Guard. The cgSARVA technology was utilized in analyzing swimmer deaths and also provided information used for the Coast Guard swimmer and boating safety public information campaign in 2011 and for the number of patrols used in 2011, leading to a significant decrease in deaths in 2011.
- VACCINE, in conjunction with the CREATE Center, analyzed the **PROTECT** model for security patrols in Boston and made recommendations for improvements for deployment in New York City.
- **cgSARVA** was used to determine the allocation of resources during **Hurricane Irene** which occurred along the east coast in the summer of 2011. The Coast Guard initially discussed diverting resources from the Great Lakes area to the east coast, but the data from cgSARVA indicated that there was a demonstrated need to keep this region fully resourced at that time and to draw the resources from another region.
- As part of the **COAST** project, we continued work to develop the cgSARVA suite of tools that can be used to analyze all Coast Guard operations across the United States, based on module-based relationships.
- We continue to develop a relationship with the **Coast Guard Sector Puget Sound Leadership**, through our partners at the University of Washington, and hope to become involved in future projects, depending on funding.
- VACCINE also developed visual analytics tools to **analyze the effects of closing Port Arthur, TX** in 2011, including the economic impact and the effectiveness of alternative mitigation strategies. VACCINE worked closely with the CREATE center to study local and national impact of port closures of varying lengths.
- Our **mobile phone hazardous material app (MERGE—Mobile Emergency Response Guide)** was delivered to TSA to be used in railcar inspections. Our tool allows a first responder to take a picture of the placard on a railcar or truck containing hazardous materials. It identifies the materials and provides response instructions quickly and simply. The information provided is tailored to the expertise level of the user, such as a police officer with minimal training (e.g., stand back 500 ft and call personnel with hazmat suits) to a fire fighter hazmat crew (e.g., treatment material, remediation protocols). MERGE was used in an exercise with Carroll County Emergency Management (IN) personnel which demonstrated that first responders could identify the appropriate response protocol much more quickly using MERGE than the standard emergency response guidebook.

- The **Travel Response Investigative Profiler**, better known as **TRIP**, was developed to understand the movement behaviors and spatio-temporal patterns of individuals. This technology was presented by the Indiana Intelligence Fusion Center as one of the “Fast Track” presentations at the National Fusion Center Training Event in Phoenix. Future research may lead to modeling an individual’s movement pattern based on correlation analysis among individual movements and infrastructures.
- In collaboration with NCFPD, research was conducted by the VACCINE team on the **possible correlation between animal and human health**, based on a study of the effect of seasonal influenza and its correlations with different companion animals (dogs, cats) syndromes within the Indianapolis area. The study indicated a moderate correlation between dogs and humans within this geographic area and suggests a future direction to investigate further links.
- The University of North Carolina at Charlotte has delivered an **evacuation decision support system and Urban Emergency Response search and command center tools** to the UNC Charlotte Police and Public Safety Department. The tools have been used in the Canada-US Experiment Resiliency Environment demonstration in Seattle at which DHS managers were in attendance.
- An improved prototype system and iPad application based on Florida International’s “**Integration Framework for Enhancing Emergency Response**” system continue to be evaluated by personnel at Miami-Dade Emergency Management (MDEM), and future pilot activities are planned as part of the evaluation process.
- Simon Fraser University has received financial support from PSTP (Public Security Technical Program) for their collaboration with the City of Richmond’s emergency management. Two workshops on **social media for emergency managers** were held and both reached maximum capacity.
- We continue to develop our network of **Minority Serving Institutions** for engaging in visual analytics and network security research and education. Morgan State University, University of Houston-Downtown and Navajo Technical College are official partners, and Tennessee State University and Fayetteville State University have expressed interest in collaborating with us on individual projects and proposals. Through Richard Alo’s connections with California State-Dominguez Hills, undergraduate students participated in affinity research groups this past year to become involved in specific research projects.

In September 2011, we hosted a **workshop in Banff, Canada**, for the purpose of further developing interest in visual analytics within Canadian institutions and organizations. We worked closely with a number of Canadian universities and VIVA (Vancouver Institute for Visual Analytics) to organize the agenda around topics of specific interest to Canadian organizations, and 40 participants attended the workshop. As a result, three seed grant awards were given to fund follow-on workshops and networking efforts. The titles of the three workshops/networking events selected are **Visualization and Policy Making: Theoretical and Empirical Explorations**, Univ. of British Columbia and Simon Fraser University; **Financial Systemic Risk Analysis**, Univ. of British Columbia; and **Personal Visual Analytics**, Univ. of Victoria, Univ. of Calgary, and Dalhousie University.



<b>VACCINE Accomplishments (April 1, 2011 – March 31, 2012)</b>	
Research Themes	38
Education Themes	6
Seed Projects Funded	5
Peer-reviewed/Refereed Journal Articles/Publications/Papers	82
Presentations	63
Other Reports	18
Scholarly Journal Citations of Published Reports	390
Student Theses	5
Patents (applied and awarded)	9
Graduate Students Participating in VACCINE Programs	50
Minority Students Participating in VACCINE Programs	9
HS-STEM Student Theses	2
HS-STEM Students Enrolled	9
K-12 Student Participation	30
VAST Challenge 2010 Awards	6
Period 2 Base Funding	\$1,399,808
Additional DHS Funding (BOA, Supplemental, etc.)	\$640,823
Funding from other Agencies Leveraged	\$5,552,974
VACCINE, Limited Liability Corp. Funding	\$40,000
Total of all Funding	\$7,633,605

Figure 3: Summary of VACCINE Accomplishments

### C. Business Model and Management Scope

The role of developing detailed operational requirements is critical for the successful transition of technologies into the various homeland security fields. The VACCINE Center of Excellence recognizes the need for significant end-user-in-the-loop involvement in the entire life cycle development process. The VACCINE team has refined our business model (Figure 4) with the goal of connecting homeland security researchers with the first responder community. Understanding the requirements of our end-users is key to the research and development of technologies that can be transitioned to the broader public safety community. Our Public Safety Consortium consists of a number of law enforcement, fire, and emergency management agencies that allow data to be shared and research conducted, furthering the development of next generation homeland security technologies.

The Consortium provides a framework where VACCINE can deploy its tools to the various agency members, and our end-users provide in-field or real world evaluation feedback on their requirements. The group meets regularly to discuss ongoing requirements to technology being developed, improvements to technologies that have been deployed and are being evaluated, as well as to brainstorm tools that are needed. VACCINE sees this Consortium as a resource that can be utilized by not only VACCINE but also DHS S&T. The Public Safety Consortium continues to grow, and VACCINE has recently reached out to other states outside the State of Indiana to engage their public safety professionals in our discussion of new technologies. Our ultimate goal is to develop technologies that have been vetted and verified by having end-users in the development process. Technologies that have been designed in this fashion will be able to transition across a larger community of end-users geographically.

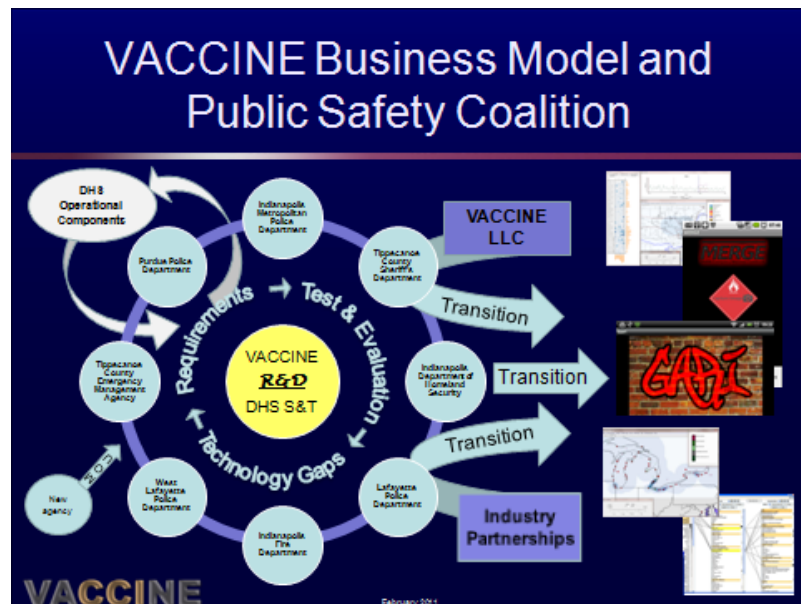


Figure 4: VACCINE Business Model

Our team has a strong collaboration history and experience that is essential to foster internal collaboration, as well as collaboration with CCICADA, other DHS COEs, government agencies, field personnel, and other researchers. Our Center's management organization has three components: management staff, a leadership board, and a senior external advisory board. The management staff is intentionally lean in order to maximize research and education dollars while helping to minimize overhead. This team is responsible for overseeing the strategy, as well as the day to day operations of VACCINE, including interfacing with DHS, CCICADA and all external partners.

**The management staff** consists of the following:

- Center Director and Research Director – David Ebert

David Ebert is a Professor in the School of Electrical and Computer Engineering at Purdue University, a University Faculty Scholar, a Fellow of the IEEE, and Director of



the Visual Analytics for Command Control and Interoperability Center (VACCINE), the Visualization Science team of the Department of Homeland Security's Command Control and Interoperability Center of Excellence. Dr. Ebert performs research in novel visualization techniques, visual analytics, volume rendering, information visualization, perceptually-based visualization, illustrative visualization, mobile graphics and visualization, and procedural abstraction of

complex, massive data. Ebert has been very active in the visualization community, teaching courses, presenting papers, co-chairing many conference program committees, serving on the ACM SIGGRAPH Executive Committee, serving as Editor in Chief of IEEE Transactions on Visualization and Computer Graphics, serving as a member of the IEEE Computer Society's Publications Board, serving on the IEEE Computer Society Board of Governors, and successfully managing a large program of external funding to develop more effective methods for visually communicating information.

- Director of Education and MSI Programs – Richard Alo

In 2010, Dr. Alo became the Education Director for VACCINE. In this capacity, he oversees and directs the education strategy. Dr. Alo also oversees the integration of



minority serving institutions into VACCINE research and education initiatives. Dr. Alo has served on several advisory and executive boards, including: Mathematical Association of America SUMMA Committee (Support for Undergraduate Minority Mathematics Awareness), Association of Departments of Computer and Information Science and Engineering at Minority Institutions (founding member), Coalition for

Diversity in Computing (Chair), National Science Board NSF GRPA Committee, Multi Sector Crises Management Center (Board of Directors), and Houston Independent School District. Dr. Alo was selected as the 2002 Educator of the Year by the Hispanic Engineer National Achievement Awards Conference.

- Education Advisor – John Stasko

In order to focus more on teaching and research, Dr. John Stasko assumed an advisory role for VACCINE’s education programs. John received his B.S. degree in Mathematics at Bucknell University in Lewisburg, Pennsylvania (1983) and Sc.M. and Ph.D. degrees in Computer Science at Brown University in Providence, Rhode Island (1985 and 1989). He joined the faculty at Georgia Tech in 1989, and his primary research area is human-computer interaction.



- Managing Director – Timothy Collins

Timothy Collins is the Managing Director of VACCINE. He oversees and implements all operational aspects of the Center including strategy, marketing, operations, finance, business development and human resources. He is an accomplished professional having a 25 year operations background in the public safety and security arena. He is a retired Indiana State Police Officer reaching the position of Region Commander and is a former Air Force Officer with a specialty in Command and Control. He is a graduate of the FBI National Academy and has an MBA from Purdue University. His business expertise includes program and project management, business development and strategic planning.



- Assistant Director of Engagement and Education – Sally Luzader

Sally Luzader is Assistant Director of Engagement and Education for the VACCINE Center. She manages all education initiatives and serves as the communications point of contact for DHS. Prior to coming to VACCINE, Sally served as Associate Director of Employer Relations in Krannert Graduate Career Services in the Krannert School of Management (Purdue); she also worked with the I-STEM Resource Network as the Manager of the Science Initiative. Sally earned her bachelor’s degree in Communications from Miami University and a Master of Arts in Higher Education from The Ohio State University. She has worked in undergraduate admissions at Miami University, MBA admissions and career services (University of Cincinnati), graduate admissions (C.W. Post), academic advising (Univ. of Southern California), executive education (Indiana University) and student affairs/recruitment for the College of Engineering and Applied Sciences at Stony Brook University on Long Island.



- Center Coordinator and Administrative Assistant – Deb Denno

Deb Denno serves as the Center Coordinator and Administrative Assistant for VACCINE. Her duties include planning and scheduling meetings and appointments; organizing and maintaining paper and electronic files; managing projects; conducting research; and disseminating information to faculty, staff, and external partners. She has a wealth of experience in business administration, including accounting, and is currently pursuing a degree in accounting. Deb worked for a large fuel company in Fort Worth, Texas before moving to Indiana in 2004. She began working for a local



Lafayette company and handled all accounting responsibilities. In 2007, Deb joined the Purdue Discovery Park team where she worked in the business office and was responsible for several multi-million dollar grant portfolios before transferring to her current position in July of 2011.

**The VACCINE Leadership Board** is responsible for the strategic decisions for the Center. This board is comprised of three permanent members plus three PIs from our universities on rotating two-year terms, selected by the nineteen university PIs. The Leadership Board oversees the Seed Project review panel, advises on research, education, and outreach decisions and reviews and approves yearly Center plans.

- David Ebert (permanent)
  - Timothy Collins (permanent)
  - John Stasko (permanent)
  - Kelly Gaither (term)
  - Brian Fisher (term)
  - Alan MacEachren (term)
- 
- The VACCINE Senior External Advisory Board provides strategic advice, information, and recommendations to the Center on basic and applied research activities, educational issues, and activities and operations related to visual analytics and command, control and interoperability in the homeland security environment. This board consists of the world's top experts in visual analytics and homeland security from the scientific, business, and government communities. Current membership includes:
    - Don Brackman  
*President, National White Collar Crime Center*
    - Chief John Buckman  
*Past President, International Association of Fire Chiefs*
    - Dieter Fellner  
*Professor and Director, Technical University of Darmstadt & Fraunhofer Institute of Computer Graphics*
    - David Kasik  
*Enterprise Visualization Architect, Boeing*
    - Daniel Keim  
*Professor and Head, Information Visualization and Data Analysis Research Group, University of Konstanz, Germany*
    - Katherine A. Mitchell  
*Director STEM Initiatives, American Indian Higher Education Consortium*
    - Mike Mitchell  
*Director of Homeland Security Programs, Pacific Northwest National Laboratory*

- Randall Murch  
*PhD, Associate Director, Center for Technology, Security and Policy and Adjunct Professor, Virginia Tech*
- Haesun Park  
*Professor, Georgia Institute of Technology*
- Kathy Smarick  
*National Consortium for the Study of Terrorism and Responses*
- Andrew Vallerand  
*Director, Public Security Technical Program*
- Leland Wilkinson  
*Executive Vice President of SYSTAT Software*
- Tom Wyss  
*Indiana State Senator, DHS State and Local Officials Senior Advisory Committee for Homeland Security Advisory Council*

## II. Research and Development Scope

The overall goal of VACCINE Center research is to create, deploy, evaluate and deliver innovative and effective integrated data and visual analytic environments—frameworks, methods, and software—that advance the start-of-the-art in analyzing massive, heterogeneous, incomplete, temporally evolving homeland security data for anticipating, detecting, and responding to homeland security mission needs. Therefore, VACCINE is developing new dynamic visual analytics techniques based on cognitive and perceptual principles that increase the effectiveness of the entire analysis process; create precision information environments; create an information discourse environment; and enable visual analysis, knowledge synthesis, and extraction of insight for actionable decision making, event detection, management, and response.

For effective visual analytics, we are tightly integrating computational processing, data management and visual representation to efficiently present relevant information and solution alternatives to the user and to improve both data management and statistical data modeling. To continue the successful deployment, scalability, and usability of developed technologies, we again focused on six research themes that integrated end-users from the beginning to the end of each specific project. Having our customers directly integrated with our projects allows them to provide input, project instigation, and relevant feedback and transition paths for DHS technology transfer. The specific projects were intended to be 12 to 36 months in duration with a clearly defined deliverable.

**Theme 1: Public Safety Coalition Projects** (state or local law enforcement, fire, emergency management, etc.)

**Theme 2: Federal Operating Component Projects** (TSA, FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)

**Theme 3: Enterprise Resiliency Environments**

**Theme 4: Event Evacuation**

**Theme 5: Visual Analytics for Security Applications (VASA)**

**Theme 6: International Collaborations**

All of the projects associated with these themes have the following key pervasive homeland security problem characteristics: massive, time evolving, heterogeneous data of varying quality; multiple-scales of problem solving, planning, management, and action; coordinated information analysis; information security and privacy challenges; and a wide variety of needs, skills, and computing resources of involved personnel. Moreover, to achieve our goal of creating this visualization and analytics environment, our research plan is based on three foundational research areas that form our framework for addressing DHS mission directives: Interactive Visual Analytic Foundations, Visually-Adapted Analytical Techniques, and Investigative Analysis and Decision Making Environments.

For various logistical, DHS direction, and timing reasons, Themes 3, 4, 5 and 6 were delayed during Year 3. We, therefore, focused on Themes 1 and 2. Theme 4, VASA, will be pursued in Year 4. The following is a list of research highlights that occurred during Year 3.

Detailed descriptions of individual research projects can be found in Part VI, Research Projects and Descriptions (listed by institution).

**Theme 1: Public Safety Coalition Projects** (representative projects)

- VACCINE continued building our **multi-agency public safety consortium** with organizations within the state of Indiana and developing new relationships with organizations such as the Indiana Intelligence Fusion Center. A Memorandum of Understanding was also negotiated with the Ohio Department of Public Safety, which includes the Ohio Dept. of Homeland Security and the Ohio State Highway Patrol. We also have public safety partners in other states such as the Charlotte-Mecklenberg Police, UNC Charlotte Police and UNC Public Safety Department in North Carolina; the Harrisburg Police in Pennsylvania; and the Miami-Dade County Department of Emergency Management in Florida, who work with our partner institutions.
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- **VALET** was also used for analysis and presentation of high-risk alcohol behavior in the Purdue campus area, working with Purdue Student Health, Housing, EMS/Fire, and Police members. A presentation was given to campus representatives at the annual Alcohol Summit held at Purdue University. The resulting findings and analysis are being integrated into educational and enforcement programs at Purdue.
- **Jigsaw** is being used by the Indianapolis Police Department, the West Lafayette Police Department, the Rock Hill Police Department (SC), and the Lafayette Police Department. Purdue has an undergraduate student working part-time in the West Lafayette Police Department to assist them in solving cold cases utilizing Jigsaw. Currently, over 150 people and organizations have downloaded the system, including Air Force Intelligence, AFRL Wright Patterson, Army Counterintelligence, Boeing, Deloitte, Naval Research Lab, NCIC, PayPal, Thomson Reuters, United Nations Investigators Office, US Attorney's Office Organized Crime Taskforce, as well as numerous newspapers and police departments.
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- Penn State has received complementary funding from the National Geospatial-Information Agency and the US Army Corps of Engineers to continue development of **SensePlace2** involving social media data. The research team continues to work actively with personnel in the Harrisburg Bureau of Police to refine the **CrimeViz** web-mapping software for their use and distribute the tool more broadly.
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- The University of North Carolina at Charlotte has delivered an **evacuation decision support system and Urban Emergency Response search and command center tools** to the UNC Charlotte Police and Public Safety Department. The tools have been used in the Canada-US Experiment Resiliency Environment demonstration in Seattle at which DHS managers were in attendance.
- An improved prototype system and iPad application based on Florida International’s **“Integration Framework for Enhancing Emergency Response”** system continue to be evaluated by personnel at Miami-Dade Emergency Management (MDEM), and future pilot activities are planned as part of the evaluation process.
- The **Travel Response Investigative Profiler**, better known as **TRIP**, was developed to understand the movement behaviors and spatio-temporal patterns of individuals. This technology was presented by the Indiana Intelligence Fusion Center as one of the “Fast Track” presentations at the National Fusion Center Training Event in Phoenix. Future research may lead to modeling an individual’s movement pattern based on correlation analysis among individual movements and infrastructures.
- In collaboration with NCFPD, research was conducted by the VACCINE team on the **possible correlation between animal and human health**, based on a study of the effect of seasonal influenza and its correlations with different companion animals (dogs, cats) syndromes within the Indianapolis area. The study indicated a moderate correlation between dogs and humans within this geographic area and suggests a future direction to investigate further links.

## **Theme 2: Federal Operating Component Projects (representative projects)**

### **United States Coast Guard**

- We continue to develop our relationship with the **US Coast Guard** and **expand use of the Coast Guard Search And Rescue Visual Analytics (cgSARVA)** technology to other areas of the Coast Guard. The cgSARVA technology was utilized in analyzing swimmer deaths and also provided information used for the Coast Guard swimmer and boating safety public information campaign in 2011 and for the number of patrols used in 2011, leading to a significant decrease in deaths in 2011.
- **CgSARVA** was used to determine the allocation of resources during **Hurricane Irene** which occurred along the east coast in the summer of 2011. The Coast Guard initially discussed diverting resources from the Great Lakes area to the east coast, but the data from cgSARVA indicated that there was a demonstrated need to keep this region fully resourced at that time and to draw the resources from another region.
- VACCINE, in conjunction with the CREATE Center, analyzed the **PROTECT** model for security patrols in Boston and made recommendations for improvements for deployment in New York City.
- VACCINE also developed visual analytics tools to **analyze the effects of closing Port Arthur, TX** in 2011, including the economic impact and the effectiveness of alternative mitigation strategies.
- As part of the **COAST** project, we continued work to develop the cgSARVA suite of tools that can be used to analyze all Coast Guard operations across the United States, based on module-based relationships. We also continued to develop a relationship with the Coast Guard Sector Puget Sound Leadership and hope to become involved in future projects, depending on funding.
- VACCINE was awarded the **Commander Atlantic Area's Excellence Coin**, a prestigious award presented by the US Coast Guard, in recognition of our work with District 9 in search and rescue/resource allocation and District 1 in conjunction with the PROTECT project.

In summation, VACCINE's research, while focused on delivering technological value to our customers, is also able to extend the state of the art in many areas including the following:

- Theoretical work in the science of analytical reasoning
- Fundamentals of visual representations for multisource, uncertain, temporally evolving, and conflicting data
- Data representations, integration, quality assessment, cleaning, and reduction for massive datasets, streaming data, and multisource data integration
- Methods and novel visual analytic tools tailored to user, task, and device requirements
- Mobile visual analytics for real-time applications
- Novel spatiotemporal modeling, detection, and prediction techniques
- New multisource correlation and visual analysis techniques (e.g., linked animal and

human health surveillance)

- Novel video analytics for tracking, event detection, and mobile video analytic applications
- Novel population distribution adaptive cluster detection and aberration detection techniques
- Novel synthetic data generation techniques for spatiotemporal data streams that match observed statistical properties of source data but are completely anonymized
- Adapted presentation methods for actionable decision making for a diverse set of users

### **III. Education Programs and Outcomes**

During Year 3, VACCINE's educational initiatives focused primarily on undergraduate and graduate level work (including work with MSI institutions) and professional education and training programs, with a lesser focus on K-12 education (primarily done by CCICADA). The VACCINE mission is to educate current Homeland Security stakeholders and the next generation of talent and enable them to make effective decisions from the mass of multisource, multimedia data they will face in their careers.

In addition to the established programs, VACCINE focused on various activities such as attendance at conferences and presentations to groups in order to promote VACCINE efforts and get support and participation for VACCINE in Year 4 and beyond. The education group has also submitted several proposals to further increase funding opportunities and future program development. Throughout all of these efforts, VACCINE and CCICADA have maintained a collaborative relationship with monthly conference calls and sharing of relevant information.

The new Assistant Director for Engagement and Education came on board in late May, 2011, and educational activities for Year 3 resumed shortly after.

#### **Minority and Underserved Programs**

VACCINE has five official MSI partners: California State University-Dominguez Hills, Florida International University, Morgan State University, Navajo Technical College, and University of Houston-Downtown. We have been approached by Tennessee State University and Fayetteville State University with regard to collaborating on specific projects and/or grant proposals, and we will continue to work with these institutions in Year 4.

From an overview perspective, these are the general accomplishments that VACCINE oversaw within its MSI education programs.

- VACCINE agreed to be a host for the 2012 DHS Summer Research Team Program for Minority Serving Institutions and received approximately 23 applications from MSI institutions for a faculty/student team to participate a research project with a VACCINE faculty member for the summer of 2012. We had one team accepted from the University of Houston-Downtown, but the applicant had to cancel due to the withdrawal of the student who had planned to participate. We will again serve as a possible host for 2013.
- Richard Alo, from the University of Houston-Downtown, continued in his role as Assistant Director of MSI Education for Year 3. In this position, he worked with several MSI institutions, including California State University-Dominguez Hills and Navajo Technical College, to develop affinity research groups in which undergraduate students were involved in public safety-related research projects.

- We continued to develop our relationship with Navajo Technical College (NTC) and began working with Tom Davis as our primary contact. Dr. David Ebert and Dr. Richard Alo traveled to NTC in the spring of 2012 to meet with faculty to discuss the development of a plan in which VACCINE can collaborate with NTC. Navajo Tech plans to submit a proposal for seed grant funding for Year 4 that falls under one or more of the E2E-related projects.
- Tim Collins and Richard Alo traveled to Houston in the fall of 2011 to meet with faculty and students from Houston Community College. Tim Collins gave a presentation regarding VACCINE and career opportunities within the field of homeland security.
- Morgan State University brought 15 undergraduate students from a variety of academic areas to the Purdue campus in June 2011 for an intensive two-week internship, as part of the Department of Homeland Security (DHS) Scientific Leadership Bridge Award (SLBA) for Minority Serving Community Colleges. Students stayed on campus in residence halls and attended lectures, visited various labs on the Purdue campus and participated in exercises relating to visual analytics. Student groups gave presentations at the end of the internship period utilizing visual analytics concepts and tools within case studies. When the students returned to Baltimore, they organized a workshop for Baltimore teachers and demonstrated how visual analytics could be incorporated into the teachers' curriculum and classroom activities.
- Florida International University, which has a large population of Latino and African-American students, continued to conduct research activities in visual analytics and involve undergraduate and graduate students in their research activities.

### **K-12 Program**

VACCINE limited its interaction in K-12 activities at the suggestion of DHS at the end of Year 2. Students from the HS-STEM program visited Principles of Engineering classes at a local high school and presented information on their research, visual analytics and connections to homeland security. As a follow-up, 30 students from the school came to campus for half a day to tour our visual analytics labs and learn about the research taking place through VACCINE. The teacher was very impressed and we plan to do a similar visit next year.

## **Undergraduate/Graduate Course Program**

### **A. HS-STEM Career Development Program**

The HS-STEM Career Development program is a competitive program funded through DHS that was established at Purdue in 2007 under David Ebert. Purdue offered fellowships to seven graduate students in 2007, three graduates and one undergraduate student in 2008, and three graduate students in 2010. Since we still had openings under the 2010 HS-STEM grant in 2011 and 2012, we continued to recruit new students. The Assistant Director of Engagement and Education met with individuals, including graduate advisors, in specific departments on the Purdue campus to make them aware of the program and enlist their assistance in telling current and prospective students about the program. She also met with the admissions office in the graduate school, and letters were sent to graduate students who were applying and/or had been admitted to specific graduate programs and met the required criteria, encouraging them to apply for the program. Current HS-STEM students spoke at an information session for prospective students and gave their perspective of the program. Specific undergraduate clubs were targeted and information was provided to them about the HS-STEM program. VACCINE partner schools were also notified and encouraged to have qualified students who planned to attend graduate school apply for the program. As a result of these recruitment efforts, we have added four new students to the program, including one who started in January 2012 and three who will enter in fall of 2012. VACCINE has applied for a continuation of funding through a proposal for the HS-STEM 2012 program.

Outlined below are the 2011 annual reports for the HS-STEM I (2007) and HS-STEM II (2008) programs, which finished in September 2011.

#### **HS-STEM I (2007 Grant) Career Development Program Activities**

##### **Annual Summary 2011 (Oct. 1, 2010-Sept. 30, 2011)**

**Summary:** In December of 2010, the program manager for the HS-STEM program at VACCINE took another position on campus and the position in VACCINE was left vacant until May 31, 2011. Due to this situation, some of the regular activities of the program were suspended for the spring semester of 2011 but were resumed beginning in the fall of 2011. There have also been some changes in the calendar of events for DHS which have altered the timing of some activities that have occurred in previous years. We are now continuing to do our monthly lunches, semester reporting and outreach activities and have resumed a regular schedule for our students. The students from the 2007 grant are all graduate students, most of whom are PhD students focusing on research.

### Monthly HS-STEM Lunches

- Held once each month in the VACCINE lab; HS-STEM students, their advisors and other university personnel associated with the program (such as University Collections and Sponsored Programs) are invited to attend.
- One student is featured each month and presents information on his/her research and its relevance to Homeland Security.
- Information sharing: participants talk about upcoming events and activities on- and off-campus that are relevant, VACCINE staff share information about new projects and clients, and students/advisors share issues of concern.

### Presentations and Posters

- Students are encouraged to do presentations and present posters at conferences and meetings both on and off campus. These activities are highlighted in each student's semester report (attached).

### Reporting

- Students/advisors submit reports to the VACCINE program manager at the end of each semester in May and December.
- Annual reports are sent to DHS in December of each year and current students' semester reports are included in the annual report. We also provide an overall summary of the program in our annual VACCINE report to DHS in June each year.

### HS-STEM Graduates/Career Update

- **David Blunck** graduated in **Aug. 2010** with a PhD in Mechanical Engineering and is employed at the Air Force Research Laboratory in OEhio.
- **Laura Hughes** graduated in **Aug. 2010** with a PhD in Biology and is employed by the Emory Vaccine Center in Atlanta, GA.
- **Karla Combs** completed her PhD in Biology in **May 2010** and is working as the Public Health Emergency and Bioterrorism Coordinator in Allegan, MI.
- **Ross Maciejewski** recently took a position with Arizona State University as a full-time faculty member in engineering.
- **Shawn McKay** is employed by the Rand Corporation.
- **Samuel Liles** will graduate with a PhD in Technology in May 2012 and is teaching at the National Defense University.
- **Bryan Sims** completed his year of service at Idaho National Labs and will return to Purdue in the spring semester of 2012 to complete his PhD in Nuclear Engineering.

## Outreach

- A presentation was given by an HS-STEM student to science students at a local high school to promote interest in STEM disciplines, visual analytics and VACCINE. The student discussed his research and its applicability to Homeland Security and visual analytics.

## Goals for 2012

Since most of the students from this group have graduated or are no longer on campus (one remaining student yet to graduate but no longer here on campus), they are no longer participating in regular events. When **Samuel Liles graduates in May of 2012**, he will already have completed his year of service and we will process the paperwork for his loan forgiveness through Purdue. He will also submit a final student report at that time, which we will pass on to DHS. As of May 2012, the students on this grant will all have completed their requirements for the program. We hope to develop an alumni network so that current and future students can contact alumni with regard to questions about the program, suggestions for internships or year of service experiences, etc.

## **HS-STEM II (2008 Grant—Agreement #2008-ST-104-000015)**

### **Career Development Program**

#### **Annual Summary 2011 (Oct. 1, 2010-Sept. 30, 2011)**

**Summary:** In December of 2010, the program manager for the HS-STEM program at VACCINE took another position on campus and the position in VACCINE was left vacant until May 31, 2011. Due to this situation, some of the regular activities of the program were suspended for the spring semester of 2011 but were resumed beginning in the fall of 2011. There have also been some changes in the calendar of events for DHS which have altered the timing of some activities that have occurred in previous years. We are now continuing to do our monthly lunches, semester reporting and outreach activities and have resumed a regular schedule for our students.

The majority of students from the 2008 grant are graduate students, most of whom are PhD students focusing on research. We did have one undergraduate in this group who is now enrolled in a PhD program at Harvard. Only one student from this group is still on campus, Daniel Richardson—the others have graduated or are completing their program off campus so are not able to participate in many of the activities listed below.

## HS-STEM Graduate/Career Update

- **Rachel Beard** is completing her PhD in Virology and will graduate in December of 2012. She is currently doing research at Wake Forest.
- **Nwokedi Idika** graduated with a PhD in Computer Science in Aug. 2010 and is currently completing his year of service at MIT Lincoln Labs. His program will be completed in February of 2012.



- **Daniel Richardson** will graduate in May 2012 with a PhD in Mechanical Engineering. He will do his year of service following graduation, possibly at the Air Force Laboratory in Ohio or Sandia National Lab in CA.
- **Tyshia Gwin** completed her undergraduate degree in biology in **May 2011**. She is now enrolled in a PhD program at Harvard and will graduate in 2016 and complete her year of service after graduation or during her graduate work.

#### Monthly HS-STEM Lunches

- Held once each month in the VACCINE lab; HS-STEM students, their advisors and other university personnel associated with the program (such as University Collections, who administer the forgivable loan program, and Sponsored Programs) are invited to attend.
- One student is featured each month and presents information on his/her research and its relevance to Homeland Security.
- Information sharing: participants talk about upcoming events and activities on- and off-campus that are relevant, VACCINE staff share information about new projects and clients, and students/advisors share issues of concern.

#### Presentations, Publications and Posters

- Students are encouraged to do presentations and present posters at conferences and meetings, both on and off campus. Many of the students publish papers in journals or publications specific to their academic discipline. These activities are highlighted in each student's semester report.

#### Reporting

- Current students (and some advisors) submit reports to the VACCINE program manager at the end of each semester in May and December.
- Annual reports are sent to DHS in December of each year and current students' most recent semester reports are included in the annual report. We also provide an overall summary of the program in our annual VACCINE report to DHS in June of each year.
- Tyshia Gwin, who finished her coursework at Purdue in May 2011 and is now in graduate school at Harvard, will submit another final report encompassing her total experience when she completes her year of service in 2017 or 2018. Daniel Richardson will submit a final report when he completes his year of service in 2013, and Nwokedi Idika will do his final report in February of 2012 when his year of service is completed.

#### Outreach

- A presentation was given by an HS-STEM student (Daniel Richardson, 2008 group) to science students at a local high school to promote interest in STEM disciplines, visual analytics and VACCINE. The student discussed his research and its applicability to Homeland Security and visual analytics.

#### Goals for 2012

In February of 2012, we will work with Nwokedi Idika to complete his paperwork for the forgiveness of his loan at Purdue, and he will then have met all requirements for the program. We will monitor the year of service for Daniel Richardson after his graduation in May 2012 and follow up with him when he completes this requirement. We will keep in touch with Tyshia

Gwin at Harvard, and we will monitor her year of service when she graduates in 2016. We will work with Rachel Beard as she completes her degree in December of 2012 and will also monitor her service requirements after graduation. We hope to develop an alumni network so that current and future students can contact alumni with regard to questions about the program, suggestions for internships or year of service experiences, etc.

### Milestones

Milestones for VACCINE Period 3 – HS-STEM Career Development Program	04/01/11 – 03/31/12			
	Quarterly			
Present in High School Classrooms	X		X	
Attend monthly UP conference Calls	X	X	X	X
Monthly lunches ( highlight one student/month)	X	X	X	X
Job recommendations / placements for students	X	X	X	X

### Program Outcomes

To date, fifteen students at Purdue University have been funded through the HS-STEM Career Development program and three additional students will begin the program this coming fall. The program is led by Dr. David Ebert, Director of VACCINE and managed by Sally Luzader, Asst. Director of Engagement and Education. Eight students have graduated with Master’s or PhDs and have gone on to continue work in homeland security fields, and several more are scheduled to graduate later in 2012.

### B. SURF/VAST Program

Purdue University hosts students every summer as part of the SURF (Summer Undergraduate Research Fellowship) Program, in which approximately 150 students from institutions all over the country come to Purdue for 11 weeks to work in individual labs and conduct research. VACCINE can support up to five students for this program, and we call our program VASP (Visual Analytic Summer Program). In the summer of 2011, VACCINE hosted three students—two from Purdue and one from Louisiana State University. The students worked in the VACCINE lab at Purdue on individual projects, including cgSARVA, GARI (specific Android applications) and the development of typographic maps. The Assistant Director of Engagement and Education advertised this program to all of the VACCINE partner institutions beginning in December and encouraged them to have their undergraduate students apply for the program for the summer of 2012.

### C. Virginia Tech

Virginia Tech’s project on “Collocated Collaborative Visual Analytics” involved two undergraduate female and one graduate female computer science students who were involved with the research on the project. As a result, the two undergraduates plan to pursue graduate

research opportunities and the graduate students received an offer for a summer internship at PNNL to continue research related to the project.

#### **D. University of Houston-Downtown**

Twenty-six undergraduate students, including 14 supported students, from Univ. of Houston-Downtown, Navajo Tech and Cal State-Dominguez Hills participated in the VACCINE Affinity Research Groups organized by Richard Alo. These were students from a combination of statistics, math and computer science. As a result of participation in this project, students gained research and collaboration experience and submitted posters and publications for the Student Research Day Conference at Cal State-Dominguez Hills.

#### **E. VAST Challenge 2011**

The VAST Challenge is a participation category of the IEEE VAST 2011 Symposium (part of VisWeek 2011). The VAST 2011 Challenge continued in the footsteps of previous contests (since 2007) with the purpose of pushing the forefront of visual analytics tools using benchmark data sets and establishing a forum to advance visual analytics evaluation methods. Another goal of the VAST Challenge is to speed the transfer of VA technology from research labs to commercial products, and increase the availability of evaluation techniques.

In order to provide more opportunities for increased participation, the VAST Challenge is comprised of an overall Grand Challenge as well as three smaller Mini Challenges.

Teams may enter one or more mini Challenges independently of entering the Grand Challenge. ALL teams submitting an entry to a VAST Challenge will be invited to discuss their work during a challenge workshop.

Entries are judged on both the correctness of the analysis (based on the availability of ground truth) and the utility of the tools in conducting the analysis. Participants have several months to prepare their submissions. The themes for the 2011 VAST Challenge were:

Mini Challenge 1: Characterization of an Epidemic Spread

Mini Challenge 2: Computer Networking Operations at All Freight Corporation

Mini Challenge 3: Investigation into Terrorist Activity

Grand Challenge: Cause and Effect

**Georgia Institute of Technology** received an award for Mini Challenge 3 for “Good Use of the Analytic Process.” **Simon Fraser University** had two student papers receive the “Best Student Entry, Discovery Exhibition” award which is given for the best real-world application of visualization by a student; the papers were “Improving Airline Safety: Tableau and Bird Strikes” and “Data Visualization of Immunological Competence of HIV Exposed but Uninfected

Infants.” **The University of North Carolina-Charlotte** received the “High Potential for Scalability Award” for their entry on “Log Visualization.” **Virginia Tech** received the “Best Use of Large Display” award for their presentation titled “Analysts Workspace.”

## **Professional Training**

### **A. Simon Fraser**

Simon Fraser University in Canada held two workshops on social media for emergency managers, and both reached maximum capacity with regard to attendance.

### **B. Banff Workshop**

VACCINE sponsored a two-day workshop in Banff, Canada in September, 2011 for Canadian researchers, policy makers and industry experts to promote the study and use of visual analytics among Canadian organizations and institutions. Forty people attended, representing 21 Canadian/US institutions and organizations. Topics were decided by the Canadian institutions and focused on those areas determined to be of the most relevance to this group: Safety and Security; Financial Risk, Business Intelligence; Health—Records and Research; Astrophysics; and Oil/Gas and Geomatics. Each topic followed the same format—overview and general panel discussion of the topic (including industry experts); small focus group discussion to generate ideas for the specific industry/topic; and general discussion of the entire group. At the conclusion of the workshop, a general discussion was held to generate ideas and topics for future projects and seed grant proposals, which were funded by VACCINE. Seven proposals were generated and three were selected:

**Visualization and Policy Making: Theoretical and Empirical Explorations** (workshop)—Univ. of British Columbia and Simon Fraser University

**Financial Systemic Risk Analysis** (workshop)—Univ. of British Columbia

**Personal Visual Analytics** (networking and workshop)—Univ. of Victoria, Univ. of Calgary, Dalhousie University

Follow-on workshops and networking events will occur during Year 4.

### **C. ULearning Platform**

The Department of Homeland Security Science and Technology Directorate (DHS/S&T/CCI) focuses on the development of education and training tools, as well as collaboration space, for the emergency response community. During the early part of Year 3, Captico, a Maryland-based company specializing in internet marketing using web technology, partnered with VACCINE at Purdue University to develop a web-based uLearning prototype for DHS/S&T/CCI to serve the emergency response community. The prototype leveraged content such as videos, presentations, narratives and links to share expert and practitioner-defined content across the emergency response community. The objective of this effort was to develop an initial short, uLearning (user

learning) tool that incorporates video, text, images, or audio of new technologies and how new technologies can be used in operational scenarios. Deliverables planned in the original proposal included a prototype of a ULearning Tool; assessment of the ULearning tool with a small set of managers/users; and plans/approach for broader uLearning applications (e.g., other technologies and end-users).

### **Project Outcomes**

Captico and Purdue have identified and prioritized learning needs within the emergency response community that may be best supported via the uLearning tool. By gathering input from first responders utilizing various methods, the uLearning tool prototype was developed to incorporate specific features and capabilities found most useful by the emergency response community.

Based on availability of funding, the plan was to target the state of Indiana as a large pilot project and give those first responders supported access to the uLearning Platform in exchange for feedback to further the development of the Platform. First responders were interviewed and their input was recorded by Captico. However, in the summer of 2011 the project was postponed due to lack of funding.

### **D. Education and Training for First Responders**

At the VACCINE annual meeting in September of 2011, a general discussion was held regarding various types of professional training VACCINE could provide. A conference call of several partner schools followed, and it was suggested that we plan a general informational meeting in Indianapolis sometime during Year 4 to educate first responders about the field of visual analytics in general, and how it could be useful to first responders in their daily jobs. Other possibilities discussed were short training sessions for local law enforcement personnel on specifics of tools such as VALET and iVALET. We also discussed the possibility of holding video or webinar trainings/discussions regarding some of the technologies, similar to what was being planned in the ULearning project. Plans have not been finalized, but there will be some type of professional training taking place in Year 4.

## IV. Partnerships and Outreach

### 1) List of Partnerships and Major Outcomes

VACCINE has been very active in both its domestic and international outreach efforts. We have built upon our existing relationships and established many new collaborative partners.

#### 1) VACCINE Public Safety Partnerships

<b>1. Indiana Public Safety Consortium</b> <ul style="list-style-type: none"><li>a. Tippecanoe County Sheriff's Office</li><li>b. Tippecanoe County Emergency Management Agency</li><li>c. Lafayette Police Department</li><li>d. West Lafayette Police Department</li><li>e. Purdue University Police Department</li></ul>	<b>2. Florida Division of Emergency Management's Region Seven</b> <ul style="list-style-type: none"><li>a. Florida International University</li><li>b. Miami-Dade County</li><li>c. Broward County</li><li>d. Palm Beach County</li><li>e. Monroe County</li></ul>
<b>3. UNCC Consortium</b> <ul style="list-style-type: none"><li>a. Charlotte Mecklenburg Police Department</li></ul>	<b>4. Washington State Consortium</b> <ul style="list-style-type: none"><li>a. Port of Puget Sound</li><li>b. U.S. Coast Guard, Seattle Sector</li></ul>
<b>5. Penn State Law Enforcement Consortium</b> <ul style="list-style-type: none"><li>a. Harrisburg Police Department</li></ul>	
<b>6. Ohio Fusion Center</b> <ul style="list-style-type: none"><li>a. Ohio Department of Public Safety</li><li>b. Ohio State Highway Patrol</li><li>c. Ohio Homeland Security</li></ul>	

In early 2012, VACCINE entered into a Memorandum of Agreement with the Ohio Fusion Center, managed by the Ohio State Highway Patrol (OSHP) and Ohio Homeland Security (OHS). "The agreement was created with the sole purpose of establishing a framework for a mutually beneficial pilot collaboration among OUP, OSHP/OHS and the DHS Centers of Excellence (COEs). The Ohio Fusion Center will assist the COEs to develop research products relevant to OSHP/OHS's and other first responders' needs. VACCINE will facilitate the OSHP's direct access to research materials and training accomplished through the DHS Centers for Excellence" (MOA, 2012).

### Technology Deployment

VACCINE's mission is to create tools and technologies for the first responder community. Understanding that most first responders require tools that are mobile, VACCINE continues to develop a suite of tools for our stakeholders to use in the mobile environment. Our suite of tools includes:

## **VALET (Visual Analytics Law Enforcement Toolkit)**

The Visual Law Enforcement Toolkit (VALET) provides law enforcement agencies with a suite of analytical tools coupled with an interactive visual interface for data exploration and analysis, forecasting, planning, and management. This system includes linked views and interactive displays that spatiotemporally model criminal, traffic and civil (CTC) incidents and allows officials to observe patterns and quickly identify regions with higher probabilities of activity.

Our toolkit provides analysts with the ability to visualize different types of data sets (census data, daily weather reports, zoning tracts, prominent calendar dates, etc.) that provide an insight into correlations among CTC incidents and spatial demographics. In the spatial domain, we have implemented a kernel density estimation mapping technique that creates a color map of spatially distributed CTC events that allows analysts to quickly find and identify areas with unusually large activity levels. In the temporal domain, reports can be aggregated by day, week, month or year, allowing the analysts to visualize the CTC activities spatially over a period of time. Furthermore, we have incorporated temporal prediction algorithms to forecast future CTC incident levels within a 95% confidence interval. Such predictions aid law enforcement officials in understanding how hotspots may grow in the future in order to judiciously allocate resources and take preventive measures. Our system has been developed using actual law enforcement data and is currently being evaluated and refined by VACCINE's Public Safety Consortium of law enforcement agencies.

The VALET software is available on a PC, iPhone, or iPad and has been deployed to members of the VACCINE Public Safety Consortium including the Tiptecanoe Co. Sheriff's Department, Lafayette Police Department, West Lafayette Police Department, and Purdue University Police Department. VALET provides advanced analysis capabilities, allowing analysts to develop and test hypothesis about criminal activities within various areas of their communities.

## **MERGE (Mobile Emergency Response Guide)**

Hazardous materials can react differently to stimuli and can cause problems in accidents and emergency situations. This fact makes them particularly dangerous to civilians and first responders. It is for this reason that the Emergency Response Guidebook was developed. This paper guide assists those in an emergency with the knowledge of how to handle hazardous materials. As one might expect, the guidebook is large and requires precious time to search an index to determine the best way to handle a particular hazardous material. The MERGE system is an electronic version of the guide with many

new features and capabilities. These new capabilities include the use of image analysis methods to automatically determine the type of hazardous materials present based on an image taken of the sign/placard. MERGE has an easy to understand user interface to instruct an emergency responder or civilian in the proper way to handle a hazardous material emergency.

MERGE was developed at the request of our first responders. Initial versions of MERGE have been deployed to several law first responders groups and have very positive responses from our targeted user groups which include: the Lafayette, West Lafayette, Indianapolis, and St. Clair, MI Fire Departments.

### **GARI (Gang Graffiti Automatic Recognition and Interpretation)**

Gangs are a serious threat to public safety throughout the United States. Gang members are continuously migrating from urban cities to suburban areas. They are responsible for an increasing percentage of crime and violence in many communities. According to the National Gang Threat Assessment, approximately 1 million gang members belonging to more than 20,000 gangs were criminally active within all 50 states and the District of Columbia as of September 2008. Criminal gangs commit as much as 80 percent of the crime in many communities according to law enforcement officials throughout the nation.

Street gang graffiti is their most common way to communicate messages, including challenges, warnings, or intimidation to rival gangs. It is, however, an excellent way to track gang affiliation and growth, or even sometimes to obtain membership information. The goal of this project is to use the knowledge gained from our work in mobile devices and applications and leverage it towards the development of a mobile-based system capable of image analysis. This system will provide an accurate and useful output to a user base through a database of gang graffiti images.

The image analysis includes obtainment of metadata (e.g., geolocation, date, and time) and the extraction of relevant features (e.g., color, shape) from the gang graffiti image. The information is sent to a server and compared against the graffiti image database. The matched results are sent back to the device where the user can then review the results and provide extra inputs to refine information. Once the graffiti is completely decoded and interpreted, it is labeled and added to the database.

GARI is being used on iPhone and Android mobile devices. We have deployed to several law enforcement agencies and first responders groups and have had very positive response from our targeted user groups.



## 2) VACCINE DHS Operating Components

### a. United States Coast Guard

#### 1) CgSARVA – Coast Guard Search and Rescue Visual Analytics

VACCINE has spent the past two years building strong ties within the USCG. We have collaborated with them to build tools that can be adapted to real time situational areas. Most significant of these projects was a detailed model allowing a thorough assessment of all CG search and rescue cases in the Great Lakes. In the Coast Guard Search and Rescue Visual Analytics (CgSARVA) project, VACCINE presents a risk analysis system that enables the interactive visualization, analysis, and assessment of search and rescue (SAR) missions completed by each USCG station.

The CgSARVA technology is deployed, and in use, at the USCG Atlantic Area Planning and Analysis Division.

The system enables the interactive analysis of trends, patterns, anomalies, and distribution of cases and associated sorties. Additionally, this assessment tool enables the determination of potential increase or decrease in risk with a reallocation of a resource; as well as known increases or decreases in the response time. The CgSARVA system features include the following:

- Linked calendar and line graph views for analyzing data patterns and distributions
- Interactive filter controls for assessing case distribution loads and locations
- Density estimation for hotspot generation
- Linked time slider controls for interactive temporal animation and exploration
- Interactive statistical summary tools for report generation

The CgSARVA technology is a vital component for analyzing risk assessment as Coast Guard staffing levels fluctuate due to budget changes, retiring volunteers, and a variety of other factors. This system provides managers and analysts with a suite of tools for analyzing the distribution of previous search and rescue cases and a methodology for understanding the risk, efficiencies, and benefits involved with reallocation or reduction of resources.

2) Analytical Visualization of the Boston PWCS Patrol Resource Allocation Environment (with CREATE) aka PROTECT-Port Resilience Operational / Tactical Enforcement to Combat Terrorism

Using the previous two years of patrol routes, we are developing statistical models for loiter point visits. Predictions of the loiter point visits will be computed and sent to the Coastguard to compare against actual visits during a time period in which the visits were unknown to the analysts. The predictive efficacy of this model will then be addressed, and determination on the ability of hostiles to predict patrol routes based on current patterns will be assessed. Sparse data will be handled by predicting the number of days between visits. Similarly in utilizing the PROTECT model, two years' worth of patrol routes will be generated. Similar statistical models will be created and a predictive model will be adapted to the PROTECT routes. Predictions of future loiter point regions will be generated from PROTECT and sent to us and our model will now assess the ability of hostiles to predict patrol routes based on potential PROTECT routes.

An interactive visual analytics environment will be created that will overlay patrol routes and potential Risk Index Numbers (RIN) numbers for targets. This environment will be developed for both desktop and hand-held platforms with a first generation tool looking at historical patrol route logs and critical infrastructure overlays. This project provided the USCG with an analysis of their current patrol route scheduling in the Boston Harbor area. Analysis of the new routes indicated that a better randomized process was now implemented and anecdotal evidence from test teams indicated that illegal activities requiring surveillance, etc. were more likely to be spotted. Prototypes have been deployed with members of the Coast Guard for analysis and feedback.

3) Analytical Visualization of the Port Arthur, TX Economic Impact Study (with CREATE)

This is a contract under our Basic Ordering Agreement. In conjunction with the resources allocation tool, we will also look at creating economic impact models that will show the effect that potential catastrophes (natural or manmade) will have. Our system will incorporate new models, showing the potential impact over the Port Arthur area utilizing census tract information, historical data, the output of the CREATE economic model and predictive values. Initial versions of the system will focus on specific threat scenarios as determined by the partnering institutions. Our analytic environment will allow views and analysis of economic impact over time, over space, and over geography to show linkages and

causalities and enable a better understanding of the relationship of certain primary and secondary economic effects.

**b. Federal Emergency Management Agency**

1) Business Continuity Information Network

Studies have shown that businesses risk failure if they are unable to reopen quickly after a disaster. To reduce these risks and improve communications within the business community, VACCINE partner, Florida International University has developed the Business Continuity Information Network (pronounced “bee-kin”), a web-based service where local businesses, emergency management, and organizations that assist businesses can gather to share critical information and support continuity efforts before, during and after a disaster. The BCIN South Florida Release supports business recovery programs initiated by county participants including Broward, Miami-Dade, Palm Beach and Monroe County through their respective Emergency Management offices.

Available year-round as a public service, this business-to-business community network provides participating companies a tool to track their key employees and supply chain status, and locate needed recovery goods and services. The system facilitates professional organizations like Chambers of Commerce to assist their members, and helps government agencies to assess damage and prioritize recovery needs. BCIN reports, maps and shares critical up to-the-minute information about infrastructure conditions and recovery efforts by working with County Emergency Management Offices and major private infrastructure providers. BCIN will localize and tailor relevant information to business managers who will use this information to better assess an event’s impact to their facilities, employees, suppliers and customers.

BCIN’s B2B network, which includes companies from different industry sectors, business and trade associations and NGOs, helps businesses locate disaster recovery resources, products, and services while allowing them to collaborate on recovery efforts. Businesses can use BCIN to report their operational status and assistance needs to county government and NGOs so these organizations can prioritize their relief efforts. Recovery dollars spent locally helps to keep local businesses open and mitigates employment loss. The BCIN South Florida Release supports business recovery programs initiated by county participants including Broward, Miami-Dade, Palm Beach and Monroe County through their respective Emergency Management offices. Private sector participants include Office Depot,

Wal-Mart, the Greater Miami Chamber of Commerce and a variety of local businesses across industry sectors. BCIN is supported by the Department of Homeland Security, IBM and the National Science Foundation.

## 2) A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data

Responders in the field (both public and private participants) are capturing footage, pictures and video, of the disaster area with mobile phones. This data is being collected but is not integrated in the incidence command systems where situation reports, incidence action plans, etc. are being held. When these materials are entered into such systems, it's done so in a manual way which is time consuming and requires careful human review and management.

To support emergency management operations, Florida International University is using advanced data integration and visual analytics techniques to analyze situation reports, incident action plans, and other type of responder reports, pictures and video clips captured in the field and automatically augment/link the reports directly to relevant multimedia content obtain in the field. Data integration techniques will be used to identify disaster specific keywords and will be used to identify the documents.

## 3) **Additional VACCINE State and Federal Partnerships**

VACCINE works closely with state and federal agencies to receive data relevant to our projects. VACCINE has a well-established process for entering into Memorandums of Understanding and Non-Disclosure Agreements to ensure protection of the parties and data involved.

- FEMA (Federal Emergency Management Agency)
- IICD (Infrastructure Information Collection Division)
- GMO (Geospatial Management Office)
- DHS internal Geospatial Working Group
- DHS University Programs
- DHS US-CERT Operations
- DHS Research Transition Working Group
- U.S. Department of State, Office of the Geographer
- National Institute of Justice
- National Institutes of Health
- National Science Foundation

- Department of Health and Human Services
- Pacific Northwest National Laboratory
- Argonne National Laboratory
- Oak Ridge National Laboratories
- Defense Research & Development Canada
- Indiana State Department of Health
- Illinois Terrorism Task Force

#### 4) **VACCINE Corporate Involvement**

In 2010, the VACCINE Center and the Purdue Research Foundation established a unique VACCINE Corporate Affiliate Program to promote VACCINE's goals and initiatives. In broad outline, this program provides the framework to enable corporations to make tax deductible gifts to support research, education, and training activities for all VACCINE member institutions. The basic structure is through the establishment of a non-profit Limited Liability Corporation (VACCINE LLC) which is managed by the Purdue Research Foundation and overseen by VACCINE's Leadership Board. The VACCINE Leadership Board advises the LLC on how to distribute donated funds to support VACCINE's goals. The corporate donations are true gifts, with no strings attached. However, there are some practical benefits to donors, including the following:

- Membership in the VACCINE, LLC is by invitation only. Member companies need to be complementary as opposed to competitive in nature.
- Corporate affiliates should be in a position to enter into separate research agreements directly with member institutions to develop proprietary technologies, contractually obligated deliverables, etc.
- Corporate affiliates will be in a position to gain early information about ongoing basic research projects at member institutions before publication.
- Corporate affiliates will have opportunities to identify and recruit students at member institutions.
- The Corporate Affiliates program will provide a forum for donors to explore research collaborations and sponsorships.
- Corporate donors will have opportunities for employed scientists to take sabbaticals to participate in relevant research projects at member institutions.

The founding member of VACCINE, LLC was Motorola Solutions. In addition to Motorola, the VACCINE team has been engaged with a number of companies including the following:

- Aegis
- ArgonST
- BanField, the Pet Hospital
- Bank of America
- CRGT
- Duke Energy
- General Dynamics
- Hallmark
- Harris Corporation
- Kimberly Clark
- Kx Systems
- NVIDIA
- Oculus Info, Inc.
- Siemens
- The Boeing Company

# VACCINE

Visual Analytics for Command, Control, and Interoperability Environments  
A U.S. Department of Homeland Security Center of Excellence



## CORPORATE VISIONARY PARTNER PROGRAM

The VACCINE Corporate Affiliate Program offers companies a unique opportunity to collaborate with VACCINE faculty, students, and researchers working at the forefront of visualization and analytics research. Members of the Program are given unparalleled access to new technologies as they move from the laboratory to the marketplace.

At VACCINE, we view research as a practical matter – placing additional emphasis on designing and building technologies and solutions that have real-world impact – saving lives. In many cases, this requires establishing partnerships with industry to translate new ideas and discoveries to products and services already in the marketplace.

### FOUNDATIONAL RESEARCH AREAS

#### Interactive Visual Analytic Foundations

- Context-aware Mobile Visual Analytics for Emergency Response
- Mobile Imaging, Rosetta Phone and Light-weight Visual Analytics for In-field Analytics

#### Visually-Adapted Analytical Techniques

- Cybersecurity Visual Analytics
- Visual Analytics for Investigative Analysis on Text Documents
- Multimedia Visual Analytics for Investigative Analysis
- Situation Surveillance and In-field Criminal Investigative Analytics
- Financial Visual Analytics
- Study of Terrorism and Responses to Terrorism (START Center) Visual Analytics
- Foreign Animal and Zoonotic Disease Visual Analytics
- GeoJunction: Collaborative Visual-computational Information Foraging and Contextualization to Support Situation Awareness
- Video Surveillance Visual Analytics
- Visual Analytics for the DHS Centers of Excellence

#### Investigative Analysis and Decision Making Environments

- Integrate Automated Analytical Reasoning into JIGSAW – a visual index of document collection
- Introduce Sustainable Visual Analytics into Command Center Environments

### BENEFITS OF THE VISIONARY PARTNER PROGRAM

**Visionary Partners** – Contribute \$50,000 per year as an unrestricted gift. Gift funds may be designated for general support of the VACCINE Center and to assist with all areas of discovery, learning and engagement, or for work on a specific research initiative.

- Gain early awareness to the latest visualization research. Through meetings and visits, companies get a preview of the latest research findings from across the VACCINE consortium. Companies that can access this information before it's published have a front-row seat to early licensing opportunities.
- Recruit VACCINE students. Our students are our most valuable assets. They add substantial value to any company as interns or employees.
- Provides a neutral convening point for exploring technology futures. VACCINE is the ideal place to bring like-minded people together in a vendor-neutral setting to explore key challenges and technological matters. VACCINE brings to the table the most highly qualified thought leaders from both academia and industry.
- Opportunity to spend a short sabbatical at a VACCINE partner university collaborating on projects of interest while gaining deep insight into the latest visual analytics research and techniques.
- There will be a global goodwill benefit to your business in its association with the 18 VACCINE partner universities.

### OTHER CORPORATE AFFILIATE OPPORTUNITIES

**Project Partners** – VACCINE is very interested in developing research projects under confidential contractual arrangements. These projects typically specify contractually obligated deliverables, address intellectual property issues, and may involve exchange of personnel between sites, as well as regularly scheduled conference calls and updates in addition to written progress reports. Typical projects begin at \$20,000 and range upward.

For more information, Contact Tim Collins, 765-494-0536, [tfcollin@purdue.edu](mailto:tfcollin@purdue.edu)

[www.VisualAnalytics-CCI.org](http://www.VisualAnalytics-CCI.org)

5) **In addition to the 18 schools comprising VACCINE, other academic partners:**

- Regenstrief Institute
- Mississippi Valley State University
- Center for Infectious Disease Dynamics, Penn State
- San Diego Supercomputer Center
- West Houston Center for Science and Engineering
- Central Washington University
- SUNY Albany
- Penn State Institute for Cyberscience
- Houston Community College
- California State University Dominguez Hills
- University of Maryland
- CREATE
- NCFPD
- CCICADA
- Rochester Institute Technology
- DIEM

6) **VACCINE International Partnerships:**

VACCINE sponsored a two-day workshop in Banff, Canada in September, 2011 for Canadian researchers, policy makers and industry experts to promote the study and use of visual analytics among Canadian organizations and institutions. Forty people attended, representing 21 Canadian/US institutions and organizations. Topics were decided by the Canadian institutions and focused on those areas determined to be of the most relevance to this group: Safety and Security; Financial Risk, Business Intelligence; Health—Records and Research; Astrophysics; and Oil/Gas and Geomatics. Each topic followed the same format—overview and general panel discussion of the topic (including industry experts); small focus group discussion to generate ideas for the specific industry/topic; and general discussion of the entire group. At the conclusion of the workshop, a general discussion was held to generate ideas and topics for future projects and seed grant proposals, which were funded by VACCINE. Seven proposals were generated and three were selected:

**Visualization and Policy Making: Theoretical and Empirical Explorations** (workshop)—Univ. of British Columbia and Simon Fraser University

**Financial Systemic Risk Analysis** (workshop)—Univ. of British Columbia

**Personal Visual Analytics** (networking and workshop)—Univ. of Victoria, Univ. of Calgary, Dalhousie University

Follow-up on workshops and networking events will occur during Year 4.



Other VACCINE international partners include:

- Carleton University, Canada
- Chalmers University, Sweden
- Dalhousie University, Canada
- Justice Institute of British Columbia, Canada
- Linköping University
- Linnaeus University
- National Institute for Research in Computer Science and Control
- Ontario Institute of Technology, Canada
- Simon Fraser University, Canada
- Swansea University
- University of British Columbia, Canada
- University of Calgary, Canada
- University of Gävle
- University of Groningen, Netherlands
- University of Konstanz
- University of Manitoba, Canada
- University of Stuttgart, Germany
- University of Victoria, Canada

## V. Technology Transition

Throughout this document, it should have become evident that VACCINE is committed to getting our technologies and programs into the hands of the individuals that need them. Since VACCINE’s inception in 2009, DHS has gradually moved towards an aggressive technology transition strategy. It is imperative to show value to the end-users via getting VACCINE tools deployed. As mentioned earlier, the role of developing detailed operational requirements is critical for the successful transition of technologies into the various homeland security fields. The VACCINE Center of Excellence recognizes the need for significant end-user-in-the-loop involvement in the entire life cycle development process. For example, in 2012, VACCINE entered into a Memorandum of Agreement with the Ohio Fusion Center, managed by the Ohio State Highway Patrol (OSHP) and Ohio Homeland Security (OHS). “The agreement was created with the sole purpose of establishing a framework for a mutually beneficial pilot collaboration among OUP, OSHP/OHS and the DHS Centers of Excellence (COEs). The Ohio Fusion Center will assist the COEs to develop research products relevant to OSHP/OHS’s and other first responders’ needs. VACCINE will facilitate the OSHP’s direct access to research materials and training accomplished through the DHS Centers for Excellence” (MOA, 2012).

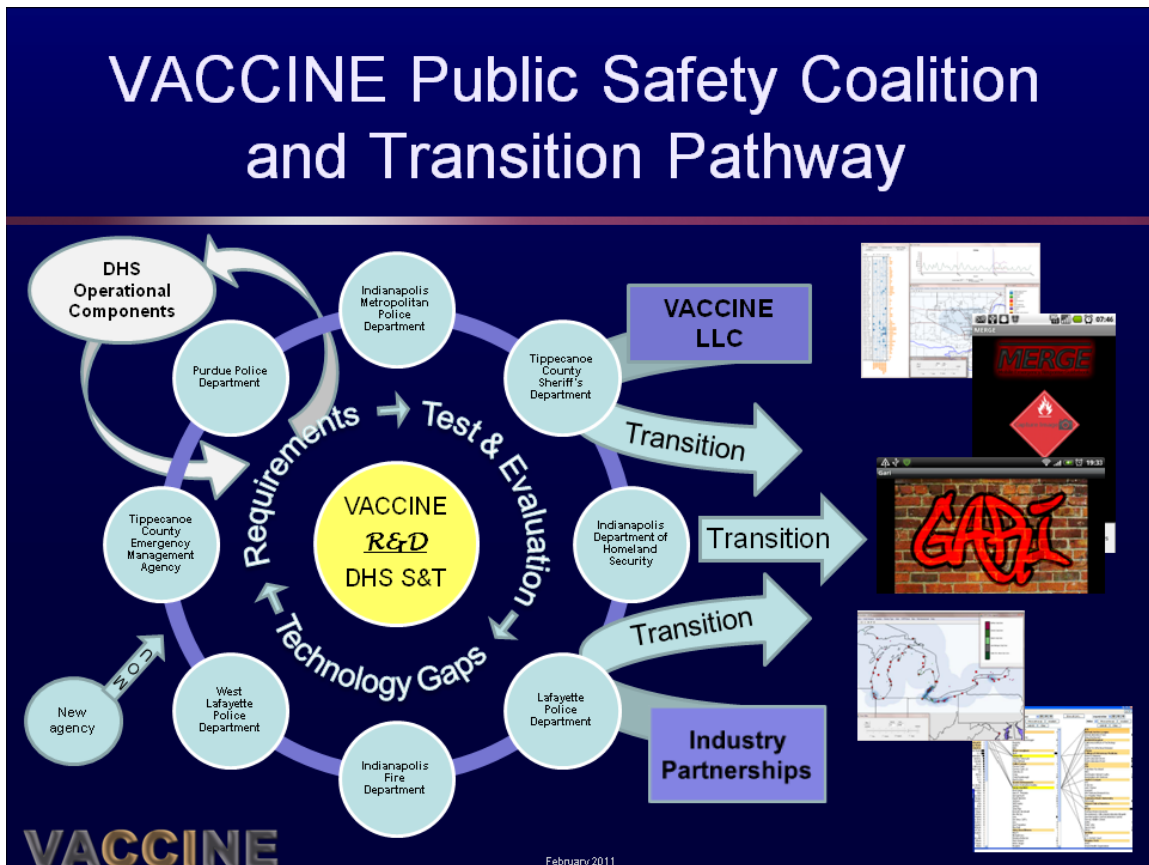


Figure 5: VACCINE Transition Pathway

In 2010, DHS S&T Office of University Programs formed the Research Transition Working Group (RTWG) in order to develop strategies and methods to step up the transition game and get more COE tools, technologies and other products to end users. The VACCINE Center is represented on the RTWG and has provided significant input into developing the goals and metrics for transition as well as aligning these goals with the recent Quadrennial Homeland Security Review.

Also, as discussed earlier, our industry partnerships and the VACCINE, LLC are critical components of our transition strategy. This is not only true for having potential vendors identified for licensing VACCINE technologies for distribution to broader markets, but also to engage end-users in the education and learning realms. For example, our relationship with Captico, led to the prototype development of the uLearning portal for training and educating the first responder community.

The following list summarizes the VACCINE technologies and where they are in terms of transition and deployment. While they are deployed for evaluation, the feedback we receive has resulted in continuous refinements to meet the needs of the users. In some cases, we are releasing new versions of technologies once a month.

**JigSaw** – VA for Exploring and Understanding Document Collections (Georgia Tech)

- Deployed for Test & Evaluation Feedback Dec - 2010
- West Lafayette PD, Lafayette PD

**PROTECT** - Port Resilience Operational / Tactical Enforcement to Combat Terrorism

- Collaboration with CREATE
- Prototype July 26, 2011

**COE Explorer** – Exploring the Centers of Excellence (Purdue, SFU)

- Collaboration with CCICADA

**CrimeViz** - Sensemaking about criminal activity in space and time (Penn St)

- Testing in progress with Harrisburg PD
- Prototype deployment planned for Q2 2011 Harrisburg PD, JIBC

**ISIS** - Infovis System for Investigating Intrusions (Stanford)

- Awaiting deployment to US CERT

**VALET** - Visual Analytics Law Enforcement Toolkit

- Deployed for Test & Evaluation Feedback - 2010
- Lafayette PD, W. Lafayette PD, Purdue PD, Tippecanoe County Sheriff

**GARI** - Gang Graffiti Automatic Recognition and Interpretation

- Initial Prototype Deployment Scheduled May 2011
- Indianapolis Gang Task Force, Lafayette PD, Purdue PD

**CGSaRVA - Coast Guard Search and Rescue Visual Analytics**

- Deployed for Operational Use – USCG LANT - 2010

**MERGE - Mobile Emergency Response Guide**

- Initial Prototype Deployment Scheduled May 2011
- Indianapolis Fire, Lafayette Fire

**Ulearning (Captico)- Training portal for S&T and COE Technologies**

- Deployed for Test & Evaluation Feedback - March 2011

# Florida International University



# Florida International University

**Institution:** Florida International University

**PI and/or Co-PI:** Dr. Shu-Ching Chen (PI)

**Project Name:** A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-agency, Multi-Partner Multimedia Data

**Academic Disciplines:** Computer Science

**Keywords associated with project:** Disaster Situation Report Enhancement, Multimedia Data Integration, User Feedback, and Vertical Search Engine

**Theme for Research Projects** (Check all that apply)  
 If this is not a research project, indicate "NA" below.

X	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
	Federal Operating Component Projects (TSA, FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
	International Collaborations
	N/A

**Theme for Education Projects** (Check all that apply)  
 If this is not an education project, indicate "NA" below.

	Minority or Underserved Programs
X	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
	N/A

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

To assess the damage of a hazard scenario, both public and private participants in the field capture pictures and videos of disaster scenes with mobile devices. Those data are being collected but not well integrated with the disaster situation reports, which are critical materials for supporting efficient decision making process. To solve this problem, we propose to use advanced data integration and visual analytics techniques to analyze situation reports and pictures as well as text captured in the field and automatically augment/link the reports directly to relevant multimedia content obtained in the field. Specifically, in the past year, we improved the original prototype system by adding an entity highlighting function to facilitate keyword identification and image filtering. We also implemented real-time user feedback functionality to reflect user preference on the fly. A new image categorization method was developed by exploring the interaction between images and texts. In addition, in order to effectively organize and retrieve disaster information available online, a disaster research engine was designed and developed to collect and present multiple web objects, such as web articles, tweets and blogs for efficient retrieval of such information. The disaster search engine together with the report-image association system provides a valuable solution for disaster situation evaluation and decision making.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input checked="" type="checkbox"/>	Compiling & Sorting DB
<input checked="" type="checkbox"/>	Data Mining
<input checked="" type="checkbox"/>	Expert Consultation
<input checked="" type="checkbox"/>	Field Monitors
<input checked="" type="checkbox"/>	Survey
<input type="checkbox"/>	Other:

**Analytic Methods**

<input checked="" type="checkbox"/>	Case Studies
<input checked="" type="checkbox"/>	Modeling
<input checked="" type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input checked="" type="checkbox"/>	Applied
<input checked="" type="checkbox"/>	Basic
<input checked="" type="checkbox"/>	Consultation
<input checked="" type="checkbox"/>	Coordination/Integration
<input checked="" type="checkbox"/>	Education
<input type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

1. An improved prototype system with major functionalities such as main report list, report-image association, filtering based on locations/subjects/keywords, image-image association, image timeline and real-time user feedback.
2. A web image categorization method by exploring the interaction between images and texts.
3. A disaster search engine for efficient retrieval of disaster related information such as web articles, tweets and blogs.



**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

NA

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

"A Research and Educational Framework to Advance Disaster Information Management in Computer Science PhD Programs," Department of Homeland Security 2010-ST-062-000039, \$400,000, 2/1/2011 - 1/31/2015, Shu-Ching Chen (PI), Tao Li (Co-PI), Jinpeng Wei (Co-PI), Zhenyu Yang (Co-PI), and Ming Zhao (Co-PI).

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

Dr. Tao Li (Co-PI) and Steven Luis (Senior Investigator)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Paul Vitro  
Emergency Management Coordinator  
Miami-Dade County Department of Emergency Management (DEM)  
9300 NW 41 St., Doral, FL 33178  
Phone: 305-468-5423  
[www.miamidade.gov/oem](http://www.miamidade.gov/oem)

Ray Misomali,  
Emergency Management Coordinator  
Miami-Dade County Department of Emergency Management (DEM)  
9300 NW 41 St., Doral, FL 33178  
Phone: 305-468-5429  
[www.miamidade.gov/oem](http://www.miamidade.gov/oem)

Soheila Ajabshir - GISP, FPEM  
Systems Manager  
Miami-Dade County Department of Emergency Management (DEM)  
9300 NW 41 St., Doral, FL 33178  
Phone: 305-468-5417

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

NA

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Accepted:

1. Mei-Ling Shyu, Chao Chen and Shu-Ching Chen, "Multi-Class Classification via Subspace Modeling," International Journal of Semantic Computing, Volume 5, Issue 1, pp. 55-78, March 2011.
2. Steven Luis, Fausto C. Fleites, Yimin Yang, Hsin-Yu Ha, and Shu-Ching Chen, "A Visual Analytics Multimedia Mobile System for Emergency Response," IEEE International Symposium on Multimedia (ISM2011), Dana Point, California USA, pp. 337-338, December 5-7, 2011. (Demo paper)
3. Qiusha Zhu, Lin Lin, Mei-Ling Shyu, and Shu-Ching Chen, "Effective Supervised Discretization for Classification based on Correlation Maximization," The 12th IEEE International Conference on Information Reuse and Integration (IRI 2011), Las Vegas, Nevada, USA, pp. 390-395, August 3-5, 2011.

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

NA

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

1. "Enhancing Situation Documents with Disaster Related Information," Evaluation Activity at Miami-Dade County Department of Emergency Management (Date to be determined).

**Patents/Copyrights** (List names)

Applications: NA

Awarded: NA

**Summary of Outcomes and Impact of Project**

The developed system is managed in a version control system and run through a test suite that validates key functionalities such as report list control, image filtering, feedback processing, and so on. By interacting with MDEM personnel through evaluation and exercise activities, the system has constantly been updated by improving user interface experience and back-end support techniques. Feedback from our collaborative partners at MDEM and the potential users suggest that our system will be very useful for emergency managers to gain insights of the situation at actual disaster scene and make quick response. We are encouraged to further develop the system into an operational pilot project and promote the commercialization of the system for the benefit of the whole EM community.

**Impact or success story associated with project**

The prototype system as well as the iPad application will be continuously evaluated by the personnel at Miami-Dade Emergency Management (MDEM), where evaluation activities regarding the developed application will be conducted.

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

NA

**Changes in research plans, if applicable:** describe any major changes in the project’s plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

NA

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

1. Presentation document for the evaluation activity at Miami-Dade County Department of Emergency Management.
2. Evaluation form.

# Georgia Institute of Technology



# Georgia Institute of Technology

**Institution:** Georgia Institute of Technology

**PI and/or Co-PI:** John Stasko

**Project Name:** Visual Analytics for Investigative Analysis on Text Documents (Jigsaw)

**Academic Disciplines:** Computer science, visual analytics

**Keywords associated with project:** Jigsaw, visualization, data analysis, visual analytics

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input type="checkbox"/>	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A
XXX	Public Safety Coalition

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input checked="" type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Zhicheng Liu, Georgia Tech, School of Interactive Computing

Mengdie Hu, Georgia Tech, School of Interactive Computing

**Undergraduate supported students** (need number only)

0

**Other Graduate Students** (non-supported) involved in project (need number only)

2

**Other Undergraduate Students** (non-supported) involved in project (need number only)

0

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

Many people and organizations routinely perform analysis that involves large collections of documents, and in particular, textual documents such as case reports, news articles, or suspicious activity reports. Investigators may seek to investigate an individual or incident, or they may simply be exploring with hopes to discover stories, narratives, or threats that may be embedded across the document collection. We have developed a visual analytics system named Jigsaw that helps investigators in such scenarios. Jigsaw pairs computational analysis of the documents with a collection of visualizations that each portray different aspects of the documents, including connections between different entities. Thus, the system acts like a visual index onto a document collection, highlighting connections between entities and allowing the investigator to understand the context of events in a more timely and accurate manner. Jigsaw helps analysts "put the pieces together" and link initially unconnected activities into a more coherent story. We are working with law enforcement and public safety organizations to explore how Jigsaw can be used in their work.



**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input type="checkbox"/>	Compiling & Sorting DB
<input type="checkbox"/>	Data Mining
<input type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input checked="" type="checkbox"/>	Other:

**Analytic Methods**

<input checked="" type="checkbox"/>	Case Studies
<input type="checkbox"/>	Modeling
<input type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input checked="" type="checkbox"/>	Other:

**Nature of Research**

<input checked="" type="checkbox"/>	Applied
<input checked="" type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

We have provided the Jigsaw software system to multiple law enforcement and public safety organizations.

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

NA

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

“Supporting Investigative Analysts and Researchers in Sense-making across Large Document Collections through Visual Analytics”, National Science Foundation, PI: John Stasko, \$489,671 (8/09-7/12)

“FODAVA-Lead: Dimension Reduction and Data Reduction: Foundations for Visualization”, National Science Foundation & Dept. of Homeland Security, PI: Haesun Park, \$3,000,000 (9/08-8/13)

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Cindy Marion, West Lafayette Police Dept., IN, (765) 775-5200,

Steve Hawthorne, Lafayette Police Dept., IN, (765) 807-1227, sdhawthorne@lafayette.in.gov

Damien Williams, Rock Hill Police Dept., SC, damienwilliams@cityofrockhill.com

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

NA

**Project Period** (only complete if different than 4/1/11-3/31-12)

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Görg, Carsten; Liu, Zhicheng; Kihm, Jaeyeon; Choo, Jaegul; Park, Haesun; Stasko, John T., "Combining Computational Analyses and Interactive Visualization for Document Exploration and Sensemaking", submitted to IEEE Transactions on Visualization and Computer Graphics.

Youn-ah Kang and John Stasko, "Examining the Use of a Visual Analytics System for Sensemaking Tasks: Case Studies with Domain Experts", submitted to IEEE VAST '12.

Charles D. Stolper, Mark Braunstein, Carsten Gorg, Zhicheng Liu, John Stasko, "How Visual Analytics Enhances Insight and Knowledge Acquisition from Expert Wine Reviews", submitted to IEEE VAST '12.

Accepted:

Zhicheng Liu, Shamkant B. Navathe, John Stasko, "Network-based Visual Analysis of Tabular Data," Proceedings of IEEE VAST '11, Providence, RI, October 2011, pp. 41-50.

Youn-ah Kang and John Stasko, "Characterizing the Intelligence Analysis Process: Informing Visual Analytics Design through a Longitudinal Field Study," Proceedings of IEEE VAST '11, Providence, RI, October 2011, pp. 21-30.

Elizabeth Braunstein, Carsten Görg, Zhicheng Liu, and John Stasko, "Jigsaw to Save Vastopolis - VAST 2011 Mini Challenge 3 Award: 'Good Use of the Analytic Process'", Proceedings of IEEE VAST '11, Providence, RI, Oct. 2011, pp. 323-324.

Pak Chung Wong, Chaomei Chen, Carsten Görg, Ben Shneiderman, John Stasko, Jim Thomas, "Graph Analytics - Lessons Learned and Challenges Ahead," *IEEE Computer Graphics and Applications*, Vol. 31, No. 5, Sept./Oct. 2011, pp. 18-29.

Youn-ah Kang, Carsten Görg, John Stasko, "How Can Visual Analytics Assist Investigative Analysis? Design Implications from an Evaluation," *IEEE Transactions on Visualization and Computer Graphics*, Vol. 17, No. 5, May 2011, pp. 570-583.

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

NA

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

“Visual Analytics”, John Stasko, National Academies Board on Science, Technology, and Economic Policy, Workshop on Measuring the Impacts of Federal Investments in Research, Session on Emerging Metrics and Models for Assessing Research Impacts, Washington D.C., April 2011

“Visual Analytics for Investigative Analysis and Exploration of Documents and Data”, John Stasko, Dalhousie University, Halifax, Nova Scotia, Canada, November 2011, Dorothy J. Killam Memorial Lecture Series

**Patents/Copyrights** (List names)

Applications: NA

Awarded: NA

### **Summary of Outcomes and Impact of Project**

We have continued our development and distribution of the Jigsaw visual analytics system. (See <http://www.cc.gatech.edu/gvu/ii/jigsaw>.) Over 150 people and organizations have downloaded the system including Air Force Intelligence, AFRL Wright Patterson, Army Counterintelligence, Boeing, Deloitte, Naval Research Lab, NCIS, PayPal, Thomson Reuters, United Nations Investigative Office, US Attorney's Office Organized Crime Taskforce, as well as numerous newspapers and police departments. In particular, we gave the system to police departments in Lafayette and West Lafayette, IN and in Rock Hill, SC. We have written and submitted papers about the system itself and about case studies of actual use of the system. Both papers are currently being considered for acceptance at a journal and conference.

We also continued development of a new interactive system called Ploceus that helps people understand tabular and relational data by generating network visualizations of that data. Ploceus allows flexible mappings from the different attributes of the relational data to the network representations.

### **Impact or success story associated with project**

A police investigator in Rock Hill, SC has used Jigsaw in research on cases. He reports that the system has been useful in investigations.

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

NA

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

NA

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

NA

# University of Houston Downtown



# University of Houston – Downtown

**Institution: University of Houston Downtown A**

**PI and/or Co-PI: PI Richard Alo; co PIs: UHD- Ongard Sirisaengtaksin, Ping Chen, Hong Lin; Navajo Tech- Tom Davis; CSUDH- Mohsen Beheshti**

**Project Name: VACCINE Affinity Research Groups**

**Academic Disciplines: Statistics, mathematics and computer science**

**Keywords associated with project:**

## **Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input type="checkbox"/>	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
1	Event Evacuations
1	Visual Analytics for Security Applications
1	International Collaborations
1	N/A

## **Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

X	Minority or Underserved Programs
X	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input type="checkbox"/>	N/A



**Students Supported on Project**

Antoine	Sarah		Melissa	Maxwell
Williams-	Jannisca;	Duber	Greenlee;	Goedjen;
Baisy;	Lilian	Gomez-	Jessie	Brian
Adetomiwa	Antunes;	Fonseca;	Uchendo	Holtkamp;
Oguntuga	Hooman	Tia	Joseph	Vanessa
	Hemmati;	Pilaroscia	Jonson	Hernandez;

**Graduate Research Assistants** (include name(s), university and department)

**Undergraduate supported students** (need number only)

UHD- 10;NTC- 4;

**Other Graduate Students** (non-supported) involved in project (need number only)

2 CSUDH

**Other Undergraduate Students** (non-supported) involved in project (need number only)

2 CSUDH; UHD-6: NTC-2

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

1. Terrorism Information Analyzer, Antoine Williams-Bais
2. Using search engine auto suggested data to build a kno  
for  
an unsupervised Word Sense Disambiguation system,  
Adetomiwa Oguntuga, Spring 2012

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input checked="" type="checkbox"/>	Compiling & Sorting DB
<input checked="" type="checkbox"/>	Data Mining
<input type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input type="checkbox"/>	Other:

**Analytic Methods**

<input type="checkbox"/>	Case Studies
<input type="checkbox"/>	Modeling
<input type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input checked="" type="checkbox"/>	Applied
<input checked="" type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

Software Packages

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

Computing Alliance for HSIs 20k scholarships

MSI CyberInfrastructure Empowerment Coalition \$50K for two workshops

California Institute of Telecommunication and IT \$38K for workshop

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies) CSUDH, NTC, FIU

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

To undertake collaborative research

**Project Period** (only complete if different than 4/1/11-3/31-12)

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

1. Please see attached Word document.

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparations], other publications)

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

**Patents/Copyrights** (List names)

Applications:

Awarded:

## **Summary of Outcomes and Impact of Project**

- ❖ Attending multiple meeting and conference calls
  - With Dr. Richard Alo
- ❖ Working in research with graduate students
  - Eugene Chamorro and Tomohiro Hayata
- ❖ Starting to conduct research projects using the Opti-Portal

Students submitted posters to Student Research Day Conference at CSUDH. In conclusion, the original goal of generating a program that can present the most important content of the Global Terrorist Database (GTD) in a easy to parse and view fashion was mostly met. A software package was created that can quickly display paragraphs for the user based on their desired parameters as well as place the locations on a map automatically. All of the information displayed is based on content of the GTD, but does not require the GTD to function. The program's sub-menus are mostly dynamically generated. If any changes or edits need to occur in the file indexes, the program's code will not need to be updated as long as the file indexes retain their original name.

## **Impact or success story associated with project**

Student publications

Student poster presentations

Research Experience

Collaboration

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

**University  
of  
North Carolina, Charlotte**



# University of North Carolina at Charlotte

**Institution: University of North Carolina at Charlotte**

**PI and/or Co-PI: William Ribarsky, PI; Jing Yang, co-PI; Jianping Fan, co-PI**

**Project Name: Multimedia, Social Media, Text, and Emergency Response Analytics**

**Academic Disciplines: Visual analytics, unstructured content analysis, decision-making, social analysis**

**Keywords associated with project: interaction, visualization, analytics, social networks, social media, emergency response, sensemaking**

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input checked="" type="checkbox"/>	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input checked="" type="checkbox"/>	Enterprise Resiliency Environments
<input checked="" type="checkbox"/>	Event Evacuations
<input checked="" type="checkbox"/>	Visual Analytics for Security Applications
<input checked="" type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input checked="" type="checkbox"/>	N/A



**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Wenwen Dou UNCC Computer Science

Yi Shen UNCC Computer Science

Yujie Liu UNCC Computer Science

Yang Chen UNCC Computer Science

**Undergraduate supported students** (need number only) 3

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

Wenwen Dou Understanding the Bi-Directional Relationship Between Analytical  
Processes and Visualization Systems Computer Science Ph.D. May, 2012

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

The project applies visual analytics methods to a range of problems of significance to DHS. In each case one or more tools or products are produced. In several instances, the tools are deployed to stakeholders. Capabilities produced include:

- Multimedia analytics methods applied to unstructured collections of images, video, and text. In some cases, a full multimedia fusion is attained. Texts in any language can be handled. Topic streams are identified and events within the stream of text or other media are indicated. Narratives can be constructed. Tens of thousands of documents can be organized and their interrelations and trends understood in this way. The methods have been applied to document collections, media streams, online news, social media, blogs, and other content.
- Mobile emergency response and emergency evacuation tools for urban environments have been developed and deployed. These tools are situationally aware; they can be updated immediately based on blocked exits, blocked paths, unexpected distribution of people, etc. Search, apprehension, and rescue tasks can be carried out where the command center and deployed officers are in full communication as to position and actions. A novel capability has been developed to provide decision support to commanders in complex emergency response situations as they evolve.
- Risk analytics capabilities have been applied to large and multi-faceted financial resources, such as at a major bank or under the jurisdiction of a major government agency. A fast access data structure has been set up for exploratory risk analysis involving several financial and geographic attributes of the user's choosing.
- A system of systems model has been set up for understanding an urban electric smart grid infrastructure. This system can investigate weak points and cascading effects due to failures in an overall infrastructure including electrical, water, transportation, food distribution, and other components. Work is being done with European partners and VACCINE colleagues.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input checked="" type="checkbox"/>	Compiling & Sorting DB
<input checked="" type="checkbox"/>	Data Mining
<input type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input checked="" type="checkbox"/>	Survey
<input type="checkbox"/>	Other:

**Analytic Methods**

<input checked="" type="checkbox"/>	Case Studies
<input checked="" type="checkbox"/>	Modeling
<input type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input checked="" type="checkbox"/>	Other: Time-dependent probabilistic event and topic modeling

**Nature of Research**

<input type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input checked="" type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input checked="" type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

- Evacuation decision support tool to UNC Charlotte Police and Public Safety Department
- Urban Emergency Response search and command center tools to UNC Charlotte Police and Public Safety Department
- Building 3D routing database and tools to CAUSE-ERE exercise team
- Graffiti identification and retrieval tool to PNNL

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

William Ribarsky, \$80,000, DHS; July 1, 2011 to June 30, 2012

Zachary Wartell and William Ribarsky, \$80,000 Army Research Office, May 1, 2011 to April 30, 2012

William Ribarsky, \$46,000, NIH, March 1, 2012 to February 28, 2013

William Ribarsky, \$125,000 NIJ, September 1, 2011 to August 31, 2012

Aidong Lu and William Ribarsky, DHS, \$90,000, July 1, 2011 to June 30, 2012

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

David Ebert, Purdue University, [ebertd@ecn.purdue.edu](mailto:ebertd@ecn.purdue.edu)

Daniel Keim, University of Konstanz, [keim@uni-konstanz.de](mailto:keim@uni-konstanz.de)

Thomas Ertl, University of Stuttgart, [Thomas.Ertl@vis.uni-stuttgart.de](mailto:Thomas.Ertl@vis.uni-stuttgart.de)

Ted Thomas, Duke Energy, [Ted.Thomas@duke-energy.com](mailto:Ted.Thomas@duke-energy.com)

Justin LaRoche, Duke Energy, [Justin.LaRoche@duke-energy.com](mailto:Justin.LaRoche@duke-energy.com)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Michael Bess, Critical Infrastructure Protection, Charlotte-Mecklenburg Police Dept., 704-614-2610, [mbess@cmpd.org](mailto:mbess@cmpd.org)

Chief Jeffrey Baker, UNC Charlotte Police, 704-687-8300, [jbaker88@uncc.edu](mailto:jbaker88@uncc.edu)

Henry James, Associate Vice Chancellor for Risk Management, Safety & Security, UNC Charlotte, 704-687-8454, [hjames1@uncc.edu](mailto:hjames1@uncc.edu)

Brent Herron, Associate Vice President for Campus Safety and Emergency Operations, University System of North Carolina, 919-962-4594, [bherron@northcarolina.edu](mailto:bherron@northcarolina.edu)

Seth Norris, Director Environmental Health, Safety, and Emergency Management, Appalachian State University, 828-262-8081, [norrissa@appstate.edu](mailto:norrissa@appstate.edu)

Randal Taira, PNNL (CAUSE-ERE project), Seattle Police

Guenther Hartfeil, BB&T, Head of Information Management, [ghartfeil@BBandT.com](mailto:ghartfeil@BBandT.com)

Arun Pinto, Bank of America, Senior Vice President, [arun.pinto@bankofamerica.com](mailto:arun.pinto@bankofamerica.com)

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

Pak Wong, Chief Scientist, PNNL, [Pak.Wong@pnl.gov](mailto:Pak.Wong@pnl.gov) Joint work on graffiti image retrieval

Shaun Kennedy, University of Minnesota, National Center for Food Protection and Defense, [kenne108@umn.edu](mailto:kenne108@umn.edu), placing the food network into the overall infrastructure as part of the VASA project.

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

1. Jamal Alsakran, Ye Zhao, Xiaoke Huang, Alex Midget, and Jing Yang: Using Entropy in Enhancing Visualization of High Dimensional Categorical Data. Submitted to IEEE Conference on Information Visualization 2012
2. Chen Yang, Hao Wei, Shixia Liu, Jing Yang, and Kun Zhou: TextPioneer: Exploring Topical Lead-Lag Evolution across Corpora. Submitted to IEEE Conference on Information Visualization 2012
3. Jing Yang, Yujie Liu, Xin Zhang, Xiaoru Yuan, Ye Zhao, Scott Barlowe, and Shixia Liu: PIWI: Interactively Exploring Large Graphs Without Clutter. Under review of IEEE Trans. Vis. Comput. Graphics
4. Ning Zhou, Yi Shen, William Ribarsky, and Jianping Fan. Automatic Image-Text Alignment for Large-Scale Web Image Indexing and Retrieval. Submitted to IEEE Transactions on Pattern Analysis and Machine Intelligence.
5. Xiaoyu Wang, Zachary Wartell, Isaac Cho, and William Ribarsky. Towards Utilizing Heterogeneous Displays in Emergency Response. Submitted to IEEE VAST 2012.
6. Jack Guest, KR Subramanian, and William Ribarsky. Visual Analysis of Situationally Aware Building Evacuations. Submitted to IEEE VAST 2012.

Accepted:

1. C. Yang, **J. Fan** "Image Collection Summarization via Dictionary Learning", **IEEE Conf. on Computer Vision and Pattern Recognition (CVPR'12)**, 2012
2. N. Zhou, J. Fan, "Discriminative dictionary learning for large-scale visual recognition", **IEEE Conf. on Computer Vision and Pattern Recognition (CVPR'12)**, 2012
3. C. Yang, P. Wong, W. Ribarsky, **J. Fan** "[Efficient Graffiti Image Retrieval](#)", **ACM International Conference on Multimedia Retrieval (ICMR'12)**, 2012
4. J. Fan, N. Zhou, "Quantitative semantic gap modeling for learning complexity estimation", IEEE Trans. on Multimedia, vol.18, no.9, 2012.
5. W. Zhang, X. Xue, **J. Fan**, "Correlative multi-label multi-instance image annotation", **IEEE ICCV (IEEE Intl Conf. on Computer Vision)**, Barcelona, 2011.
6. W. Zhang, X. Xue, **J. Fan**, "Automatic image annotation with weakly labeled dataset", **ACM Multimedia**, Scottsdale, Arizona, USA, 2011.
7. C. Yang, **J. Fan**, "Effective summarization of large-scale web images", **ACM Multimedia**, Scottsdale, Arizona, USA, 2011.
8. N. Zhou, Y. Shen, J. Peng, X. Feng, **J. Fan**, "Leveraging auxiliary text terms for automatic image annotation", ACM WWW (Intl World Wide Web Conferences), Hyderabad, India, 2011.
9. Jamal Alsakran, Yang Chen, Dongning Luo, Ye Zhao, Jing Yang, Wenwen Dou, Shixia Liu: Real-Time Visualization of Streaming Text with a Force-Based Dynamic System. IEEE Computer Graphics and Applications 32(1): 34-45 (2012)
10. Dongning Luo, Jing Yang, Milos Krstajic, William Ribarsky, Daniel A. Keim: EventRiver: Visually Exploring Text Collections with Temporal References. IEEE Trans. Vis. Comput. Graph. 18(1): 93-105 (2012)

*(Continued below)*

### **Summary of Outcomes and Impact of Project**

- We developed a set of novel techniques for graffiti recognition and retrieval, combining them into an effective working system. We first designed a series of techniques for effective character detection. Next, we conducted semantic-wise and image-wise retrieval on the detected character components rather than the entire image to avoid the influence of background noise. The visual and semantic matching scores were combined to give the final matching result.
- We developed very general text and fused multimedia analysis tools. The text tools can be applied to a variety of sources including collections of reports, research papers, books, and streaming media such as Twitter, Facebook, and online news feeds. Some results are described in the success stories below. At the behest of Joe Kielman, we have also begun to investigate movements involved with mass murders in Africa and the Middle East using the social media techniques.
- Outcomes and impacts with respect to VASA and the development of emergency response, training, and planning capabilities are described in the success stories below.

### **Impact or success story associated with project**

- We incorporated our urban routing and emergency response system into the Canada-US Experiment Emergency Resiliency Environment (CAUSE –ERE) scenario and then participated in the demonstration on June 21-22 in Seattle, Washington. DHS managers were in attendance for the experiment. The experiment involved an earthquake in the Pacific Northwest spanning the U.S.-Canada border. Our system was used for mobile emergency routing and situational awareness in a downtown Seattle building. Involved were Randal Taira and Thomas Sanquist of PNNL.

*(Continued below)*

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

There has been a significant issue encountered with respect to the mandatory arbitration required by our German partners in VASA. We are working through this and hopefully have a solution. In general, U.S. Universities find it quite hard to handle arbitration requirements like these because they apply outside the laws of the state.

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

N/A

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

**Project Outcomes** (*Continued*)

Accepted (*Continued*):

11. Jamal Alsakran, Yang Chen, Ye Zhao, Jing Yang, DongningLuo: STREAMIT: Dynamic visualization and interactive exploration of text streams. Proc. IEEE Pacific Visualization Symposium 2011: 131-138
12. Yang Chen, Jamal Alsakran, Scott Barlowe, Jing Yang, Ye Zhao: Supporting effective common ground construction in Asynchronous Collaborative Visual Analytics. IEEE VAST 2011: 101-110.
13. William Ribarsky, Wenwen Dou, and Zachary Wartell. Event Structuring as a General Approach to Building Knowledge in Time-Based Collections. Advances in Visual Analytics: in Memory of Jim Thomas. (Springer, 2012).

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

1. William Ribarsky, Invited panel organizer, “Analytics & Awareness”, NC Defense Opportunities Workshop (April, 2012).
2. William Ribarsky, Invited panel organizer, “The Future of Big Data Analytics,” Charlotte Informatics 2012 (May, 2012).

**Patents/Copyrights** (List names)

Applications:

Awarded:



**Impact or success story associated with project (continued)**

- On November 18, 2011, we ran a full-scale police exercise. In this exercise, a person with a gun enters a campus building. There are victims, including gunshot victims. The UNC Charlotte Police respond, setting up the mobile command center outside the building. The fully equipped SWAT Team is sent into the building. The Team used our mobile emergency system to communicate locations, find routes, identify locations and condition of victims, etc. Based on this information, the Commander sent commands (including drawn search areas) via the mobile system. The shooter was found and neutralized; victims were located and removed.
- In March, 2012 we ran a tabletop exercise with our situationally aware evacuation system for three different scenarios to determine our system's usability, effectiveness for real-time decision-making, and to assess needs for improvements. A business continuity office staff member (an expert in running training exercises) designed the scenarios. The UNCC police chief, a senior police officer, and the software team participated in the exercise. All three scenarios involved a cluster of four campus buildings and the evacuation of approximately 5000 people. The three scenarios were: a gas leak in a building, an active shooter in a building, and an explosion in a utility plant near the buildings. Each scenario involved unexpected blocking of certain exit routes and gathering points outside the buildings. The police chief and the rest of the participating team were unaware of how each scenario would unfold and had to respond as the situation developed. Video of each of the three exercises was recorded for analysis, followed by feedback from the emergency personnel. The system was operated by a member of the software team while commands were issued by the police chief. The ability to see the layouts of the buildings and the surrounding area as the situation developed was considered quite valuable, as was the near real-time responsiveness of the system in changing the flow of evacuees as paths became blocked. The police chief was able to make decisions about where to send officers based on the results displayed by the system.
- At the end of June, 2012 we will run a joint exercise with the UNC Charlotte Police and the Charlotte Police that will integrate the above emergency response and evacuation components.
- We are running an analysis of social media to track protest events. Initial analysis has been on the Occupy Wall Street Movement and covers the movement since before its breakout protest on Sept. 17, 2011 to now. Combining topic modeling with geographic and named entity analysis, we can extend this analysis to "flash mob" gatherings, identifying where and when they will happen and what groups may be involved. The City of Charlotte is quite interested in this capability for the Democratic National Convention and other uses.
- Using the modeling environment we have set up for VASA, we are working with Envision Charlotte, a partnership of city, county, non-profits, Duke Energy, and other companies that is developing an urban sustainability and infrastructure resiliency effort for Charlotte. The model incorporates energy production and distribution, transportation, social models, and economic models. We are working with the Measurement Committee of Envision Charlotte (Ribarsky is a member) to decide what key measurements to make and, with the help of the model, determine what they mean in terms of sustainability and resiliency. The City of Charlotte and Mecklenburg County are deeply involved with this measurement activity. This model and some of the results will be incorporated into our VASA modeling efforts, which will also incorporate modeling of the food distribution network.

# Pennsylvania State University



# Pennsylvania State University

**Institution: Penn State University**

**PI and/or Co-PI: Alan MacEachren (PI); Anthony Robinson (CoPI)**

**Project Name: Symbology Standardization Support**

**Academic Disciplines: Geography & Information Sciences and Technology**

**Keywords associated with project: Map Symbology, geospatial standards, mobile mapping, semantics and ontology for mapping**

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input checked="" type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc)
<input checked="" type="checkbox"/>	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input checked="" type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Raechel Bianchetti, Penn State Department of Geography  
Elaine Guidero, Penn State Department of Geography  
Joshua Stevens, Penn State Department of Geography

**Undergraduate supported students** (need number only)

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

Mapmakers at DHS use a wide range of methods for visually representing geographic data, and new means are needed to develop, share, and disseminate map symbols in order to enhance interoperability in crisis situations. The Symbology Standardization Support project aims to design, develop, and evaluate new mechanisms to enhance geographic information sharing within DHS and between DHS and local/state/federal stakeholders. This project's objectives are to develop interactive, web-based tools for developing standardized map symbol sets and to widely and flexibly disseminate those symbols through easy-to-use tools. A key deliverable for this project is a web-based tool called SymbolStore, which allows users to visually browse, search for, and download available map symbols that are used across DHS divisions and focus areas. In addition, SymbolStore allows users to contribute the symbols they use and to tag them with metadata and categories to support natural language searches through the SymbolStore interface to retrieve symbols that are relevant to specific crisis situations. In the coming year, this project will also focus on integrating lessons learned from the development of an iterative, distributed method for developing and refining map symbol standards to support distributed refinement of symbols and metadata that are uploaded to SymbolStore.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input checked="" type="checkbox"/>	Compiling & Sorting DB
<input type="checkbox"/>	Data Mining
<input checked="" type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input checked="" type="checkbox"/>	Survey
<input type="checkbox"/>	Other:

**Analytic Methods**

<input checked="" type="checkbox"/>	Case Studies
<input type="checkbox"/>	Modeling
<input type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input checked="" type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

- SymbolStore.org, a public-facing version of our SymbolStore tool, was made available to the public during the reporting period. It can be accessed at [www.symbolstore.org](http://www.symbolstore.org).
- Symbol Store service to support two DHS S&T SBIR funded projects, one awarded to Charles River and one to Physical Optics
- Symbol Store service to support two DHS S&T funded project at PNNL

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

- The project team has begun collaborating with SBIR partners at Charles River and Physical Optics. Both groups have been briefed on our SymbolStore development progress and provided with access to our tools and code upon request.
- The project team has begun collaborating with PNNL on use of SymbolStore as a source of map symbology to support their DHS-funded technology development.

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

n/a

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

DHS Science and Technology (Jon Dale and Honore Nyuyse)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

FEMA – Todd Raziano (todd.raziano@dhs.gov)

IICD – Carol McCaig (carol.mccaig@dhs.gov)

CBP – Scott Crozier (scott.crozier@dhs.gov)

GMO (DHS Geospatial Management Office)

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

- As noted above, the project team has begun collaborating with PNNL on use of SymbolStore as a source of map symbology to support their DHS-funded technology development. The goal is to generate a demonstration application that illustrates the potential of technology developed at each site to interoperate.

**Project Period** (only complete if different than 4/1/11-3/31-12)

March 1, 2010 – March 31, 2013



**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

**Accepted:**

1. Robinson, A.C., Roth, R.E., Blanford, J., Pezanowski, S., and A.M. MacEachren. (2011) A Collaborative Process for Developing Map Symbol Standards. *Spatial Thinking and Geographic Information Sciences*. Tokyo, Japan, September 14-16, 2011.
2. Robinson, A.C., Roth, R.E., and A.M. MacEachren (2011) [Understanding User Needs for Map Symbol Standards in Emergency Management](#). *Journal of Homeland Security and Emergency Management*. 8(1): Article 33.
3. Roth, R.E., Finch, B.G., Blanford, J.I., Klippel, A. Robinson, A.C. and MacEachren, A.M. (2011) [Card sorting for cartographic research and practice](#). *Cartography and Geographic Information Science* 38(2): 89-99.
4. Robinson, A.C., Roth, R.E., Blanford, J., Pezanowski, S. and MacEachren, A.M. in press: Developing map symbol standards using a distributed, asynchronous process. *Environment and Planning B: Planning and Design*.

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

1. Multi-scale Symbolization for Emergency Mapping (Report)
2. Results of Symbol Standardization Process conducted with DHS IICD Users (Report)
3. Dynamic Symbol Experiment Results (Report)
4. Symbology to support remote, map-based collaboration (Short Review)
5. Line, polygon, and temporal symbology requirements for DHS (Short Review)
6. Map export capability for reports that automatically adapt symbology to output formats and embed sufficient metadata to support interpretation (Short Review)
7. Semantic web to support matching symbology across agencies (Short Review)
8. Standard color schema for universal application to existing symbol sets (Short Review)
9. Symbol frame revision for operations and/or degree of change (Short Review)
10. Opportunities for Semantics Research in Emergency Management (Full Literature Review)
11. Survey of Mapping for Mobile Devices (Full Literature Review)

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

1. Bianchetti, R.A., J. Blanford, A. Klippel, A.C. Robinson, and A.M. MacEachren. 2011. Critical Evaluation of International Emergency Management Symbology. *The 107th Annual Meeting of the Association of American Geographers*. Seattle, WA: April 15.
2. Bianchetti, R.A., A.M. MacEachren, A. Klippel, A.C. Robinson, F. Hardisty, J. Blanford, R. Li and J. Yang. (2011) Comparing Cartographic Point Symbol Design with Card Sorting Methods. *North American Cartographic Information Society (NACIS) 2011*. Madison, WI: October 12-14.
3. Guidero E, F Hardisty, RE Roth, A Klippel, AC Robinson, and AM MacEachren. 2011. Representing change using point symbols. *The 107th Annual Meeting of the Association of American Geographers*. Seattle, WA: April 15.
4. Pezanowski S, AC Robinson, E Guidero, R Bianchetti, F. Hardisty, J Blanford, RE Roth, and AM MacEachren. 2011. An interactive, web-based tool for discovering and sharing map symbols. *The 107th Annual Meeting of the Association of American Geographers*. Seattle, WA: April 15.
5. Troedson, S. and A.C. Robinson. (2011) Using Web-Based Tools to Share Symbology: A Case Study with Mapmakers from the California Department of Water Resources. *North American Cartographic Information Society (NACIS) 2011*. Madison, WI: October 12-14.

**Patents/Copyrights** (List names)

Applications: n/a; Awarded: n/a

### **Summary of Outcomes and Impact of Project**

**During the reporting period, this project had the following outcomes:**

- Development of a full-featured working prototype SymbolStore, featuring the ability for DHS users to upload symbols, add metadata to symbols, and to browse/retrieve symbols and preview them on realistic map backgrounds.
- Development and launch of a public-facing SymbolStore, accessible at [www.SymbolStore.org](http://www.SymbolStore.org)
- Submitted report on results of our Symbol Standardization Process with DHS users at IICD
- Five short literature reviews on emerging trends related to geographic representation and information sharing
- Two in-depth literature reviews on Semantic Web linkages to Symbology and Mobile Mapping and Symbology
- Completion of an experiment (and full report on its results) to evaluate symbol frame designs to support dynamic symbology
- Report on Multi-Scale Symbol design

### **Impact or success story associated with project**

To date, the project team has worked with personnel from CBP, IICD, FEMA, DNDO, US Fire Service, and DHS' National Operations Center to evaluate the use of map symbols and existing symbol standards (2009 – 2010) and to develop and test a new process for standardizing map symbols (2010 – 2011). In 2011-2012, the project team has taken lessons learned from this in-depth work with DHS stakeholders to develop an interactive web-based tool called SymbolStore that allows users to contribute, search for, preview, and retrieve map symbols through an easy to use interface. The SymbolStore is the first tool of its kind designed explicitly to support sharing geographic representation methods to promote and enhance crisis mapping interoperability at DHS.

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

n/a

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

n/a

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

n/a

# Pennsylvania State University

**Institution: Penn State University**

**PI and/or Co-PI: Alan MacEachren (PI); Prasenjit Mitra (CoPI)**

**Project Name: Situational Surveillance & In-Field Criminal Investigative Analytics: Geovisual Analytics Methods**

**Academic Disciplines: Geography & Information Sciences and Technology**

**Keywords associated with project: geovisual analytics, crime mapping, spatio-temporal, crime analysis**

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input checked="" type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
<input type="checkbox"/>	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input checked="" type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Robert Roth, Penn State University, Dept. of Geography

**Undergraduate supported students** (need number only)

1

**Other Graduate Students** (non-supported) involved in project (need number only)

3

**Other Undergraduate Students** (non-supported) involved in project (need number only)

3

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

Robert Roth, INTERACTING WITH MAPS: THE SCIENCE AND PRACTICE OF CARTOGRAPHIC INTERACTION  
Penn State University, Dept. of Geography, Ph.D., Dec. 2011

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

This research and development is a component of efforts supporting the Public Safety Coalition. Activities undertaken this year extended on work from the previous year to develop methods for web-based mapping and spatio-temporal visual analysis of crime incidents. Focus was on support of criminal investigative analytics. Methods developed are adaptable to other kinds of place-based incidents or events (e.g., infectious disease reports). Collaboration was established with the Harrisburg, PA Bureau of Police and active interaction between that organization and the research team at Penn State during the year was used to refine tools and to support release of the initial version of GeoVISTA CrimeViz for use by the Harrisburg Police. In addition, an active collaboration with the research team at Purdue was established and will continue. This latter collaboration enables sharing of research outcomes and associated software with the broader Public Safety Coalition.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input checked="" type="checkbox"/>	Compiling & Sorting DB
<input type="checkbox"/>	Data Mining
<input checked="" type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input checked="" type="checkbox"/>	Survey
<input type="checkbox"/>	Other:

**Analytic Methods**

<input checked="" type="checkbox"/>	Case Studies
<input type="checkbox"/>	Modeling
<input type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input checked="" type="checkbox"/>	Other: Task Analysis

**Nature of Research**

<input type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input checked="" type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

**GeoVISTA CrimeViz Software:** Combines use of open-source database and server technology configured to support crime incident data from Harrisburg with web-mapping tools developed by the project team (also with an Open Source license).

**GeoVISTA CrimeViz – Setup Guide:** Technical documentation on installation of software

**GeoVISTA CrimeViz – User Guide:** Guide for end users on how to use the software and examples of applications.

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

**GeoVISTA CrimeViz** Software: While not commercialized, the software is currently processing daily crime incident updates from the Harrisburg Bureau of Police and is available to them for use.

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

NA

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Harrisburg Bureau of Police, Cpt. Cindy Baldwin and Sgt. Deric Moody (DMoody@cityofhbg.com)

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

**GeoVISTA CrimeViz** has been provided to the VACCINE team at Purdue to support work to merge analytical methods from the VALET software with interactive web-mapping tools in CrimeViz. Through Purdue, access to the software has been provided to Steven Hawthorne, Crime Analyst with the Lafayette, IN Police Dept.

**Project Period** (only complete if different than 4/1/11-3/31-12)

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

- Roth, R.E., Ross, K.S., Finch, B.G., Luo, W. and MacEachren, A.M. submitted: Spatiotemporal Crime Analysis in U.S. Law Enforcement Agencies: Current Practices and Unmet Needs.

Accepted:

- Auer, T., MacEachren, A.M., McCabe, C., Pezanowski, S. and Stryker, M. (2011) [HerbariaViz: A web-based client-server interface for mapping and exploring flora observation data](#). *Ecological Informatics*, doi:10.1016/j.ecoinf.2010.1009.1001.
- Roth, R.E., Finch, B.G., Blanford, J.I., Klippel, A. Robinson, A.C. and MacEachren, A.M. (2011) [Card sorting for cartographic research and practice](#). *Cartography and Geographic Information Science* 38(2): 89-99.
- Murdock, MJ, NV Maziekas, and RE Roth. (2012) [The Basic Ordnance Observational Management System: Geovisual exploration and analysis of improvised explosive devices](#). *The Journal of Maps*

**Other Reports:** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

- Roth RE, F Hardisty, and AM MacEachren. (accepted on extended abstract March 2011) Coordinated, multi-view geovisualization for spatiotemporal crime analysis. In: M Leitner (ed) *Crime Modeling and Mapping*. Springer, Geotechnologies and Environment Series.

**Presentations:** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

- Roth RE. 2011. Interactive Cartography: What we know and what we need to know. *North American Cartographic Information Society (NACIS) 2011*. Madison, WI: October 12-14.
- RE Roth. 2011. Useful and usable geovisualization for crime analysis. *The Penn State Department of Geography Coffee Hour Colloquium Series*. University Park, PA: March 18.

**Patents/Copyrights** (List names)

Applications:

Awarded:



### **Summary of Outcomes and Impact of Project**

Based upon a comprehensive literature review together with a set of semi-structured interviews with personnel from seven intermediate- to large-size law enforcement agencies in the United States, we identified four broad unmet needs: (1) expanding and combining available geographic information sources, (2) improving the usability of crime mapping and analysis tools, (3) integrating geographic and temporal representations with analyses methods, and (4) improving support for strategic crime analysis. This finding, together with active input from our law enforcement partners in Harrisburg, was used to guide design, implementation, and refinement of GeoVISTA CrimeViz. This stage of work included an in-depth task analysis with 10 participants from the Harrisburg Bureau of Police. That case study had three outcomes: (1) it provided an assessment of the cartographic interaction theory developed in Robert Roth's dissertation research, (2) it provided a training opportunity for personnel from Harrisburg to obtain focused training in use of crime mapping tools, and (3) it provided important input to refinement of the CrimeViz interface to make it easier to learn and use. A primary outcome of the research is that GeoVISTA CrimeViz is now operational with automatic daily updates of crime incident data for Harrisburg, providing interactive spatio-temporal visualization capabilities for crime analysis. Impact or success story associated with project

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

The potential offered by GeoVISTA CrimeViz to support regular analysis of spatio-temporal patterns of crime in Harrisburg, through a free and easy to use web-mapping interface is a component in the decision by Harrisburg to re-establish the position of Crime Analyst within the Bureau. The Penn State research team plans to continue adding to GeoVISTA CrimeViz capabilities in support of Harrisburg's needs and to build on that success to distribute the tools more broadly.

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

NA

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

Attachments include: (a) GeoVISTA CrimeViz Setup Guide, (b) GeoVISTA CrimeViz User Guide, (c) Appendices from Robert Roth's Ph.D. dissertation related to user studies associated with GeoVISTA CrimeViz development.

# Pennsylvania State University

**Institution: The Pennsylvania State University**

**PI and/or Co-PI: Alan MacEachren, Prasenjit Mitra**

**Project Name: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness**

**Academic Disciplines: Geography & Information Sciences and Technology**

**Keywords associated with project: geovisual analytics, social media analytics, text analytics, situational awareness, emergency management.**

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input checked="" type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
<input type="checkbox"/>	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input checked="" type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Ying Chen, The Pennsylvania State University, Department of Computer Science and Engineering

Ishan Behoora, The Pennsylvania State University, Department of Computer Science and Engineering

Alexander Savelyev, The Pennsylvania State University, Geography

**Undergraduate supported students** (need number only)

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

This project has focused on building a tool that can help us monitor open-source text data in real-time, with the emphasis on supporting situational awareness. In order to demonstrate the efficacy of our prototype visual analytic system, SensePlace2, we have experimented in the domain of emergency management and disaster relief. Our system receives streams of tweets obtained from Twitter in response to about 200 query keywords. These are entity-extracted, geocoded, and stored in a back-end database and text index. Our visual analytic interface enables end-users to query the data using keywords, a timeline and geospatial range queries. The visual analytic interface shows a sample of 1000 most relevant tweets on a pane, as well as a map pane showing aggregates by geographical regions of where the tweets come from and what locations the tweets are from. During the last year, we have improved the scalability of the system such that it can now handle a large volume of tweets, added a time-line-based temporal querying, improved the front-end interface so that it can allow the end-user to interact with the system and help correct inaccuracies, enabled querying via a regional hierarchy of locations. We have experimented with the system to gauge its usefulness and iteratively adapted the system to improve its effectiveness.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input checked="" type="checkbox"/>	Compiling & Sorting DB
<input checked="" type="checkbox"/>	Data Mining
<input type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input checked="" type="checkbox"/>	Other: RSS feeds from social text streams

**Analytic Methods**

<input checked="" type="checkbox"/>	Case Studies
<input type="checkbox"/>	Modeling
<input checked="" type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input checked="" type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

SensePlace2 system software for the visual analytic toolkit.

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date) SensePlace2 toolkit has been developed.

A version of SensePlace2 is being tested by the US Army Corps of Engineers and they have solicited a proposal for continued development.

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

\$100,000, Lockheed Martin Corp. , PI Prasenjit Mitra, Discovery and Verification of Anomalies, 1/1/11-12/31/11.

\$148,882, National Geospatial-Intelligence Agency, (option year on existing grant, focused on news story processing capabilities added to SensePlace2), PI: Alan MacEachren, August 23, 2010 – Aug. 22, 2011

\$120,642.00, US Army Corps of Engineers: (focused on visualization of qualitative geographic data, with SensePlace2 as the implementation environment), PI: Alan MacEachren, 5/23/2011 – 10/23/2012

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies) co-PI: Prasenjit Mitra

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

US Army Corps of Engineers, Douglas Caldwell, Douglas.R.Caldwell@usace.army.mil

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

NA

**Project Period** (only complete if different than 4/1/11-3/31-12)

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

**Submitted:**

1. Tomaszewski, B. and MacEachren, A.M. submitted: Geovisual Analytics to Support Crisis Management: Information Foraging for Geo-Historical Context. *Information Visualization {invited extension of paper originally published in Proceedings of IEEE VAST 2010}*.

**Accepted:**

1. Caragea C, McNeese M, Jaiswal A, Traylor G, Kim H, Mitra P, Wu D, Tapia A, Giles CL, Jansen J, et al. Classifying Text Messages for the Haiti Earthquake. *Proceedings, 8th International Conference on Information Systems for Crisis Response and Management (ISCRAM)*. Lisbon, Portugal; 2011
2. Bajpal K, Jaiswal A. A Framework for Analyzing Collective Action Events on Twitter. *Proceedings, 8th International Conference on Information Systems for Crisis Response and Management (ISCRAM)*. Lisbon, Portugal; 2011
3. MacEachren AM, Robinson AC, Jaiswal A, Pezanowski S, Savelyev A, Blanford J, Mitra P. Geo-Twitter Analytics: Applications in Crisis Management. *Proceedings, 25th International Cartographic Conference*. Paris, France; 2011
4. MacEachren AM, Jaiswal A, Robinson AC, Pezanowski S, Savelyev A, Mitra P, Zhang X, Blanford J. SensePlace2: GeoTwitter Analytics Support for Situational Awareness. *IEEE Conference on Visual Analytics Science and Technology*. 2011, 181-190.
5. Tomaszewski, B., Blanford, J., Ross, K., Pezanowski, S. and MacEachren, A.M. 2011: Supporting geographically-aware web document foraging and sensemaking. *Computers Environment and Urban Systems* 35, 192-207.

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

NA

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

... see attached, p. 9

**Patents/Copyrights** (List names)

Applications: NA / Awarded: NA



### **Summary of Outcomes and Impact of Project**

1. Scalable visual analytic toolkit SensePlace2.
  - a. Scalability ensured by innovative database design, indexing that allows large-scale storage and retrieval of social text streams such as those obtained Twitter.
  - b. Improved algorithms to geo-code mentions of location names in social text streams in the presence of limited contextual information.
2. Timeline functionality that allows for range queries for temporal attributes.
3. Improved user interaction functionality
4. Clustering of similar tweets in order to enable improved examination of topics being tweeted.
5. With complementary funding from USACE, we developed methods to flexibly access geographic information using the standard Geonames hierarchy of place names for the world.

### **Impact or success story associated with project**

We have received complementary funding from both the National Geospatial-Information Agency and the U.S. Army Corps of Engineers to develop additional capabilities on top of SensePlace2 (the system developed within this MDRP)

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

none

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

Geocoding of social media text streams in the presence of limited context information was identified as a major challenge; we continue to develop methods to address this and a pending proposal to the USACE would support additional research focused on this issue.

Allowing the end-user to examine region-hierarchies and examining the data based on such hierarchies was identified as a desirable feature and added.

Migration from a crawling based data fetching strategy to a RSS-feed based fetching strategy was necessitated by changes in Twitter and the migration has been implemented satisfactorily.

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

## Addendum – Presentations

1. Luo, W., Yin, P., Hardisty, F., Blanford, J., MacEachren, A.M. (2011). [Spatial social network visual analytic tool](#). *The 107th Annual Meeting of the Association of American Geographers*. Seattle, WA: April 12-16, 2011.
2. Savelyev, A. Robinson, A.C., MacEachren, A.M. (2012) [Analysis of Methods for Representing and Interacting with Qualitative Geographic Information](#). The 108th Annual Meeting of the Association of American Geographers. New York: Feb 24-28, 2012
3. Luo W, Yin PF, Hardisty F, MacEachren AM. 2012. [Understanding How Dynamic Social Interaction Shapes the Space: A Geovisual Analytic Approach](#) The 108th Annual Meeting of the Association of American Geographers. New York: Feb 24-28, 2012.
4. MacEachren, A.M. (2011). [Geovisual Analytics: Leveraging Geographic Information](#), invited presentation at Data Science & Epidemiology Workshop, Penn State University, Oct. 6-7.

# Purdue University



# VACCINE 2011 Annual Report

## Summary for David Ebert, Purdue University

**Institution:** Purdue University

**PI and/or Co-PI:** David Ebert

**Project Name:** Various (see individual reports)

**Academic Disciplines:** Computer Engineering, Computer Science

**Theme for Research Projects:**

- Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
- Federal Operating Component Projects (TSA, FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
- Visual Analytics for Security Applications

**Students Supported on Project:**

Graduate Research Assistants

- Total of 12 (listed in Individual reports)

**Other Undergraduate Students involved in projects :**

- Total of 3

**Student Theses in 2011:**

SungYe Kim, Context-adaptive illustrative Visualization and Analytics Techniques, Electrical and Computer Engineering, Purdue University, Ph.D., May 13, 2012

**Research Projects:**

- CgSARVA
- VALET (including high-risk alcohol behavior)
- iVALET
- COAST
- USCG – PROTECT Visualization
- USCG – Port Arthur Visualization
- USCG – Swimmer Analysis
- TRIP
- Human – Animal Health Monitoring

**Technical Approach:**

Varies by project (see individual reports)

**Deliverables:**

Varies by project (see individual reports)

**Technology Transitions:**

Varies by project (see individual reports)

**Collaborating Partners** (includes end-users and other agencies):

Varies by project (see individual reports)

**Projected Outcomes:** (Publications, Presentations, etc., based on this VACCINE-funded project) Peer-Reviewed/Refereed Publications, Journals, Conferences:

## Publications:

- Maciejewski, R., Jang, Y., Leitte, H., Woo, I., Gaither, K., Ebert, D., "Abstracting Attribute Space for Transfer Function Design," *IEEE Transactions on Visualization and Computer Graphic*, 2012.
- Ko, S., Jang, Y., Maciejewski, R., Ebert, D., "MarketAnalyzer: An Interactive Visual Analytics System for Analyzing Competitive Advantage Using Point of Sale Data," *Computer Graphics Forum (Proceedings of IEEE/Eurographics EuroVis 2012)*, 2012.
- Livengood, P., Maciejewski, R., Chen, W., Ebert, D., "OmicsVis: An Interactive Tool for Visually Analyzing Metabolomics Data," *BMC Bioinformatics*, 2012.
- Kwon, B., Javed, W., Ghani, S., Elmqvist, N., Yi, J., Ebert, D., "Evaluating the Role of Time in Investigative Analysis of Document Collections Manuscript Type," *IEEE Transactions on Visualization and Computer Graphics*, to appear 2012.
- Elmqvist, N., Ebert, D., "Leveraging Multidisciplinary in a Visual Analytics Graduate Course," *IEEE Computer Graphics and Applications*, May/June 2012, appear.
- Maciejewski, R., Pattath, A., Ko, S., Hafen, R., Cleveland, W., Ebert, D., "Automated Box-Cox Transformations for Improved Visual Encoding," *IEEE Transactions on Visualization and Computer Graphics*, to appear, 2012.
- Oliveros, S., Eich-Miller, H., Boushey, C., Ebert, D., and Maciejewski, R., "Applied Visual Analytics for Exploring the National Health and Nutrition Examination Survey," *Hawaii International Conference on System Sciences*, 2012.

## 2011

- Afzal, S., Maciejewski, R., Ebert, D., "Visual Analytics Decision Support Environment for Epidemic Modeling and Response Evaluation," *IEEE Conference on Visual Analytics Science and Technology (VAST)*, 2011.
- Malik, A., Maciejewski, R., Maule, B., Ebert, D., "A Visual Analytics Process for Maritime Resource Allocation and Risk Assessment," *IEEE Conference on Visual Analytics Science and Technology (VAST)*, 2011.
- Livengood, P., Chen, W., Maciejewski, R., Ebert, D., "A Visual Analysis System for Metabolomics Data," *IEEE Symposium on Biological Data Visualization (Biovis 2011)*, 2011.
- Jang, Y., Gaither, K., Ebert, D., "Time-Varying Data Visualization Using Functional Representations," *IEEE Transactions on Visualization and Computer Graphics*, 2011.
- Maciejewski, R., Livengood, P., Rudolph, S., Collins, T., Ebert, D., Brigantic, R., Corley, C., Muller, G., Sanders, S., "A Pandemic Influenza Modeling and Visualization Tool," *Journal of Visual Languages and Computing*, 2011.

### Presentations:

- Ebert, D., "Teaching Visual Analytics: Leveraging Multidisciplinarity," *Eurographics 2012 Panel*, Cagliari, Italy, May 2012.
- Ebert, D., "Visual Analytics: From Situational Awareness to Risk-Based Decision Making," *Financial Risk Visual Analytics Workshop*, Banff, CA, May 2012.
- Ebert, D., "Visual Analytics: Powering Discovery, Innovation, and Decision Making (Much more than Big Data Analytics plus Visualization)," **Keynote talk**, *ISCRAM 2012, Information Systems for Crisis Response and Management*, Vancouver, BC, April 2012.
- Ebert, D., "Visual Analytics: Powering Discovery, Innovation, and Decision Making (Much more than Big Data Analytics plus Visualization)," **Keynote talk**, *BRAVA 2012, 1<sup>st</sup> Brazilian Visual Analytics Workshop*, Sao Paulo, Brazil, March 2012.
- Ebert, D., "Visualization and Analytics For Geospatial and Temporal Data," *Ohio State Highway Patrol*, Columbus, OH, March 2012.
- Ebert, D., "Visual Analytics for Command Control and Interoperability Environment, U.S. Department of Homeland Security Science and Technology All Hands Meeting, Washington, DC, March 2012.
- Ebert, D., "Predictive Visual Analytics for Discovery and Decision Making," **Keynote Talk**, *Eli Lilly Corporate Research Symposium*, Indianapolis, IN, January 2012.
- Ebert, D., "Visual Analytics for Decision Making," *HICSS Tutorial on Visual Analytics*, HICSS 2012, Maui, HI, January 2012.
- Ebert, D., "Visual Analytics Applications for Decision Making: From Research to End-User," **Keynote Talk**, *NSF FODAVA Meeting*, Atlanta, GA, December 2011.
- Ebert, D., "Visual Analytics for Transportation Security," *U.S. Transportation Security Agency Headquarters*, Washington, DC, December 2011.

- Ebert, D., “Visual Analytics for Public Health and Safety,” NATO Workshop on Visualization and Health, Vancouver, CA, November 2011.
- Ebert, D., “Risk-Based Visual Analytics for Maritime Resource Allocation,” *2<sup>nd</sup> USCG Maritime Risk Symposium*, Piscataway, NJ, November 2011.
- Ebert, D., “Visual Analytics to Enable Effective Policy and Decision Making,” IEEE Visweek Panel on Visual Analytics for Policy Making, *IEEE Visweek 2011 Conference*, Portsmouth, VA, October 2011.
- Ebert, D., “Predictive and Proactive Visual Analytics,” US Coast Guard Atlantic Area Command, Portsmouth, VA September 2011.
- Ebert, D., “Visual Analytics to Enable Discovery and Decision Making: Potential, Challenges, and Directions,” Consortium for Supercomputing Advisory Council: Challenges and Future of High-Performance Computing, Washington, DC., September 2011.
- Ebert, D., “Predictive and Proactive Visual Analytics,” *ACM SIGKDD 2012 Conference Tutorial*, San Diego, CA, August 2011.
- Ebert, D., “Visual Analytics for Command, Control, and Interoperability Environments,” U.S. Transportation Safety Agency, Washington, DC, August 2012.
- Ebert, D., “Predictive Interactive Visual Analytics for Homeland Security, State of Ohio Intelligence Fusion Center, Columbus, OH, July 2011.
- Ebert, D., “Predictive Interactive Visual Analytics for Homeland Security, U.S. Transportation Safety Agency, Indianapolis, IN, June 2011.
- Ebert, D., “Visual Analytics at Scale,” Scientific Visualization Workshop, Dagstuhl Germany, June 2011.
- Ebert, D., “Visual Analytics at Scale,” VAC Consortium Meeting, College Park, MD, May 2011.
- Ebert, D., “Interactive Visual Analytics for Crisis Management,” US/Sweden Visual Analytics for Floods and Pandemics Workshop, Norrkoping, Sweden, April 2011.

**Patents/Copyrights:**

Varies by project (see individual reports)

**Summary of Outcomes and Impact of Project:**

Varies by project (see individual reports)

**Impact or Success Story Associated With Project:**

Varies by project (see individual reports)

# Purdue University

**Institution: Purdue University**

**PI and/or Co-PI: David Ebert, Ross Maciejewski, Tim Collins**

**Project Name: Analytical Visualization of the Port Arthur, TX Economic Impact Study**

**Academic Disciplines:**

**Keywords associated with project:**

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
<input checked="" type="checkbox"/>	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input type="checkbox"/>	N/A



**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Sungahn Ko, Electrical and Computer Engineering, Purdue University

**Undergraduate supported students** (need number only)

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

The mission of the USCG Marine Safety Program is to ensure environmentally safe operations of all vessels operating in U.S. waters. Disruption of services at individual seaports will have local, regional, and national economic impacts. It is worth noting that according to the 2008 "Maritime Safety Performance Plan", US deep-draft seaports and supporting firms employed more than 8 million people and contributed approximately \$2 trillion to the U.S. economy. The USCG Maritime Safety program executes daily activities designed to reduce the likelihood that a catastrophic incident will occur and, should one occur, respond in order to minimize the impact and restore full operations. One question is: How does the cost of Maritime Safety compare with the economic impact due to disruptive incidents occurring in deep-draft seaports and the overall function of the Maritime Transportation System?

Therefore, the Maritime Economic Impact Study project examines the economic impact locally and nationally for port closures in the area of Port Arthur Texas. This project has generated a large volume of market sector data for the impact of closures of different durations. It has also explored the impact of mitigation strategies. This large series of tables and numbers is difficult to use by decision makers in analysis consequence and response scenarios and making decisions with trade-offs. Interactive visual analytics can alleviate these problems and provide a powerful tool since the results are more easily interpreted visually. This requires visualization utilizing spatial and temporal analytics (and visualization) blended with a multivariate correlative analysis to form an interactive tool that facilitates interactive display of economic impact by choosing type of vessel, types of inspection programs. The user can explore different strategies and see the evolved impact over time. Therefore, we have developed a visual analytics environment for this data based on the recent growth of visual analytics as a powerful tool.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input type="checkbox"/>	Compiling & Sorting DB
<input type="checkbox"/>	Data Mining
<input checked="" type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input checked="" type="checkbox"/>	Other: Simulation

**Analytic Methods**

<input checked="" type="checkbox"/>	Case Studies
<input checked="" type="checkbox"/>	Modeling
<input checked="" type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input type="checkbox"/>	Hybrid Basic—Applied
<input checked="" type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

We have developed a visual analytics environment for the exploration of the economic impact of a Port shutdown in Port Arthur Texas using data from the USC economic study . This tool allows the viewer to select market sectors and mitigation strategies and visualize the impact within the local region and nationally.

We present a pixel-based visualization system that can manage all economic sectors and models. Furthermore, any resilience adjustments are reflected on-the-fly within the visualization. With the addition of reordering functions comparative visualization of impact between the Port region and the U.S can be easily evaluated.

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

BOA HSHQDC-10-A-BOA34--\$160,000, David Ebert, 1/24/2011 – 9/8/2011.

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

US Coast Guard, R & D Center—Craig Baldwin, Craig.W.Baldwin@uscg.mil

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

CREATE – VACCINE worked with CREATE to study local and national economic impact of port closures of varying lengths.

**Project Period** (only complete if different than 4/1/11-3/31-12)

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Accepted:

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

**Patents/Copyrights** (List names)

Applications:

Awarded:

**Summary of Outcomes and Impact of Project**

VACCINE personnel have developed a visual analytics environment for the analysis, exploration and decision making of the effects of a port closure in Port Arthur, TX. The tools created run on Windows PCs and provide users with a graphical user interface with which to explore the economic impact data by market sector and by mitigation strategy.

**Impact or success story associated with project**

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

# Purdue University

**Institution: Purdue University**

**PI and/or Co-PI: David Ebert**

**Project Name: Coastal Operations and Analysis Suite of Tools (COAST)**

**Academic Disciplines:**

**Keywords associated with project:**

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
<input checked="" type="checkbox"/>	Federal Operating Component Projects (TSA, FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input type="checkbox"/>	N/A



**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)  
Silvia Oliveros-Torres, Purdue University, Electrical and Computer Engineering  
Abish Malik, Purdue University, Electrical and Computer Engineering  
Sunghan Ko, Purdue University, Electrical and Computer Engineering

**Undergraduate supported students** (need number only)

2

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

We have extended the initial Coast Guard Search and Rescue Visual Analytics to include multiple districts. This is just one piece in aid in the effort of the Coast Guard to design and implement a system to analyze all their operations across the United States. The whole system is based in module-based relationships. Our system covers the GIS Visualization module, Coverage Models module, and Allocation Models module. The system includes linked views and interactive displays that allow the interactive analysis of trends, patterns, and anomalies among the U.S. Coast Guard operations. Our system allows users to observe and determine potential upgrades based on station location and demand. The system calculates four different metrics based on the cases a given station responds, it normalizes the scores, and finally gives a general score that can be used to compare stations amongst each other. The system is still in a creation and testing phase and there are plans to include all the districts in it.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input checked="" type="checkbox"/>	Compiling & Sorting DB
<input checked="" type="checkbox"/>	Data Mining
<input checked="" type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input type="checkbox"/>	Other:

**Analytic Methods**

<input type="checkbox"/>	Case Studies
<input checked="" type="checkbox"/>	Modeling
<input checked="" type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input checked="" type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

COAST will be delivered to the Coast Guard Headquarters (CG-771) .

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

United States Coastguard

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Coast Guard Headquarters (CG-771)

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

**Project Period** (only complete if different than 4/1/11-3/31-12)

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Accepted:

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

**Patents/Copyrights** (List names)

Applications:

Awarded:

**Summary of Outcomes and Impact of Project**

This tool is in the early stages where collaboration with Coast Guard Headquarters has just begun.

**Impact or success story associated with project**

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

**Changes in research plans, if applicable:** describe any major changes in the project’s plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

# Purdue University

**Institution:**Purdue University

**PI and/or Co-PI:** David S. Ebert, Ross Maciejewski

**Project Name:** Coast Guard PROTECT Visualization

**Academic Disciplines:**Game Theory, Visualization, Geography

**Keywords associated with project:** PROTECT, game theory, coast guard, scheduling

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
<input checked="" type="checkbox"/>	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input checked="" type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Shehzad Afzal, Department of Computer Science, Purdue University  
I feel like either Sungahn or Abish was also supported on this

**Undergraduate supported students** (need number only)

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

This is a contract under our Basic Ordering Agreement. Using the previous two years of patrol routes, we are developing statistical models for loiter point visits. Predictions of the loiter point visits will be computed and sent to the Coastguard to compare against actual visits during a time period in which the visits were unknown to the analysts. The predictive efficacy of this model will then be addressed, and determination on the ability of hostiles to predict patrol routes based on current patterns will be assessed. Sparse data will be handled by predicting the number of days between visits. Similarly in utilizing the PROTECT model, two years worth of patrol routes will be generated from the PROTECT model. Similar statistical models will be created and a predictive model will be adapted to the PROTECT routes. Predictions of future loiter point regions will be generated from PROTECT and sent to us and our model will now assess the ability of hostiles to predict patrol routes based on potential PROTECT routes. An interactive visual analytics environment was created that overlays patrol routes and potential RIN numbers for targets. This environment is developed for both desktop the first generation tool looking at historical patrol route logs and critical infrastructure overlays. The first generation tool was deployed to a provisional set of members for analysis and feedback.



**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input checked="" type="checkbox"/>	Compiling & Sorting DB
<input type="checkbox"/>	Data Mining
<input type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input type="checkbox"/>	Other:

**Analytic Methods**

<input checked="" type="checkbox"/>	Case Studies
<input checked="" type="checkbox"/>	Modeling
<input checked="" type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input type="checkbox"/>	Hybrid Basic—Applied
<input checked="" type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

We delivered a visual analytics tool for exploring patrol routes generated by PROTECT, as well as an in-depth analysis of the PROTECT patrol route schedules compared with historical routing.

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

Prototypes deployed with members of the Coastguard.

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

CREATE Center partners at USC (David should know their exact names)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

USCG – Craig Baldwin, others? Again, David should have these names.

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

VACCINE has collaborated with the CREATE Center to provide an Analytical Visualization of the Boston PWCS Patrol Resource Allocation Environment, also known as PROTECT (Port Resilience Operational/Tactical Enforcement to Combat Terrorism).

**Project Period** (only complete if different than 4/1/11-3/31-12)

No idea

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted: None

Accepted: None

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

None

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

None

**Patents/Copyrights** (List names)

Applications:

Awarded:

**Summary of Outcomes and Impact of Project**

This project provided the USCG with an analysis of their current patrol route scheduling in the Boston Harbor area. Analysis of the new routes indicated that a better randomized process was now implemented and anecdotal evidence from test teams indicated that illegal activities requiring surveillance, etc. were more likely to be spotted.

**Impact or success story associated with project**

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

None

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

None

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

David should have all of the reports that we sent.

# Purdue University

**Institution: Purdue University**

**PI and/or Co-PI: David S. Ebert, Ross Maciejewski**

**Project Name: Coast Guard Search and Rescue Visual Analytics**

**Academic Disciplines: Visualization, Geography, Statistics**

**Keywords associated with project: Coast Guard, Search and Rescue, Visual Analytics, Geography**

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
<input checked="" type="checkbox"/>	Federal Operating Component Projects (TSA, FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input checked="" type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Abish Malik, Department of Electrical and Computer Engineering, Purdue University  
Silvia Oliveros, Department of Electrical and Computer Engineering, Purdue University  
Sunghan Ko, Department of Electrical and Computer Engineering, Purdue University

**Undergraduate supported students** (need number only)

3

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

We have developed a comprehensive visual analytics system to analyze the risks to maritime traffic and public safety associated with the reallocation of available Coast Guard resources and shutting down of stations mandated due to budget changes, retiring volunteers, among other factors. The system includes linked views and interactive displays that allow the interactive analysis of trends, patterns and anomalies among the U.S. Coast Guard Search and Rescue (SAR) operations and their associated sorties. Our system allows users to determine the potential increase or decrease in risks associated with shutting down certain station(s) in terms of factors including response times, potential lives and property lost and reallocation of available resources. The system also enables a thorough assessment of all SAR operations conducted by each U.S. Coast Guard station in the Great Lakes region. In addition, the system provides officials with the tools to determine which Coast Guard stations were more optimally suited to assume control of the operations of the closed station(s) by comparing the optimal transportation routes of the available stations to all the SAR cases previously handled by the closed station. This year we adapted our system to show the air stations in the Great Lakes and to show coverage areas of each station in the Great Lakes. Additionally, the system was expanded to District Five where an analysis was made to show the correlation between flare notifications and open cases along with their standard cost factored in. Future plans include more work in the risk analysis domain.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input checked="" type="checkbox"/>	Compiling & Sorting DB
<input checked="" type="checkbox"/>	Data Mining
<input checked="" type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input type="checkbox"/>	Other:

**Analytic Methods**

<input checked="" type="checkbox"/>	Case Studies
<input checked="" type="checkbox"/>	Modeling
<input checked="" type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input checked="" type="checkbox"/>	Hybrid Basic—Applied
<input checked="" type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

cgSARVA software has been delivered to USCG D9 and Atlantic Area Command Operations Analysis group (LANT-7).



**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

Prototypes deployed with members of the Coastguard.

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

None

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

USCG District 9 and LANT-7

LCDR Ben Maule, Ben.J.Maule@uscg.mil

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

**Project Period** (only complete if different than 4/1/11-3/31-12)

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Malik, A., Maciejewski, R., Jang, Y., Oliveros, S., Yang, Y., Maule, B., White, M., Ebert, D. S., "A Visual Analytics Process for Maritime Response, Resource Allocation and Risk Assessment," *Information Visualization*, (To appear)

Accepted:

Malik, A., Maciejewski, R., Maule, B., Ebert, D., "A Visual Analytics Process for Maritime Resource Allocation and Risk Assessment," *Proceedings of the IEEE Conference on Visual Analytics Science and Technology (VAST)*, 2011.

Malik, A., Maciejewski, R., Jang, Y., Oliveros, S., Yang, Y., Maule, B., White, M., Ebert, D. S., "A Visual Analytics Process for Maritime Response, Resource Allocation and Risk Assessment," *Information Visualization*, (To appear)

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

None

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

October 2011 – Abish Malik, Coast Guard Search and Rescue Visual Analytics, IEEE Visual Analytics Science and Technology Conference

**Patents/Copyrights** (List names)

Applications:

Awarded:

**Summary of Outcomes and Impact of Project**

This tool has provided guidance and analytical evidence to USCG D9 to evaluate the effectiveness of their resource allocation for their Search and Rescue Mission in the Great Lakes and the role the Coast Guard Auxiliary has in this mission. The tool enables the USCG to consider what-if scenarios for resource allocation, evaluate the effect of the reduction of Auxiliary Stations and reallocation of resources, as well as staffing hours to still successfully fulfill their SAR mission.

**Impact or success story associated with project**

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

None

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

None

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

# Purdue University

**Institution:** VACCINE, Purdue University

**PI and/or Co-PI:** Dr. David S. Ebert

**Project Name:** Coast Guard Swimmer Deaths

**Academic Disciplines:**

**Keywords associated with project:** Swimmer Deaths

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
<input checked="" type="checkbox"/>	Federal Operating Component Projects (TSA, FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input checked="" type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

**Undergraduate supported students** (need number only)

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

Number of deaths involving swimming and boating in great lakes rose from 90 in 2009 to 164 in 2010, an 82% increase. This projects aims at analyzing the data related to swimmer deaths in District 9 for year 2010 and help provide an explanation or identify the major factors contributing to this increase in swimmer deaths. This analysis was used in planning and public service campaigns aimed at reducing swimmer deaths for the summer of 2011 season. During analysis, time-of-day, day-of-week and monthly swimmer death patterns were studied. In addition, the geographic distribution of such incidents was also studied. Hotspot maps were created for each of the summer months for 2010 and were compared to previous years. In our analysis, we found that august has the highest frequency of swimmer deaths and if you consider time-of-day then late afternoon was the time when most of these incidents happened. The highest concentration of such incidents was located in Lake Michigan (south and west shore). For boating deaths, mid-July to mid-August was the time when highest frequency of such incidents happened and there was one week where such incidents were significantly high. Friday, Saturday and Sunday accounted for almost all deaths related to boating incidents. We summarized and reported our results to Coast Guard to help inform operational planning for fiscal year 2011. Later on, it was reported that drowning and boating related incidents decreased to 104 in 2011 which was almost a 37 percent decrease.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input checked="" type="checkbox"/>	Compiling & Sorting DB
<input type="checkbox"/>	Data Mining
<input type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input type="checkbox"/>	Other:

**Analytic Methods**

<input type="checkbox"/>	Case Studies
<input type="checkbox"/>	Modeling
<input type="checkbox"/>	Sampling
<input type="checkbox"/>	Statistical Analysis
<input checked="" type="checkbox"/>	Other:

**Nature of Research**

<input checked="" type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

Summary of finding along with the result snapshots in the form of Excel files.

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance



**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

**Project Period** (only complete if different than 4/1/11-3/31-12)

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Accepted:

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

**Patents/Copyrights** (List names)

Applications:

Awarded:

### **Summary of Outcomes and Impact of Project**

In our analysis, we found that August has the highest frequency of swimmer deaths and if you consider time-of-day then late afternoon was the time when most of these incidents happened. The highest concentration of such incidents was located in Lake Michigan (south and west shore). For boating deaths, mid-July to mid-August was the time when highest frequency of such incidents happened and there was one week where such incidents were significantly high. Friday, Saturday and Sunday accounted for almost all deaths related to boating incidents. We also found that there is an early and late season increase. We summarized our findings and Coast Guard used these results in their operational planning for fiscal year 2011 and also in designing the public service message campaigns. There was a drop of almost 37% in swimmer deaths in 2011.

### **Impact or success story associated with project**

It was reported by Coast Guard that there was a decrease of almost 37% of swimming and boating related incidents in 2011. The news related to this appeared in several newspapers. This link contains a story related to this success:

[http://www.purdue.edu/newsroom/research/2011/story-print-deploy-layout\\_1\\_16743\\_16743.html](http://www.purdue.edu/newsroom/research/2011/story-print-deploy-layout_1_16743_16743.html).

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

# Purdue University

**Institution: Purdue University**

**PI and/or Co-PI: David Ebert**

**Project Name: High Risk Alcohol Behavior Analysis**

**Academic Disciplines: Computer Engineering**

**Keywords associated with project:**

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input checked="" type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
<input type="checkbox"/>	Federal Operating Component Projects (TSA, FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Abish Malik, Electrical and Computer Engineering, Purdue University  
Ahmad Razip, Electrical and Computer Engineering, Purdue University

**Undergraduate supported students** (need number only)

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

This project involves geographic information system (GIS) mapping of the Purdue University, West Lafayette, campus and surrounding areas to identify the environments (housing, locations) where alcohol-related incidents (arrests, transports, vandalism, calls) occur which can be targeted for interventions. Mapping of the spatiotemporal locations (specifically addresses/times/dates) has helped identify the hot spots for potential interventions by the university authorities. Multiple datasets including law enforcement, university events and emergency medical services datasets were analyzed and explored to profile high risk drinking behaviors.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input checked="" type="checkbox"/>	Compiling & Sorting DB
<input type="checkbox"/>	Data Mining
<input type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input type="checkbox"/>	Other:

**Analytic Methods**

<input type="checkbox"/>	Case Studies
<input type="checkbox"/>	Modeling
<input type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input checked="" type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

West Lafayette Police Department: Jason Dombkowski, jldombkowski@westlafayettepd.us

Purdue Police Department: John Cox, jkcox@purdue.edu

Purdue Fire Department: Kevin Ply, kmply@purdue.edu

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

**Project Period** (only complete if different than 4/1/11-3/31-12)

2/1/2012-present



**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Accepted:

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

"From Hot Places to Hot Spaces - What are our students seeing, doing and experiencing?", April 2012, Purdue University.

**Patents/Copyrights** (List names)

Applications:

Awarded:

**Summary of Outcomes and Impact of Project**

**Impact or success story associated with project**

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

# Purdue University

**Institution: Purdue University**

**PI and/or Co-PI: David Ebert**

**Project Name: Human-Animal Health monitoring**

**Academic Disciplines:**

**Keywords associated with project: health, human-animal, monitoring**

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input checked="" type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
<input type="checkbox"/>	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input checked="" type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

**Whitney Huang, Purdue University, Department of Statistics**

**Undergraduate supported students** (need number only)

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

The role of public health surveillance is to collect, analyze and interpret data about biological agents, diseases, risk factors and other health events in order to provide timely dissemination of collected information to decision makers. Surveillance methods that can detect disease at a pre-diagnostic stage are generally referred to as syndromic because they have the ability to recognize outbreaks based on the symptoms and human behavior prior to first contact with the healthcare system. Thus, monitoring the companion animal population of a society (e.g. dogs, cats) can provide early warning signs for emerging diseases. In this case study the effect of seasonal influenza and its correlation with different companion animals (e.g., cats, dogs) syndromes within Indianapolis area is investigated.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input checked="" type="checkbox"/>	Compiling & Sorting DB
<input type="checkbox"/>	Data Mining
<input type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input type="checkbox"/>	Other:

**Analytic Methods**

<input type="checkbox"/>	Case Studies
<input type="checkbox"/>	Modeling
<input type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input checked="" type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

We delivered a full statistical analysis of correlations between human and animal health.

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

**Project Period** (only complete if different than 4/1/11-3/31-12)

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Accepted:

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

White paper: Human-Pet respiratory syndromic monitoring

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

**Patents/Copyrights** (List names)

Applications:

Awarded:



### **Summary of Outcomes and Impact of Project**

After data cleaning and appropriate data transformation, moderate correlation is found between dog and human in Indianapolis area during 2008/7-2010/6 even with relatively noisy (low signal to noise ratio) pet data. Nearby metropolitan (Columbus area) shows similar results with weaker correlation and longer lag time (with respect to dog signal). The correlations obtained from 2004/10-2005/9 show similar results but the order (lag/lead) is reversed. This work found spatio-temporal correlation which is useful for syndromic monitoring and prediction.

### **Impact or success story associated with project**

This study shows a possible future direction to investigate further links between human and animal health.

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

Data is not still sufficient enough to make a conclusion and due to the lack of data, the analysis encountered severe noise effects in this study.

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

NA

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

# Purdue University

**Institution:** Purdue University

**PI and/or Co-PI:** David Ebert, Tim Collins, Purdue University

**Project Name:** Mobile Visual Analytics Law Enforcement Toolkit (iVALET)

**Academic Disciplines:** Computer Science

**Keywords associated with project:** Public safety, risk assessment, situational awareness, mobile device

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
<input type="checkbox"/>	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Ahmad Mujahid Mohammed Razip, Purdue University, Electrical and Computer Engineering

Abish Malik, Purdue University, Electrical and Computer Engineering

Shehzad Afzal, Purdue University, Electrical and Computer Engineering

**Undergraduate supported students** (need number only)

1

**Other Graduate Students** (non-supported) involved in project (need number only)

0

**Other Undergraduate Students** (non-supported) involved in project (need number only)

3

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

With the increasing magnitude and complexity of modern datasets, it is becoming more difficult for analysts to efficiently extract relevant information, specifically in the mobile domain. The goal of this project is to develop a mobile visual analytics law enforcement toolkit designed to equip law enforcement agencies and citizens with effective situational awareness and risk assessment tools. The system provides users with a suite of interactive tools that allow them to perform analysis and detect trends, patterns and anomalies among criminal, traffic and civil (CTC) incidents. The system provides dynamically linked views that enable the exploration of spatiotemporal CTC incidents data as well as interactive risk assessment tools that allow users to identify regions of potential high risk and determine the risk at any user-specified location and time. With a chemical plume dispersal modeling tool, the system also allows law enforcement officers and first responders to have better awareness in emergency chemical release situations. The system has been designed for the iPhone/iPad environment and is currently being used and evaluated by a consortium of law enforcement agencies.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

- |                          |                        |
|--------------------------|------------------------|
| <input type="checkbox"/> | Compiling & Sorting DB |
| <input type="checkbox"/> | Data Mining            |
| <input type="checkbox"/> | Expert Consultation    |
| <input type="checkbox"/> | Field Monitors         |
| <input type="checkbox"/> | Survey                 |
| <input type="checkbox"/> | Other:                 |

**Analytic Methods**

- |                          |                      |
|--------------------------|----------------------|
| <input type="checkbox"/> | Case Studies         |
| <input type="checkbox"/> | Modeling             |
| <input type="checkbox"/> | Sampling             |
| <input type="checkbox"/> | Statistical Analysis |
| <input type="checkbox"/> | Other:               |

**Nature of Research**

- |                          |                             |
|--------------------------|-----------------------------|
| <input type="checkbox"/> | Applied                     |
| <input type="checkbox"/> | Basic                       |
| <input type="checkbox"/> | Consultation                |
| <input type="checkbox"/> | Coordination/Integration    |
| <input type="checkbox"/> | Education                   |
| <input type="checkbox"/> | Hybrid Basic—Applied        |
| <input type="checkbox"/> | Hybrid Applied—Consultation |

**Deliverables** (other than publications and reports listed below)

iVALET app, which was deployed on a number of iPad/iPhone devices of end-users

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Tippecanoe County Sheriff's Office,  
Lafayette Police Department,  
West Lafayette Police Department,  
Purdue Police Department,

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

**Project Period** (only complete if different than 4/1/11-3/31-12)

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

EUROVIS 2011  
VAST 2012

Accepted:

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

iVALET, Ahmad Razip, 12/13/2012, VACCINE Public Safety Consortium Meeting, Purdue University

**Patents/Copyrights** (List names)

Applications:

Awarded:

**Summary of Outcomes and Impact of Project**

**Impact or success story associated with project**

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.



# Purdue University

**Institution: Purdue University**

**PI and/or Co-PI: David Ebert, Tim Collins, Purdue University**

**Project Name: TRIP: Travel Response Investigative Profiler**

**Academic Disciplines:**

**Keywords associated with project:**

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input checked="" type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
<input type="checkbox"/>	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Junghoon Chae, Purdue University, Electrical and Computer Engineering

**Undergraduate supported students** (need number only)

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

**Research Problem /Abstract (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).**

As individuals' movements could have correlations with social and/or geo-temporal factors, it is critical to understand the movement behaviors and spatio-temporal patterns of individuals. Moreover, needs for integrated visualization and analysis of the spatio-temporal movement history motivated the development of our tool. TRIP enables spatio-temporal visualization, exploration and analysis among individual movements as well as individual movement and infrastructures. Given individual movement history, various geo-spatial and temporal cues are visualized. As geo-spatial cues, locations markers including newest/oldest indicators, driving routes, reachable areas along the routes and county boundary are overlaid on the map. The routes and reachable areas are also used to present possible relationships and shared areas among individuals' movement as well as individuals and infrastructures. As temporal cues, each location is numbered in temporal order. Route connecting locations changes its thickness to show that an individual moved towards the direction increasing the thickness. Furthermore, the duration of stay at each location is highlighted using ring shaped glyphs.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input type="checkbox"/>	Compiling & Sorting DB
<input checked="" type="checkbox"/>	Data Mining
<input type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input type="checkbox"/>	Other:

**Analytic Methods**

<input type="checkbox"/>	Case Studies
<input checked="" type="checkbox"/>	Modeling
<input type="checkbox"/>	Sampling
<input type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

TRIP software has been delivered to Indiana Intelligence Fusion Center.

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Indiana Intelligence Fusion Center

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

**Project Period** (only complete if different than 4/1/11-3/31-12)

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Accepted:

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

Fast Track presentations at the National Fusion Center Training Event in Phoenix, Arizona, April 2-5, 2012 presented by Indiana Intelligence Fusion Center

**Patents/Copyrights** (List names)

Applications:

Awarded:

### **Summary of Outcomes and Impact of Project**

TRIP is an ongoing project initiated to provide the prediction of individuals' movement through an integrated spatio-temporal visualization, exploration and analysis of multiple individuals' movement history. Various geo-spatial and temporal cues are incorporated onto the map without using separate views. In the future, correlation analysis among individual movements and infrastructures would provide users with tools of modeling individual's movement patterns.

### **Impact or success story associated with project**

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

# Purdue University

**Institution: Purdue University**

**PI and/or Co-PI: David Ebert, Tim Collins, Purdue University**

**Project Name: Visual Analytics Law Enforcement Technology**

**Academic Disciplines: Computer Engineering, Statistics**

**Keywords associated with project:**

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input checked="" type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
<input type="checkbox"/>	Federal Operating Component Projects (TSA, FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input type="checkbox"/>	N/A



**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Abish Malik, Purdue University, Electrical and Computer Engineering

**Undergraduate supported students** (need number only)

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

The exploration of criminal incident reports for detecting trends, discovering anomalies and evaluating resource usage is an ever-expanding issue for law enforcement agencies. As such, tools need to be developed that assist law enforcement officials in their analysis in order to take preventive measures and judiciously allocate available resources. In order to better facilitate crime incident analysis, we have developed a comprehensive visual analytics system for both PCs and mobile devices which provides police officials with access to their data on the fly.

Our system allows users to visualize data geo-spatially on a map and provides filtering tools that filter crime by the type of offense committed. The crime being visualized can additionally be filtered by time to analyze the correlation of different crimes with time. Our system enables users to view a history of previous crime incidents and forecast a pattern of crime using automated algorithms. Moreover, the users have the ability to receive immediate feed of events.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input type="checkbox"/>	Compiling & Sorting DB
<input type="checkbox"/>	Data Mining
<input checked="" type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input type="checkbox"/>	Other:

**Analytic Methods**

<input type="checkbox"/>	Case Studies
<input checked="" type="checkbox"/>	Modeling
<input type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Tippecanoe County Sheriff's Office, Lafayette Police Department, West Lafayette Police Department, Purdue Police Department

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

**Project Period** (only complete if different than 4/1/11-3/31-12)

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Accepted:

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

Paper in revision:

Malik, A., Maciejewski, R., Yang, Y., Huang, W., Elmqvist, N., Ebert, D., "A Correlative Analysis Process in a Visual Analytics Environment", *IEEE Conference on Visual Analytics Science and Technology*, October 2012

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

**Patents/Copyrights** (List names)

Applications: Patent application #: U.S. 13/291,761

Awarded:

**Summary of Outcomes and Impact of Project**

**Impact or success story associated with project**

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

# Purdue University

**Institution: Purdue University**

**PI and/or Co-PI: Edward J. Delp**

**Project Name: Mobile Imaging: Gang Graffiti Recognition and Analysis (GARI) and Mobile Emergency Response Guide (MERGE)**

**Academic Disciplines: Electrical Engineering**

**Keywords associated with project: gang graffiti, hazardous materials, mobile telephones**

## **Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input checked="" type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
<input type="checkbox"/>	Federal Operating Component Projects (TSA, FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

## **Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input checked="" type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Albert Parra Pozo, ECE, Purdue  
Andrew W. Haddad, ECE, Purdue

**Undergraduate supported students** (need number only)

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

Albert Parra Pozo , "An Integrated Mobile System for Gang Graffiti Image Acquisition and Recognition",  
Purdue, ECE, M.S., December 2011

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

Gangs are a serious threat to public safety throughout the United States. Gang members are continuously migrating from urban cities to suburban areas. Street gang graffiti is their most common way to communicate messages, including challenges, warnings or intimidation to rival gangs. It is, however, an excellent way to track gang affiliation and growth, or even sometimes to obtain membership information. The goal of this project is to use the knowledge gained from our work in mobile devices and applications and leverage it towards the development of a mobile-based system capable of image analysis. This system will provide an accurate and useful output to a user based on a database of gang graffiti images.

Hazardous Materials can react differently to stimuli and can cause problems in accidents and emergency situations. This fact makes them particularly dangerous to civilians and first responders. It is for this reason that the Emergency Response Guidebook was developed. This paper guide assists those in an emergency with the knowledge of how to handle Hazardous Materials. As one might expect, the guidebook is large and requires precious time to search an index to determine the best way to handle a particular hazardous material. The MERGE system is an electronic version of the guide with many new features and capabilities. These new capabilities include the use of image analysis methods to automatically determine the type of Hazardous Materials present based on an image taken of the sign/placard.



**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input type="checkbox"/>	Compiling & Sorting DB
<input type="checkbox"/>	Data Mining
<input type="checkbox"/>	Expert Consultation
<input checked="" type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input type="checkbox"/>	Other:

**Analytic Methods**

<input type="checkbox"/>	Case Studies
<input type="checkbox"/>	Modeling
<input type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input checked="" type="checkbox"/>	Applied
<input checked="" type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

We have delivered the GARI application to more than 15 law enforcement agencies in Indiana and have more than 700 gang graffiti images taken by more than 30 users.

The MERGE application has been delivered to TSA and several fire departments in Indiana.

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

none

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

none

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

For GARI:

Indianapolis Metropolitan Police Department

Department of Homeland Security

Indiana Intelligence Fusion Center

Hammond Police Department

Lafayette Indiana Police Department

Purdue University Police Department

Indiana Department of Correction

Hancock County Sheriff

Indiana State Police

Tippecanoe County Prosecutor's Office

Anderson Police Department (Criminal Investigation Division)

For MERGE:

TSA

Indianapolis Fire Department

Purdue Police Department

Lafayette Police Department

Tippecanoe County Sheriff Department

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

A. Parra, M. Boutin, and E. J. Delp, "Location-Aware Gang Graffiti Acquisition and Browsing on a Mobile Device," Proceedings of the SPIE/IS&T Conference on Multimedia on Mobile Devices, January 2012, San Francisco, CA.

### **Summary of Outcomes and Impact of Project**

Initial versions of the GARI and MERGE applications have been deployed to several law enforcement agencies and first responders groups. We have had very positive response from our targeted user groups.

Both applications are being used in the field to collect and process data.

### **Impact or success story associated with project**

Both applications have been reported in the news media as examples of “successes” of DHS funding.

We have had continuous positive feedback from our users.

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

One problem we have encountered is that the server for the GARI application is located at Purdue. We feel it is more appropriate that this be located at a law enforcement agency, particularly as our users want to add more information into the GARI database that borders on law enforcement intelligence information.

**Changes in research plans, if applicable:** describe any major changes in the project’s plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

No changes are planned...we will keep listening to our users and develop more capabilities into both applications.

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

none

# Purdue University

**Institution:** Purdue University

**PI and/or Co-PI:** Niklas Elmqvist

**Project Name:** Visual Analytics for the DHS Centers of Excellence (COE-Explorer)

**Academic Disciplines:** Advanced Data Analysis and Visualization

**Keywords associated with project:** graph visualization, node-link diagrams, data mining, tag clouds, text retrieval.

## **Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
<input checked="" type="checkbox"/>	Federal Operating Component Projects (TSA, FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

## **Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input checked="" type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Sohaib Ghani, Ph.D. Candidate (4th year), School of Electrical and Computer Engineering, Purdue University

**Undergraduate supported students** (need number only)

0

**Other Graduate Students** (non-supported) involved in project (need number only)

1

**Other Undergraduate Students** (non-supported) involved in project (need number only)

0

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

None.

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

The DHS Centers of Excellence has produced a wealth of research, education materials, and projects over the years, and this material will continue to grow as the activities of the various centers expand. The ability for reflection, analysis, and investigation of this material is vital, and may yield both new and old connections, ideas, and insights. Furthermore, exposing the material to the scientific community and other government agencies, as well as the general public, is an important goal of our center. In this project, we leverage visual analytics methods for interacting and exploring this large knowledge resource in an interactive visual form that is easy to access for quick browsing, yet powerful enough to support advanced analysis and review.

More specifically, this project develops table-based, graph-based, and timeline-based visualizations of the DHS Centers of Excellence program in an easily accessible format, but which also supports faceted browsing and querying on the multiple dimensions associated with the data. In other words, the idea is to allow users—investigators, students, and program officers alike—the ability to understand the entire activities of the DHS Centers of Excellence program from many different viewpoints, such as research topics, collaborations, funding portfolios, investigator social networks, and project trajectories over time.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input checked="" type="checkbox"/>	Compiling & Sorting DB
<input checked="" type="checkbox"/>	Data Mining
<input type="checkbox"/>	Expert Consultation
<input checked="" type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input type="checkbox"/>	Other:

**Analytic Methods**

<input checked="" type="checkbox"/>	Case Studies
<input type="checkbox"/>	Modeling
<input type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input checked="" type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

Deliverables for this project includes several web-based tools and websites:

- COE Explorer tool: <https://engineering.purdue.edu/~elm/projects/coe-explorer/>
- COE Portal: <https://engineering.purdue.edu/~elm/projects/coe-portal/>
- COE Keyword Explorer: <http://www-scf.usc.edu/~haowang/coe/explorer.php>
- COE Wordonoi (currently no public website)



**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

The first three of the above four deliverables---COE Explorer, COE Portal, and COE Keyword Explorer---have already been made available only and thus partially delivered to end-users. We are still exploring commercialization options, but deploying the tools is the first step towards evaluating their suitability and performance. The COE Wordonoi tool, which visualizes the contents of research projects and not just their relations and organizational structure, is still under development and is an active research project.

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

Currently none.

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

David Ebert (VACCINE/Purdue), John Stasko (VACCINE/Georgia Tech), Brian Fisher (VACCINE/SFU), Ed Hovy (CCICADA/USC)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

DHS Office of University Programs (Matt Clark, Charles Sitkoff)

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

The COE-Explorer project is an active collaboration between VACCINE (Purdue University, Georgia Tech, and SFU) and VACCINE (USC). The areas of responsibility are well-defined: the CCICADA team works on the data management and analytics, whereas the VACCINE team uses this data to create interactive visual and web-based tools for effectively viewing and understanding this data. So far, this division of labor has been very successful, largely thanks to a well-defined interface between the two centers.

**Project Period** (only complete if different than 4/1/11-3/31-12)

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

S. Ghani, N. Elmqvist, D. S. Ebert. Wordonoi: Visualizing the Structure and Textual Contents of Knowledge Networks. Submitted to *IEEE InfoVis 2012* (March 2012).

<https://engineering.purdue.edu/~elm/projects/wordonoi/wordonoi.pdf>

Accepted:

S. Ghani, N. Elmqvist, J. S. Yi. Perception of Animated Node-Link Diagrams for Dynamic Graphs. *Computer Graphics Forum* (IEEE EuroVis 2012 proceedings), to appear, 2012

<https://engineering.purdue.edu/~elm/projects/dyngraph/dyngraph.pdf>

S. Ghani, N. Elmqvist, D. S. Ebert. MultiNode-Explorer: A Visual Analytics Framework for Generating Web-based Multimodal Graph Visualizations. Workshop paper presented at the *EuroVis Workshop on Visual Analytics* (EuroVA 2012), to appear, 2012.

<https://engineering.purdue.edu/~elm/projects/coe-explorer/multinode-explorer.pdf>

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

N/A.

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

S. Ghani. Perception of Animated Node-Link Diagrams for Dynamic Graphs. IEEE EuroVis 2012, June 7, Vienna, Austria. (to appear)

S. Ghani. MultiNode-Explorer: A Visual Analytics Framework for Generating Web-based Multimodal Graph Visualizations. IEEE EuroVA 2012, June 5, Vienna, Austria. (to appear)

**Patents/Copyrights** (List names)

Applications: N/A.

Awarded: N/A.

### **Summary of Outcomes and Impact of Project**

The COE Explorer project has not only been a good example of collaboration between the two DHS CCI centers—VACCINE and CCICADA—but it has also seen wide impact for exposing the research mission of the VACCINE center to the general public. The tool has been a "featured project" on the VACCINE website for several months, and PI Elmqvist is regularly contacted with questions about the tool, its capabilities, and the data it is visualizing (a total of some 15 such emails have been received). Furthermore, as evidenced by the below success story, the tool has also been highly successful with its intended audience: investigators, program officers, and policymakers.

### **Impact or success story associated with project**

A success story for the COE Explorer project comes from Matt Clark, Director of DHS OUP (Summer 2010):

*"Your work on these tools has been a huge help to our organization, and your recent last-minute development of the Interagency Explorer tool has also proven the value of the COE network's skills and extensive expertise to our interagency partners. Referring to the Interagency Explorer, one of my interagency colleague's words were: "It's perfect!," and his agency pledged their thanks and appreciation to you and your team at Purdue. They will be using the Explorer in an upcoming meeting with representatives at the Undersecretary level from a number of Federal agencies, and we anticipate that this will bring broad exposure to the VACCINE team..."*

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

None.

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

- **Interactive social network analysis** (Elmqvist - Purdue) – We are improving the COE Explorer application to make it possible to perform some social network analysis within the tool.
- **Improved dataset** (Hovy - USC) – Based on the existing OUP database, our emphasis is on improving the quality and the contents of the dataset being visualized using the COE Explorer
- **Textual content** (Elmqvist, Ebert - Purdue) – Showing the textual contents of the related entities will improve the perception of the research topics of the COE OUP network.

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

COE Explorer instructional video (created by Brian Fisher at SFU):

<https://engineering.purdue.edu/~elm/projects/coe-explorer/coe-explorer.m4v>

# Simon Fraser University, CA



SIMON FRASER  
UNIVERSITY

# Simon Fraser University

**Institution: Simon Fraser University**

**PI and/or Co-PI: Brian Fisher**

**Project Name: MDRP06**

**Academic Disciplines: Cognitive Science, Interaction Design**

**Keywords associated with project:**

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input type="checkbox"/>	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
X	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input type="checkbox"/>	Visual Analytics for Security Applications
X	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Richard Arias Hernández, Simon Fraser University School of Interactive Arts and Technology (postdoc)  
Nadya Calderon Romero Alexandra, Simon Fraser University School of Interactive Arts and Technology  
Sabrina Hauser, Simon Fraser University School of Interactive Arts and Technology

**Undergraduate supported students** (need number only)

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

Andrew Wade: Visual Analytics for Aviation Safety: A Collaborative Approach to Sensemaking. SFU  
School of Interactive Arts and Technology August 22, 2011

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

Work bridging US and Canadian emergency preparedness, response, and recovery. Our role is to support cross-border coordination through work with emergency managers at the City of Richmond and City of Vancouver, in coordination with the Canadian Federal Public Security Technical Program (Ministry of Public Safety and Ministry of Defence). We coordinate with PSTP projects in Command, Control, and Interoperability and GIS (MASAS). as well as technology providers SMART, Macdonald Dettwiler, EmerGeo, SMT, and Solace Systems. We begin by training as emergency managers at JIBC, taking the same courses and meeting the same criteria as EOC personnel. We then train at a city EOC with their staff. In collaboration with EOC staff we then design interactive technologies that realize new standards (MASAS, System-of-Systems, Capability-Based Planning) in EOC operations. These include multitouch displays, coordinated use of multiple form-factor displays in the EOC, extending to mobile computing for first responders, stakeholders, and citizens. Other deliverables include training EOC planners and staff on techniques for incorporating citizen input from cell phones etc. into emergency response. Much of the finding for this work comes from Canadian sources (NSERC, PSTP) however DHS funding is key to our ability to insure that our technologies and procedures support cross-border coordination.



**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input type="checkbox"/>	Compiling & Sorting DB
<input type="checkbox"/>	Data Mining
<input checked="" type="checkbox"/>	Expert Consultation
<input checked="" type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input checked="" type="checkbox"/>	Other: "pair analytic" planning sessions in our "shadow EoC" lab using real data and systems

**Analytic Methods**

<input checked="" type="checkbox"/>	Case Studies
<input type="checkbox"/>	Modeling
<input checked="" type="checkbox"/>	Sampling
<input checked="" type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input checked="" type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input checked="" type="checkbox"/>	Consultation
<input checked="" type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input type="checkbox"/>	Hybrid Basic—Applied
<input checked="" type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

Field study analyses : Initial field work with emergency management team at City of Richmond and EmerGeo researchers. Study of vulnerabilities in operational communication with recommendations for design of visual analytic applications and supporting technologies. Distributed cognition study examining collaborative system-of-systems problem solving in prototype VA environment using emergency operations scenario. Publication advancing joint activity theory to real-time collaborative emergency operations management

Two workshops on social media for emergency managers, both reached maximum capacity. Fisher was Chair of Information Systems for Crisis Response and Management (ISCRAM) 2012 in Vancouver.

Implementation of Virtual EOC (VEOC) using real MASAS data from SFU servers capable of supporting excercises.

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

Prototypes only at this stage

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

NSERC Strategic Partnership Program: “Visual Analytics for Emergency Management” \$150K/yr. in year 2 of 3. work with Canadian EOCs, tech companies, and PSTP officials on “virtual EOC” and social media. Fisher PI.

NSERC Strategic Partnership Program: “Interactive and Visual Analysis Tools for Activity Monitoring Data” \$150K/yr. in year 1 of 3 to develop analytic tools for exploring, visualizing, and examining sensor network data (e.g. for tracking the evacuations of personnel) Pourang Irani PI (Fisher Co-i)

\$50k from PSTP to support City of Richmond and research team members to visit San Diego EOC to exchange best practices.

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

PSTP (Defence/Public Safety). If Canadian-funded activities are included: EmerGeo Inc, MacDonald Dettwiler and Associates, Oculus, Purelink, SMART technologies, SMP, Solace Systems,

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

City of Richmond & City of Vancouver emergency managers.

Please provide name of agency, contact name and email address.

Deborah Procter, Emergency Manager, City of Richmond. (604) 233-3331, dprocter@richmond.ca

Daniel Stevens, Emergency Manager, City of Vancouver (604) 829-4380, Daniel.Stevens@vancouver.ca>

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

Our participation on ERE/CAUSE exercise June 2011 combined efforts from our lab and collaborator Peter Anderson, PNNL NVAC and VACCINE.

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

**Arias-Hernández, R. , Green, T.M. , Fisher, B.** (in press) From Cognitive Amplifiers to Cognitive Prostheses: Understandings of the Material Basis of Cognition in Visual Analytics."Computational Picturing," a special issue for Interdisciplinary Science Reviews 37(1).

Fisher, B., **Green, T.M., Arias-Hernández, R.** (2011) "Visual Analytics as a Translational Cognitive Science," Topics in Cognitive Science 3,3 609–625.

**Kwon, B.C.,** Fisher, B. Yi, J.S. (2011) Visual Analytic Roadblocks for Novice Investigators. IEEE Conference on Visual Analytics Science and Technology. Providence RI, (Full paper, 8 pages)

**Nobarany, S., Haraty, M., & Fisher, B.** (2011) Facilitating the Reuse Process in Distributed Collaboration: A Distributed Cognition Approach. Proceedings of CSCW.

**Arias-Hernandez, R, Kaastra, L.T.,** and Fisher, B. (2011) Joint Action Theory and Pair Analytics: In-vivo Studies of Cognition and Social Interaction in Collaborative Visual Analytics. In L. Carlson, C. Hoelscher, and T. Shipley (Eds.), Proceedings of the 33rd Annual Conference of the Cognitive Science Society (pp. 3244-3249). Austin TX: Cognitive Science Society.

**Haraty, M., Nobarany, S., Fels, S.S. & Fisher, B. D.** (2011) Leveraging trust relationships in digital backchannel communications. CHI EA '11: Proceedings of the 2011 annual conference extended abstracts on Human factors in computing systems.

**Savikhin, A., Lam, H.C.,** Fisher, B., Ebert, D. (2011) Experimental Study of Financial Portfolio Selection with Visual Analytics for Decision Support (full paper). Proceedings of the 44th Annual Hawaii International Conference on System Sciences. IEEE Digital Library

Lindquist, E., Ebert, D., Fisher, B., & Jędrzejek, C, (2011) Visualization and Policy Development: Implications for Theory-Building (Visweek Panel) . IEEE Conference on Visual Analytics Science and Technology, Providence RI

**Arias-Hernández, Green, T.M.,** Fisher, B. (2011) From cognitive amplifiers to cognitive prostheses: understandings of the material basis of cognition in visual analytics. Visualisation in the Age of Computerisation. Said Business School, Oxford University Oxford UK.

**Arias-Hernández, R., Green, T.M.,** Fisher, B. (2011) Pair Analytics: Capturing Reasoning Processes in Collaborative Visual Analytics (full paper). Proceedings of the 44th Annual Hawaii International Conference on System Sciences. IEEE Digital Library

Ebert, D., Fisher, B, & Gaither, K. (2011) Symposium on Fundamentals and Applications of Visual Analytics. Proceedings of the 44th Annual Hawaii International Conference on System Sciences. IEEE Digital Library

Fisher, B. (2011) Visualisation Network-of-Experts 11th Workshop: Visual Analytics and Network Operations and Health. NATO Research and Technology Organization Research Study Group IST-85 (Keynote address)

Fisher, B. (2011) Visual Analytics as a Cognitive Science. EuroVA, Bergen Norway. (Keynote address)

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Accepted:

### **Summary of Outcomes and Impact of Project**

We have been successful in translating the work done in our laboratory to practices in emergency management in the City of Richmond. Our researchers participated in the ERE and consult on policy decisions (e.g. for social media) with Richmond emergency manager Deborah Procter. Our VEOC lab setup works with real data and software, integrating multitouch capabilities with state-of-the-art Common Operating Picture MASAS standards, supporting commercial providers MDA and EmerGeo in building products for use in the field.

### **Impact or success story associated with project**

We have succeeded in gaining financial support from PSTP for our collaboration with the City of Richmond. This directly funds them to work with us on our projects, enabling us to build effective participatory design with end users, which should support buy-in and real-world success for our VEOC.

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

# Virginia Tech



# Virginia Tech

**Institution:** Virginia Tech

**PI and/or Co-PI:** Chris North

**Project Name:** Colocated Collaborative Visual Analytics

**Academic Disciplines:** Computer Science, Human-Computer Interaction

**Keywords associated with project:** Large displays, visualization, collaboration, sensemaking

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input type="checkbox"/>	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
<input type="checkbox"/>	Federal Operating Component Projects (TSA, FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input checked="" type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input checked="" type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Lauren Bradel, Virginia Tech, Computer Science

**Undergraduate supported students** (need number only)

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)

**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

The goal of this project is to research how large high-resolution displays can be used to help analysts collaborate in a co-located setting. Results indicate that the space provided by the large display can help analysts establish common ground during analysis by creating a common spatial organization of the information. This enabled pairs of analysts working on a shared large display to produce improved analytic results, better than analysts who did not effectively share the display space. Analysts tended to segregate analytic roles into forager and sensemaker. Current visual analytics software must be redesigned to better take advantage of the display space and support this shared analytic process.



**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input type="checkbox"/>	Compiling & Sorting DB
<input type="checkbox"/>	Data Mining
<input type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input checked="" type="checkbox"/>	Survey
<input checked="" type="checkbox"/>	Other: human subjects experiments

**Analytic Methods**

<input checked="" type="checkbox"/>	Case Studies
<input type="checkbox"/>	Modeling
<input type="checkbox"/>	Sampling
<input type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input type="checkbox"/>	Applied
<input checked="" type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

Georgia Tech, John Stasko

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

PNNL: Student Lauren Bradel planned internship to continue experiments

**Project Period** (only complete if different than 4/1/11-3/31-12)

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Bradel L, Andrews C, North C, Endert A, Koch, K. Large High-Resolution Displays for Co-located Collaborative Intelligence Analysis: Display Usage and Territoriality. Submitted to Intl Journal of Human-Computer Studies.

Accepted:

Vogt K, Bradel L, Andrews C, North C, Endert A, Hutchings D. Co-located Collaborative Sensemaking on a Large High-Resolution Display with Multiple Input Devices. In: INTERACT 2011. Vol. 6947. INTERACT 2011. Lisbon, Portugal; 2011. p. 589 - 604.

Singh A, Bradel L, Endert A, Kincaid R, Andrews C, North C. Supporting the cyber analytic process using visual history on large displays. In: Proceedings of the 8th International Symposium on Visualization for Cyber Security. Proceedings of the 8th International Symposium on Visualization for Cyber Security. New York, NY, USA; 2011. p. 3:1–3:8.

Endert, A., Andrews, C., Bradel, L., Zeitz, J., North, C., "Designing Large High-Resolution Display Workspaces", ACM Advanced Visual Interfaces (AVI), 2012.

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

Bradel L, Andrews C, Endert A, Vogt K, Hutchings D, North C. Space for Two to Think: Large, High-Resolution Displays for Co-located Collaborative Sensemaking. Technical Report TR-11-11. 2011.

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

Lauren Bradel, "Co-located Collaborative Sensemaking in Visual Analytics", Poster presented at Grace Hopper Women in Computing Conference, Nov 2011.

**Patents/Copyrights** (List names)

Applications:

Awarded:

### **Summary of Outcomes and Impact of Project**

Results indicate that the space provided by the large display can help analysts establish common ground during analysis by creating a common spatial organization of the information. This enabled pairs of analysts working on a shared large display to produce improved analytic results, better than analysts who did not effectively share the display space. Analysts tended to segregate analytic roles into forager and sensemaker. Current visual analytics software must be redesigned to better take advantage of the display space and support this shared analytic process.

### **Impact or success story associated with project**

Two undergraduate female computer science students attracted into graduate research as a result of participating in the project as undergraduates.

Graduate female computer science student obtained summer internship at PNNL to continue research related to the project.

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

**Changes in research plans, if applicable:** describe any major changes in the project's plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.

# University of Washington



# University of Washington

**Institution: University of Washington**

**PI and/or Co-PI: Mark Haselkorn**

**Project Name: Enhancing Interactive Visual Analysis and Decision Making Environments**

**Academic Disciplines: Human Centered Design & Engineering**

**Keywords associated with project: Decision Making**

**Theme for Research Projects** (Check all that apply)

If this is not a research project, indicate "NA" below.

<input checked="" type="checkbox"/>	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
<input checked="" type="checkbox"/>	Enterprise Resiliency Environments
<input type="checkbox"/>	Event Evacuations
<input checked="" type="checkbox"/>	Visual Analytics for Security Applications
<input type="checkbox"/>	International Collaborations
<input type="checkbox"/>	N/A

**Theme for Education Projects** (Check all that apply)

If this is not an education project, indicate "NA" below.

<input type="checkbox"/>	Minority or Underserved Programs
<input type="checkbox"/>	Undergraduate and Graduate Education Program
<input type="checkbox"/>	Professional Education and In-Service Programs
<input checked="" type="checkbox"/>	N/A

**Students Supported on Project**

**Graduate Research Assistants** (include name(s), university and department)

Robin Mays, University of Washington, Human Centered Design & Engineering

**Undergraduate supported students** (need number only)

**Other Graduate Students** (non-supported) involved in project (need number only)

**Other Undergraduate Students** (non-supported) involved in project (need number only)

**Student Thesis in 2011** (include name, thesis title, university, department, degree, date)



**Research Problem /Abstract** (in 200 words or less, provide a summary of the project goals and objectives, in simple language understandable to someone outside the project's field).

Visual analytic and decision making environments can best be enhanced by placing the work and information flow at the center of design and development. We worked with the U.S. Coast Guard, Sector Puget Sound, to understand and model their emergency response workflow and apply that to the design and development of visual analytic tools to support that workflow. With only \$5K of funding during this period, we could only begin the trust building and knowledge acquisition phases of this work. There have been no expenditures of VACCINE funding since June of 2011.

We leveraged our role in VACCINE to establish our role with the National Center for Cognitive Informatics and Decision Making in Healthcare, under the DHHS SMART Program. Therefore, our effort during this period focused on workflow modeling and decision making in healthcare environments.

**Technical Approach** (Check all that apply)

**Data Collection Methods**

<input type="checkbox"/>	Compiling & Sorting DB
<input type="checkbox"/>	Data Mining
<input checked="" type="checkbox"/>	Expert Consultation
<input type="checkbox"/>	Field Monitors
<input type="checkbox"/>	Survey
<input checked="" type="checkbox"/>	Other: Ethnographic research

**Analytic Methods**

<input type="checkbox"/>	Case Studies
<input checked="" type="checkbox"/>	Modeling
<input type="checkbox"/>	Sampling
<input type="checkbox"/>	Statistical Analysis
<input type="checkbox"/>	Other:

**Nature of Research**

<input checked="" type="checkbox"/>	Applied
<input type="checkbox"/>	Basic
<input type="checkbox"/>	Consultation
<input type="checkbox"/>	Coordination/Integration
<input type="checkbox"/>	Education
<input type="checkbox"/>	Hybrid Basic—Applied
<input type="checkbox"/>	Hybrid Applied—Consultation

**Deliverables** (other than publications and reports listed below)

None

**Technology Transitions** (describe any products/technologies in process or that have completed transition to commercialization; include actions and progress to date)

1. **U.S. Provisional Patent, “Modeling & Analysis Tool for Healthcare Processes (MATH),” filed on January 13, 2012, serial number 61/586,227.**
2. **U.S. Provisional Patent, “Methods and Systems for Improving Clinical Workflow by Enabling Remote Clinician-Patient Interaction,” filed on May 27, 2011, serial number 61/490,840.**

**Additional Funding Sources Leveraged:** include amount, source of funding, PI and period of performance

**National Center for Cognitive Informatics and Decision Making in Healthcare, DHHS SMART Program, \$281,824.00, Mark Haselkorn (PI), April 2011 – March 2012.**

**Collaborating Partners** (academic Co-PI's, businesses, or other government funding agencies)

**Collaborating End-Users** (specific DHS operating components such as FEMA, TSA, Coast Guard or federal, state, local law enforcement, fire, emergency management, etc.)

Please provide name of agency, contact name and email address.

Coast Guard Sector Puget Sound, Anne Tyler, Anne.K.Tyler@uscg.mil

**Collaboration with other VACCINE project teams, national labs, and other Homeland Security Centers of Excellence** (CREATE, NCFPD, START, PACER, ALERT, NCBSI, MIREES, ZADD, CHC and NTSCOE).

Describe purpose and nature of the collaboration and any follow-up to the discussion, if applicable.

Brian Fisher, Simon Fraser University, Vancouver, BC.

**Project Period** (only complete if different than 4/1/11-3/31-12)

**Project Outcomes** (Publications, Presentations, etc., based on this VACCINE-funded project)

**Peer-Reviewed/Refereed Publications, Journals, Conferences:** list only citation below, must also provide/attach electronic copy of all individual publications to VACCINE

If additional space is needed, please attach a separate Word document listing relevant materials.

Submitted:

Accepted:

1. **Walton, Rebecca W.; Mays, Robin E.; Haselkorn, Mark P. (2011)** "Defining 'Fast': Factors Affecting the Experience of Speed in Humanitarian Logistics, " ***In Proceedings of the 2011 International Conference on Information Systems for Crisis Response and Management (ISCRAM2011)*** [Fully-refereed, blind, 45% acceptance] Winner, ISCRAM Best Paper Award, May 2011.
2. **Mays, Robin E.; Zachry, Mark; Garrison-Laney, Carolyn; Murat, Alper; Haselkorn, Mark P. (2011)** "Aligning Border Security Workflow and Decision Making with Support Information and Communications Systems." ***In Proceedings of the 2011 International Conference on Information Systems for Crisis Response and Management (ISCRAM2011)*** [Fully-refereed, blind, 45% acceptance].

**Other Reports** (including white papers, book chapters, manuscripts submitted, in revision or accepted/in press [not including those in preparation], other publications)

**Presentations** (include title, presenter, date, meeting, location. Attach PowerPoint if available). If additional space is needed, please attach a separate Word document listing relevant materials.

1. "The Role of Usability, Workflow, and Patient-Centered Cognitive Support in Improving Health Information Technology," AMIA 2011, Washington, D.C., October 24, 2011.
2. "Introducing the MATH Method and Toolsuite for Evidence-based HIT." AMA-IEEE Medical Technology Conference," Boston, October 18, 2011.
3. "**Defining 'Fast': Factors Affecting the Experience of Speed in Humanitarian Logistics,** " ***ISCRAM 2011***, Lisbon, Portugal, May 2011.
4. "**Aligning Border Security Workflow and Decision Making with Support Information and Communications Systems,**" ***ISCRAM 2011***, Lisbon, Portugal, May 2011.

**Summary of Outcomes and Impact of Project**

We have gained significant understanding of Coast Guard workflow and decision making and have established a trust relationship with Coast Guard Sector Puget Sound Leadership. We are positioned to engage in a visual analytic demonstration project should funding be available.

**Impact or success story associated with project**

Under separate, leveraged, funding, our current focus is in the area of healthcare. We have successfully modeled workflow in a clinical environment and used that to work with practitioners in the design and development of a mobile application that enhances communication between patients and healthcare providers. That application, called Priority Contact, is being piloted in the sandbox environment of the Veterans Healthcare Administration.

**Issues Encountered, if applicable:** intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc.

**Changes in research plans, if applicable:** describe any major changes in the project’s plans or objectives, such as initiatives added or omitted, compared to those outlined in the original, funded proposal.

Adjusted our DHS research to a 5K level of support.

**Supporting Documentation:** list items and attach electronically, including survey instruments, photos, models, letters to participants, or other unique documentation.