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 4

April 1, 2012 – June 30, 2013

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PURDUE UNIVERSITY

Georgia Tech · UHD · IU · FIU · Stanford · Arizona State University · Justice Institute of British Columbia · North Carolina A&T · Penn State · UW

UNC Charlotte · SFU Simon Fraser University Thinking of the World · UBC · Swansea University Prifysgol Abertawe · Morgan State University · Virginia Tech · The University of Texas

Universität Stuttgart · Navajo Technical College · University of Victoria · Carleton University · Victoria University · Brown University · University of Manitoba · University of Pennsylvania

U.S. Department of Homeland Security

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 Purdue University with Georgia Tech, Jackson State University, and Morgan State University providing an advisory role. VACCINE currently has four official MSI partners, Morgan State University, Florida International University, Jackson State University, and Navajo Tech. The VACCINE team is currently comprised of the following 26 universities with the associated Principal Investigator listed for each school:

University	***PI***
Arizona State University	Dr. Ross Maciejewski
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 Carpendale
Jackson State University	Dr. Richard Alo

University	PI
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 Department of Homeland Security, as well as all of the mission areas.

Figure 2: VACCINE International Team Members and Partners

B. Accomplishments

During Year 4, the VACCINE team worked diligently to create a robust portfolio of research and academic projects, as well as to make significant progress in our outreach and overall transition activities. Highlights of our team's efforts include the data in Figure 3 as well as the following:

- VACCINE continued to build our **multi-agency public safety consortium** with organizations beyond the borders of Indiana; we developed new relationships with organizations such as the Illinois State Police, the Cook County Sherriff's Department, the NYPD, Morgan State University, the Stevens Institute, Sejong University, and the Boy Scouts of America. Additionally, VACCINE has 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.
- Our **Visual Analytic Law Enforcement Toolkit (VALET)** continues to be used in the Lafayette, West Lafayette, and the Purdue Police Departments. Further, the Indianapolis Police Department, the Tippecanoe County Sheriff's Office, the Ohio State Highway Patrol, the Illinois State Police, and has most recently The New York Police Department have all begun testing or deploying the tool. As the predictive analytics component of the software continues to improve, we continue to receive input and feedback to make adjustments to the technology in order to optimize it for use in the field. Additionally, we

have contracted with a consulting firm to ensure the software is commercial grade. The mobile version of VALET (iVALET) continues to be a popular option for law enforcement officers depending upon their roles and responsibilities. In keeping with the goal of transitioning this software, we have reached out to (and had visits from) a number of corporate entities to gauge their interested in licensing the tool.

- **VALET** continues to be 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, and continues to be used annually for a variety of presentations. The resulting findings and analysis are being integrated into educational and enforcement programs at Purdue.
- In December of 2012, VACCINE received an award in recognition of its research and innovation in the development of data enterprise solutions and visualization in support of TSA and Ohio Homeland Security.
- The United State Coast Guard, in collaboration with VACCINE, completed the verification, validation, and accreditation process for the cgSARVA tool. This marks the first time in COE history that a tool produced by one of the Centers of Excellence has been accredited by the USCG. The formal signing was completed at Coast Guard Head Quarters by Rear Admiral Lee on April 22nd of 2013.
- **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. . 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.
- **GARI (Gang Graffiti Recognition and Analysis)** is being used by the Indianapolis Metropolitan Police, the Indiana Intelligence Fusion Center Gang Task Force, the INGang program, the Cook County Sherriff's Department, and in the Navajo Nation, and should be deployed shortly to the Illinois State Police. Additionally, a number of other law enforcement entities have expressed interest in using and deploying the tool. Recently, we have developed a community version for release that runs in a similar manner, but only allows for the reporting of graffiti with no information visible to the individual uploading/reporting the graffiti image. Firstlink, a consulting company, has looked at the GARI tool and completed a market analysis to assist in determining the best transition plan for the technology. While the tool is in operation and has servers installed at the Indiana Intelligence Fusion Center in Indianapolis and the Cook Country Sherriff's Department in Chicago, a long term plan for maintenance and support has not been completed. At present, we are exploring a number of options. There are currently 54 users of the system in Indianapolis, and 23 within Cook County. There are an additional 70 or so users testing from our own server and over 1200 images have been collected and uploaded.
- For the past two years, the Penn State GeoVISTA Center, with support from VACCINE, has been developing the Symbol Store, a web-based interactive tool designed to help

mapmakers share point symbols. The Symbol Store allows users to browse for symbols by keyword, category tags, and contributors. It also allows for symbols to be previewed on realistic maps prior to download. All symbols can be saved in common raster and vector formats for use in all types of mapping software. The initial prototype of the Symbol Store was evaluated by flood mapping experts from the State of California, and the results of this user study led to multiple refinements now implemented in the public version of Symbol Store. Maps are a primary means for supporting information sharing and collaboration in emergency management and crisis situations. While a variety of formalized map symbol standards for emergency contexts exist, they have not been widely adopted by mapmakers. Informal symbol sets are commonly used within emergency management groups, but until now there has not been a flexible mechanism for discovering, sharing, and previewing these symbol sets among mapmaker. **cgSARVA** was used to determine the allocation of resources and rebuild priority during Superstorm Sandy which devastated the New Jersey Shoreline in October 2012. In using cgSARVA, the USCG was able to rapidly and accurately determine the number of incidents that various stations had responded to in previous years making it easy to determine which stations should be prioritized based on historical information..

- 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. VACCINE has recently started Phase II of the project.
- In collaboration with the VACCINE and the Miami-Dade County Department of Emergency Management, DITRG (Disaster Information Technologies Research Group (DITRG) at Florida International University) has produced a tool known as the Multimedia Aided Disaster Information Integration System (MADIS). This tool, which has been successfully demoed during VACCINE Annual Meetings as well as through several disaster training scenarios, makes it easier for emergency managers to gather relevant information by automatically linking situation reports directly to imagery obtained and uploaded by responders and the public.
- The **Travel Response Investigative Profiler**, better known as **TRIP**, was developed by VACCINE to understand the movement behaviors and spatio-temporal patterns of individuals. As individual movements have potential correlations with social and/or geo-spatial factors, it is critical to understand the spatiotemporal patterns of individual movement behavior. Therefore, this visual analytics approach offers great potential through interactive and scalable techniques, helping analysts to extract, isolate, and examine the results interactively. TRIP allows an analyst to explore and examine spatiotemporal correlation among individual movements and between infrastructures, such as airports and schools. The Indiana Intelligence Fusion Center has once again been our partner in providing feedback and assisting in improving this tool over the past year.
- UNCC partner Dr. William Ribarsky has developed risk analytics capabilities which 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. In addition, methods have been developed to determine risk and possibility of fraud by examining the data and looking for trends and events in

multiple different types of data, including unstructured data. RiskVA has been successfully vetted by senior management at Bank of America and is starting to be used by analysts in the bank. It is the first step in a rich set of financial visual analytics tools. A version can be made available to government agencies to assist in the investigation of financial debt.

- 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.
- We continue to develop our network of **Minority Serving Institutions** for engaging in visual analytics research and education. Morgan State University, Jackson State University, Florida International University and Navajo Technical University are official partners. Over the past year, there were numerous engagement opportunities and a number of collaborative projects with the MSI partners in both education and research. Morgan State has participating in both student and professional education courses VACCINE has conducted, as well as working with some of the Visual Analytics Tools (Valet) to see how they can add features or adapt the technology to their own needs on the Morgan State Campus. Jackson State University has been our partner in hosting and planning one of the professional development courses held in July 2013. Florida International University continues to research and develop various visual analytics tools and systems for first responders in the Miami-Dade community. Finally, Navajo Technical University has access to GARI and used it to collect images of gang graffiti in Navajo Nation over the past year.
- In May of 2013, VACCINE and CCICADA conducted a joint retreat in Chicago, Illinois. Principle investigators from both halves of the CVADA center met to discuss their current research, projects, and collaborations. The purpose of the one day event was for the PIs to look for projects that may lend themselves to natural collaborations. During the course of the day, the investigators were briefed on some of the projects and research occurring at the other center, and eventually given time to meet one on one to discern any matches or interest in research. The event was well received and both halves of the center are still looking at collaborative projects.
- In order to increase cooperation with other COEs, VACCINE has engaged in projects not only with its sister half, CCICADA, but with the National Center for Secure and Resilient Maritime Commerce and the National Center for Food Protection and Defense.

VACCINE Accomplishments (April 1, 2012 – June 30, 2013)	
Research Themes	21
Education Themes	7
Seed Projects Funded	3
Peer-reviewed/Refereed Journal Articles/Publications/Papers	56
Presentations	61
Other Reports	10
Scholarly Journal Citations of Published Reports	228
Student Theses	13
Patents (applied and awarded)	1
Graduate Students Participating in VACCINE Programs	56
Minority Students Participating in VACCINE Programs	25
HS-STEM Student Theses	2
HS-STEM Students Enrolled	9
K-12 Student Participation	0
VAST Challenge 2011 Awards	1
Period 3 Base Funding	$ 2,442,730.
Additional DHS Funding (BOA, Supplemental, etc.)	$1,764,021.
Funding from other Agencies Leveraged	$611,190.
VACCINE, Limited Liability Corp. Funding	$53,968.
Total of all Funding	$4,871,909.

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 involvement through 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 critical to the research and development of technologies, which will be transitioned to the broader public safety community. Part of that understanding takes the form of our Public Safety Consortium.

The Public Safety Consortium consists of a number of law enforcement, fire, and emergency management agencies that allows for 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 and 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 future tools that would facilitate increased accuracy and ease of understanding data in the homeland security realm. 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 continues to expand its end-user community beyond the state of Indiana, including the Illinois State Police, the Cook County Sherriff's Department, the Ohio State Highway Patrol, the NYPD and numerous other interested parties. Each year we move closer to our ultimate goal of developing technologies that have been vetted and verified by having end-. Technologies designed in this fashion have the ability to be translational across a larger community of end-users geographically.

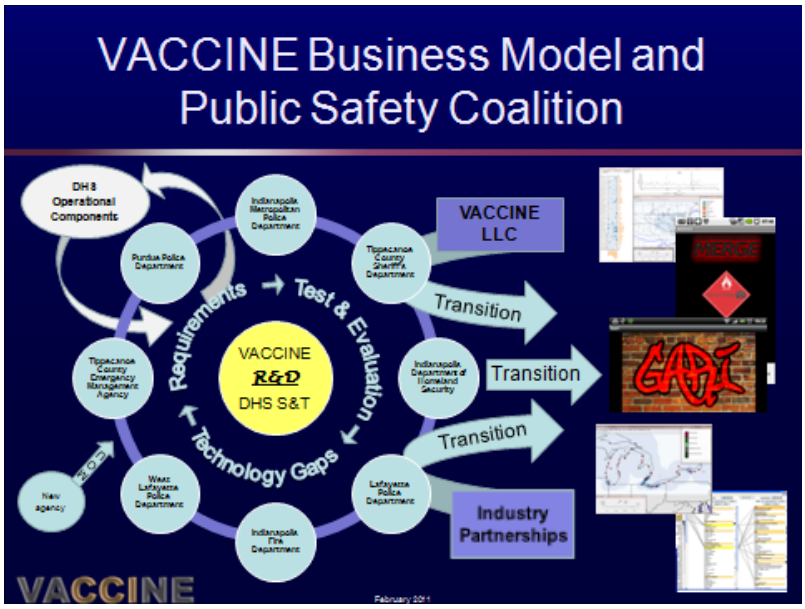

Figure 4: VACCINE Business Model

The VACCINE team has a strong, collaborative history and experience, which is essential to fostering internal collaboration, as well as collaboration with CCICADA, other DHS COEs, government agencies, field personnel, and researchers. Our Center's management structure has three components: management staff, a leadership board, and an external advisory board. The management staff is kept intentionally lean in order to maximize research and education funding while minimizing 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. VACCINE staffing includes a director, managing director, center coordinator/administrative assistant, and education manager (part time) and finally an engagement and transition manager.

The VACCINE 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, which advance the start-of-the-art tools 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 user's effectiveness and the effectiveness of the entire analysis and decision making 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.

The ever-growing volume of homeland security, science, engineering, and user-generated data creates a need for valuable, timely analysis tools that enable interactive visual analysis for comprehension and provide critical insights from this sea of data. Recently, this problem has been referred to as the "Big Data" problem. Big Data continues to be a growing news topic and research topic within the IT and business community as exemplified by *The New York Times'* recent entire special section on Big Data, *IEEE Computer*'s special issue on Big Data, and over 10 special issues/sections of IEEE publications on Big Data in 2013. VACCINE researchers have focused on Big Data challenges since 2004 when Dr. Joe Kielman and DHS funded Dr. Jim Thomas to lead a team to define the research challenges of visual analytics for the problems facing our nation. The visual analytics research agenda (*Illuminating the Path: The Research and Development Agenda for Visual Analytics)* that was the result of our efforts is exactly focused on enabling discovery, decisions, and actions from Big Data. Our team has been developing innovations in this area for almost 10 years and has extensive experience in solving Big Data challenges in public safety, public health, security, policy, business intelligence, social media, science, and engineering. VACCINE focuses on all of the dimensions of the Big Data problems: **Velocity, Volume,** and **Variety.** There are several groups who claim Veracity or Viscosity of data are the 4th dimension and we have expertise in those areas as well. Human-guided visual analytics can solve many of the problems that are still unsolved by most automated Big Data Analytics techniques.

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 research themes that have integrated end-users from the beginning to the end of each specific project. Having our customers directly integrated with our projects allows them to instigate new projects, provide input, relevant feedback, and transition paths for DHS technology transfer. Our projects are planned to be 6 to 36 months in duration with clearly defined deliverables and transition paths. Our main research thrusts are the following:

- **Core Visual Analytics** Techniques– We are focusing on integrated, interactive visual exploration, analysis, and decision making environments to enable effective decisions from massive, time-evolving multimedia data.

- **Interactive Scalable Analytics Techniques** – A key challenge is developing statistical, spatiotemporal, image, video, signal, machine learning techniques designed and adapted for human-in-the-loop visual analytic environments that scale to real world "Big Data" solutions.
- **Science of Interaction** for Visual Analytics – Key findings in visual analytics have demonstrated that collaboration over and interaction with data are key components of an integrated computational-human decision making loop. This human-information interaction occurs at many levels from individual manipulation of data representation, to interactive cognitive discovery combined with automated analysis, to coordinative and distributed interactive analysis among groups of individuals. We are focusing on clearly defining and developing a **Science of Interaction** to support ubiquitous and collaborative analysis and discovery utilizing new, transparent interaction tools.
- **Evaluation of Visual Analytics** in real world environments – Determining the effectiveness of visual analytics techniques and systems in actual operations use is a tremendous challenge since we are trying to determine if these new techniques and tools provide new insights, increase the rate of insights, or increase the effectiveness and efficiency of people doing complicated and sometimes very lengthy tasks. This is a completely different challenge than determining if someone can more readily find an outlier or pattern in a visualization or if someone can complete a very simple task more quickly. Traditional perceptual testing, computer interface, and human-computer interaction techniques are insufficient. Therefore, VACCINE researchers bridging cognitive science, visual cognition, human computer interaction, and visual analytics are exploring and advancing research in this area expanding and adapting techniques such as cognition in the wild and paired analytics.

Our research and development efforts can also be categorized into three thematic overarching projects, our E2E projects, related to topic area and the end user community as follows:

- **Theme 1: Public Safety Coalition Projects** (e.g., state or local law enforcement, fire, emergency management)
- **Theme 2: Federal Operating Component Projects** (e.g., TSA, FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
- **Theme 3: Visual Analytics for Security Applications (VASA)**

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. The following is a list of research highlights that occurred during Year 4. 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 Project Highlights:

- VACCINE continued building our **multi-agency public safety consortium** with organizations within the state of Indiana and extending it across the Midwest and Country. New partners include the Ohio Strategic Analysis and Intelligence Center (SAIC) – a DHS Fusion Center, the Ohio State Highway Patrol, the Illinois State Police,

the Cook County Sherriff's Department, and the New York City Police Department (NYPD).

- Our **Visual Analytic Law Enforcement Toolkit (VALET)** continues to be used in by Indiana police departments and now the Ohio State Highway Patrol, Illinois State Police, and New York City Police department have deployed it for evaluation. Within Indiana, it is being loaded onto the mobile data terminals in police cars, and our mobile iVALET system is being extensively evaluated within Indiana.
- **Jigsaw** is now available for free download and is being used by the Indianapolis Police Department, the West Lafayette Police Department, the Rock Hill Police Department (SC), and the Lafayette Police Department. Currently, hundreds of 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.
- **GARI (Gang Graffiti Recognition and Analysis)** has been transitioned and deployed for use across Indiana through deployment the Indiana Fusion Center Gang Task Force Network (INGANG). It has also been deployed to the Cook County Illinois Sherriff's department and they are in the process of uploading over 20,000 gang graffiti images into the database. The system now also supports a tattoo database as well and the Indiana Department of Corrections is populating that database from their records.
- 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.
- 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 and demonstrated that first responders could identify the appropriate response protocol much more quickly using MERGE than the standard emergency response guidebook.
- An improved prototype system and iPad application based on Florida International's "**Integration Framework for Enhancing Emergency Response**" system continues to be evaluated by personnel at Miami-Dade Emergency Management (MDEM), and further pilot activities are planned as part of the evaluation process.

Theme 2: Federal Operating Component Projects Representative Project Highlights with the United States Coast Guard Projects:

- We continue to improve **the Coast Guard Search and Rescue Visual Analytics (cgSARVA)** technology with more capabilities. As part of the **COAST** (Coastal Operations Analytical Suite of Tools) 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 for multiple missions and considering multiple asset types (boat and air). The COAST project is a joint E2E project of both halves of the CVADA Center of Excellence (VACCINE and CCICADA) where metrics from cgSARVA feed into decisions and optimization plans for CCICADA's Boat Allocation Model (BAM) and output of this model can be visually analyzed using cgSARVA.
- **CgSARVA** was used by USCG Atlantic Area Command in planning resource allocation in response to Hurricane Sandy in the fall of 2012 and as part of COAST has been used in prioritizing the rebuilding of the 14 severely damaged USCG stations in the wake of Sandy, as well as determining the capabilities needed in the rebuilt stations. It also continues to be used by USCG in resource allocation and mission optimization across many districts, at headquarters, and Atlantic Area Command.
- For USCG Commander Atlantic Area, VADM Robert Parker, VACCINE developed an interactive visual analytics environment for resource allocation and performance evaluation – **iOPAR** to enable interactive mobile decision making and analytical exploration of operations, performance, and analytical metrics.

Theme 3: VASA Project Highlights:

The VASA project is a collaboration between VACCINE members, German Universities, and several international corporations to design a decision making environment considering cascading critical infrastructure issues. Effective analysis for emergency situations caused by severe weather conditions and natural disasters requires understanding of a comprehensive set of data, including weather, critical infrastructures, and transportation network logistics. However, both civic and business analysts often encounter difficulty in estimating the impact of an event, forecasting damage, and discovering optimal solutions from various resources due to incomplete sets of data, lack of reliable simulation models, and no existing environments for decision-making. We are designing and developing a visual analytics system that provides this environment for analysts and decision-makers.

Currently VASA project components have been developed for power grid and smart grid issues related to alternative energy production fluctuations, computer network integration in the smartgrid, social media as indicators for events and consumption, public transportation alternatives, food distribution networks, and severe events and disasters. These prototypes are being integrated and evaluated and will also be expanded to consider issues with black-outs and brown-out scenarios, extreme temperature effects on critical infrastructure (e.g., heat waves), contingency planning, resiliency, and even green business decision metrics and factors.

III. Education Programs

During Year 4, VACCINE's educational initiatives focused primarily on undergraduate and graduate level work (including work with MSI institutions) and professional education and training programs. The VACCINE educational mission is to educate current Homeland Security stakeholders and the next generation of talent in order to enable them to make effective decisions from the mass of multisource, multimedia data they will face in their careers.

In November of 2012, VACCINE held an education summit in order to set educational goals for the remainder of the center's initial six year grant. A number of VACCINE PIs and staff from Morgan State University, Purdue University, Georgia Tech, Simon Fraser University, and a guest from Virginia Tech. Throughout the two day summit, various educational goals were discussed an the following actions were determined to be the educational goals for year 4:

- VACCINE will collect the Visual Analytics courses offered at all partner institution.
- A number of the VACCINE schools now have master's degrees or certificates in Visual Analytics or Cyber Security, both of which are of interest to VACCINE. We are working on collecting this information or a regular basis.
- VACCINE would reach out to more community colleges in order to explore that option as a method of professional development/education.
- VACCINE decided to host a training for educators during the summer of 2013 on the Jackson State University campus in order to propagate the concept of visual analytics and explore how the discipline may be incorporated into a variety of fields.
- Explore schools with criminal justice programs to see if there is interest in that field.

  VACCINE was able to explore these options and has started to develop deeper relationships with community colleges and criminal justice organizations and programs. In years 5 and 6 of the center, we will continue with our current educational initiatives and attempt to reach a wider audience with our collective information.

Minority Serving Institution Partners

VACCINE has a number MSI partners Florida International University, Morgan State University, Navajo Technical College, Jackson State University, and the University of Houston-Downtown to a lesser degree. We have worked closely with these schools, as they are part of the VACCINE team, in both the research area as well as the educational mission of the center. Throughout year 4 of the VACCINE center, there were numerous engagement and learning activities conducted with our MSI partners. A few are mentioned below:

- VACCINE agreed to be a host for the 2013 DHS Summer Research Team Program for Minority Serving Institutions and received approximately 11 applications from MSI institutions for a faculty/student team to participate a research project with a VACCINE faculty member for the summer of 2013. We were paired with a student/faculty team from the University of Texas – Kingsville. Dr. Nuri Yilmaz and his student, Mr. William Jaramillo, temporarily joined the VACCINE team on Purdue University's campus for

approximately two months between June and August of 2013. The research team was paired with Dr. Edward Delp of Purdue University to work on their research of enhancing image filtration and analysis from UAVs. Specifically, their project explored enhancing and restoring distorted or degraded images taken by UAVs, with applications for use in border surveillance and other homeland security applications.

- We continued to develop our relationship with Navajo Technical University (NTU) and began working with Alice Carron as our primary contact. During year 4, Navajo Technical University submitted a proposal for seed funding in order to use the GARI tool and catalog the graffiti that is rampant in the Navajo Nation. Navajo tech had five undergraduate interns and two faculty members who cooperated with local law enforcement collecting images of graffiti across the Navajo reserve using GARI. The team has collected a number of images and would like to use them as part of a public awareness campaign for some of the issues within the community. 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.

Undergraduate/Graduate Course Program

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 three who entered in fall of 2012. VACCINE has applied for a continuation of funding through a proposal for the HS-STEM 2012 program and has been awarded additional funding to be distributed in year 5.

The HS STEM program has had 2 graduates complete not only their degrees, but their years of service. Dr. Daniel Richardson received his PhD in Mechanical Engineering and completed his

year of service during the summer of 2013.He spent his time at Purdue researching and learning about Mechanical Engineering. The HS-STEM area he was most interested in was the Explosives, Detection, Mitigation, and Response arena. His project involved explosive detection and identification with advanced laser techniques. In order to complete his year of service, Daniel has been working as a National Research Council Research Associate at the Wright Patterson Air Force Base. He is currently part of the laser diagnostics group at the Air Force Research Laboratory (AFRL). Daniel's work has increased the understanding of fundamental fluid dynamics as well as the application of laser diagnostics to challenging environments. This, in turn, is related to the areas of explosive detection, biological, and chemical threat detection. Mr. Matt Levendoski spent his time at Purdue University pursuing a master's degree in cyber forensics. Matt graduated in the spring of 2013 and is still working on completing his service requirements. While he was a student, he did participate in a number of internships including work with Lockheed Martin and the Purdue Police Department in cyber forensics.

In order to create a cohort from students who have various disciplines, but all share an interest in Homeland Security, there are monthly HS STEM luncheons. This is a time for one student to present and the rest to learn where there are in their careers and research and how this all pertains to homeland security. Additionally, students are required to submit semester reports and updates on both their research and any service they are participating in.

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. Nine 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 over the next few years.

SURF/VAST Program

Purdue University has a Summer Undergraduate Research Fellowship Program (SURF) in which, undergraduates have the opportunity to participate in research at various labs throughout the summer. In this program, approximately 150 undergraduate students spend 11 weeks working in individual labs and conduct research. VACCINE has participated in this program in the past, and did so again this year. We call our version of this program VASP (Visual Analytic Summer Program). In the summer of 2013, VACCINE hosted two students from Purdue University in the lab for 11 weeks. The students on individual projects, including Scatterblog, Valet, and other smaller projects. The students who worked in the lab were so productive and interested in the research that we have offered them employment for the school year.

Professional Training

A. Ivy Tech

VACCINE had been in continued contact with Ivy Tech, a network of community colleges throughout the state of Indiana. After meeting with a number of faculty and administrators, we have discussed a number of ways to incorporate Visual Analytics into the curriculum throughout year 5 of the center. While looking at community colleges to interact with, we determined Ivy Tech held a lot of potential due to its structure. While there is a campus in Lafayette, IN near Purdue University, there are actually 31 campuses across the state. When meeting with our local group, we discussed having VACCINE present at their Deans meeting, in which deans from each of the campuses get together to discuss curriculum. Another advantage of Ivy Tech is that a number of our first responder partners actual instruct part time at the Lafayette Campus, allowing them to understand and potential incorporate our tools into their coursework.

B. Education and Training for First Responders

VACCINE routinely presents the tools and technology developed to a number of different law enforcement entities; occasionally those presentations take the form of professional training in addition to a presentation on the types of tools and applications developed by VACCINE. There have been a number of presentations to Fusion Centers over the past year that went through some of the tools step by step and provided use information. Further, some of the tools already have completed training videos and others are still in production. Additionally, during the VACCINE Annual Meeting in September of 2012, law enforcement officers and first responders were training on a number of the VACCINE tools. Trainings were conducted of the VALET/iVALET, Jigsaw, GARI, and MERGE.

IV. Partnerships and Outreach

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. 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). This MOU has been the kick off to a great partnership with the Ohio State Highway Patrol and the Ohio Homeland Security Department. Not only have we continued to partner with Ohio, but we have expanded our partnerships west as well, to the state of Illinois and a number of operations within the state. The number of requests we receive for the tools and technology we produce does not allow us to partner with every agency that make a request at this time. We are working diligently, daily, to determine the best way to interact and deploy our tools to all that request.

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 a number of agencies. VALET provides advanced analysis capabilities, allowing analysts to develop and test hypothesis about criminal activities within various areas of their communities. While development of VALET and iVALET has taken place over a number of years, this past year we have tested in operationally with a number of law enforcement agencies (specially the Ohio State Highway Patrol, the Lafayette Police Department, The Illinois State Police and the NYPD are all currently testing or using the software functionally). Given the current stage in development, we are looking to transition or license the software in year 5 and have had a number of conversations with companies that would be interested in the long-term support of the software.

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. MERGE has 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, and is available by request.

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., geo-position, 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. As mentioned, in year 4 VACCINE worked with Firstlink in the hopes of developing a thorough transition plan based on their market analysis. At present, we have explored the concept of housing various servers in fusion centers across the country as so many groups have expressed interest in the tool. We have been in contact with Cook County and the INGang Network to discuss having their two servers communicate information/queries as a way of linking information across state lines. At present, we are looking into a long term support and development structure for the tool. .

SCATTERBLOG

Scatterblog is a social media analysis tool which looks at real time twitter information to monitor and detect any anomalies for the purpose of alerting first responders to any incident they may need to respond to. Analysis of public behavior plays an important role in crisis management, disaster response, and evacuation planning. Unfortunately, collecting relevant data can be costly and finding meaningful information for analysis is challenging. Recent advances in technology have enabled social media services to support space-time indexed data, and internet users from all over the world have created a large volume of time-stamped, geo-located data. Such spatiotemporal data has immense value for increasing situational awareness of local events, providing insights for investigations and understanding the extent of incidents, their severity, and consequences, as well as their time-evolving nature.

The initial deployment and testing of Scatterblog was conducted at the Boy Scout Jamboree in July of 2013. We worked with a number of volunteers at the event in order to determine key word filters to look for in attempting to detect any event or threat to the 30,000 individuals that participated in the event in some role. The tool is still being refined, but there a number of agencies interested in using it and have seen it in action. The current development status working to transition to the tool to a web-based version in order to circumvent various firewall and IT issues some of our end users have described.

VACCINE DHS Operating Components we work with:

United States Coast Guard, CgSARVA – Coast Guard Search and Rescue Visual Analytics

VACCINE has spent the past three years building strong ties within the USCG. We have collaborated with them to build tools that can be adapted to real time situational areas. The 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, and has also been verified, validated, and accredited by the USCG for use Coast Guard wide. .

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. Additionally, VACCINE also worked to develop iOPAR and ORAM for use by the Coast Guard in reviewing their operational protocols and risk management. Those tools have not yet been accredited and are described in detail in the project reports.

VACCINE has begun initial discussions with a number of other DHS operating components including CBP and USCIS to assist with big data problems. These projects are still in the initial phases.

VACCINE is also continuing work on 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.

1) **Additional VACCINE State and Federal Partners 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

2) **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.. The corporate donations are true gifts, but are structured in a manner that the corporation

can choose to have a portion of the support be distributed to a specific partner school. There are 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
- Boeing
- CRGT
- Duke Energy
- General Dynamics
- Hallmark
- Harris Corporation
- J2
- Kimberly Clark
- Kx Systems
- NVIDIA
- Oculus Info, Inc.
- Siemens

3) In addition to the 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

VACCINE has a number of international partnerships, most of which do presently or have in the past collaborated on research project. These partners include:

- Carleton University, Canada
- Chalmers University, Sweden
- Dalhousie University, Canada
- Justice Institute of British Columbia, Canada
- Linkoping 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

II. 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.

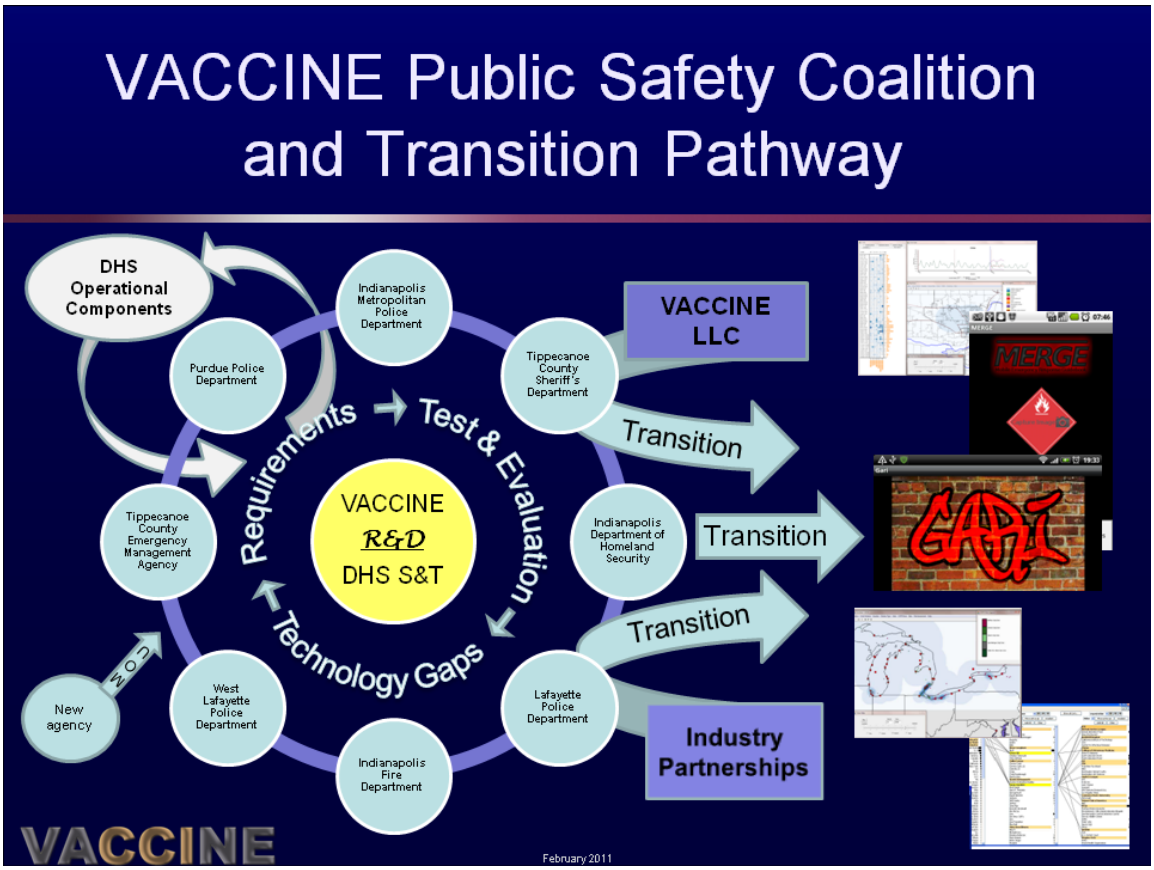

Figure 5: VACCINE Transition Pathway

The following list summarizes the VACCINE technologies and their stage of transition and deployment. While 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, Illinois State Police, Ohio State Highway Patrol, NYPD

GARI - Gang Graffiti Automatic Recognition and Interpretation
- Initial Prototype Deployed May 2011
- GARI server transitioned to the Indiana Intelligence Fusion Center March 2013
- GARI server transitioned to the Cook County Sherriff's Department May 2013
- GARI server transitioned to the Illinois State Police - pending
- Indianapolis Gang Task Force, Lafayette PD, Purdue PD, Cook County Sherriff's Department, Illinois State Police.

cgSARVA - Coast Guard Search and Rescue Visual Analytics
- Deployed for Operational Use – USCG LANT - 2010

MERGE - Mobile Emergency Response Guide
- Initial Prototype deployed May 2011
- Indianapolis Fire, Lafayette Fire

Scatterblog – Social Media/Twitter Analysis and Monitoring System
- Initial Prototype deployed in July 2013 to the Boy Scouts of America for testing at their Annual Jamboree
- Still in testing and evaluation (developing a web-based version based on feedback). A number of agencies are waiting to acquire.

Arizona State University

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Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Arizona State University

PI and/or Co-PI: Ross Maciejewski

Project Name: Developing a spatial statistics framework in the visual analytics for law enforcement technology suite

Academic Disciplines: Computer Science, Geography, Statistics

Keywords associated with project: visual analytics, law enforcement, spatial statistics, SatScan

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
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
	N/A

VACCINE Annual Report – Year 4

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)
Yifan Zhang, Computer Science, Arizona State University
Feng Wang, Computer Science, Arizona State University

Undergraduate supported students (need number only) ☐

O**ther Graduate Students** (non-supported) involved in project (need number only) ☐

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

Student Thesis in 2013 (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 will explore the integration of advanced spatial statistics for hypothesis testing into the VALET and iVALET framework. We will assess the integration of spatial scan statistics within the context of user interactions and explore combination of user selected regions with scan statistics for hypothesis testing. Given the runtime of spatial statistics, novel implementations and parallel structures will need to be explored for use on the iPhone and iPad. We will also explore the combination of density estimation with advanced statistical measures such as G* and LISA as a means of finding spatially significant regions of crime. These measures will be used for report generation and alert algorithms to direct end-users to interesting patterns within their categorical spatio-temporal data. Concurrently, we will also explore the application of other statistical measures on the temporal components of the data, setting up scripts for batch processing of categories stored in the database. In this manner, we will be able to facilitate an automated report generation which can be scheduled to push alerts to user's iPhones (based on user privileges) which indicate events of interest. Finally, we will explore the aggregation and dissemination of this categorical data for use by the general public. In this task, we will explore comparisons to moving averages and predictive events to allow for an analogous crime weather map showing deviations from the normal expectations. The benefits of such work will be to enable analysts to statistically determine spatial anomalies (as opposed to purely visual exploration).

VACCINE Annual Report – Year 4

Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
x	Data Mining
	Expert Consultation
	Field Monitors
	Survey
	Other:

Analytic Methods

	Case Studies
	Modeling
	Sampling
x	Statistical Analysis
	Other:

Nature of Research

x	Applied
	Basic
	Consultation
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

Delivered updated software modules on VALET to VACCINE.

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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

VACCINE Annual Report – Year 4

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If any item does not apply to your project, please indicate "NA" under the heading.

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.

ASU has been making contacts with the NYPD:

Philip G. McGuire, Assistant Commissioner Programs & Policies, New York City Police Dept., PHILIP.MCGUIRE@nypd.org>

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 4/1/12-6/30-13): 1/1/13 – 6/30/13

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VACCINE Annual Report – Year 4

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

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:

Zhang, Y., Mack, E., Rey, S. J., Maciejewski, R., "Exploring Indices of Industrial Diversity with Visual Analytics," *IEEE Conference on Visual Analytics Science and Technology*

Accepted:

Kim, S., Maciejewski, R., Malik, A., Jang, Y., Ebert, D. S., Isenberg, T., "Bristle Maps: A Multivariate Abstraction Technique for Geovisualization," *IEEE Transactions on Visualization and Computer Graphics*

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) Maciejewski, R., "Applied Visual Analytics for Exploring the National Health and Nutrition Examination Survey," School of Nutrition and Health Promotion, Arizona State University, January, 2013.
2) Maciejewski, R., "Analytical Brushing for Spatiotemporal Analysis," Computer Graphics and Visualization Summit, King Abdullah University of Science and Technology (KAUST), Saudi Arabia, April, 2013

Patents/Copyrights (List names)

Applications:

Awarded:

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Summary of Outcomes and Impact of Project

This work saw the integration of spatial scan statistics for anomaly detection into the VALET framework, as well as the deployment of local indicators of spatial autocorrelation for spatial cluster analysis.

Impact or success story associated with project

Work at ASU has led to new law enforcement contacts for VACCINE through the New York City Police Department.

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.

Florida International University

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VACCINE Annual Report – Year 4

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

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, Multimedia Object Classification, Multimedia Semantic Retrieval, 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

VACCINE Annual Report – Year 4

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

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

Li Zheng, School of Computing and Information Sciences, Florida International University

Undergraduate supported students (need number only)	1
O**ther Graduate Students** (non-supported) involved in project (need number only)	4
Other Undergraduate Students (non-supported) involved in project (need number only)	2

Student Thesis in 2013 (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).**

To improve the work of all the agencies and emergency managers involved in the recovery process of a disaster scenario, we have developed a prototype system called the Multimedia-Aided Disaster Information System (MADIS), which utilizes advanced data integration and visual analytic techniques to analyze situation reports and automatically augment/link them to relevant pictures and videos of disaster areas. To enhance the system performance, our research work is summarized as follows.

In order to effectively organize and retrieve disaster information available online, a disaster search engine is needed 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. In this project, we develop a disaster multimedia search engine, which provides the functionality of organizing, indexing and retrieving disaster multimedia information. Advanced data mining and multimedia processing techniques are used to summarize and visualize the search results based on not only multimedia content but also the associated textual and social media meta-data. The developed system can greatly help decision makers and emergency managers in the area to get insight into the actual disaster situation and make quick responses. Different strategies are deployed to classify online web objects. Furthermore, an information integration module is developed using the event extractor and provides a new search interface based on the integrated information.

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Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

X	Compiling & Sorting DB
X	Data Mining
X	Expert Consultation
X	Field Monitors
X	Survey
	Other:

Analytic Methods

X	Case Studies
X	Modeling
X	Sampling
X	Statistical Analysis
	Other:

Nature of Research

X	Applied
	Basic
	Consultation
X	Coordination/Integration
X	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

1. Web multimedia object classification methods.
2. Bag-of-Visual-Phrases Model and Cross-Domain correlation knowledge.
3. Junk image filtering and image summarization methods.
4. Image retrieval method based on correlation-based feature analysis and multi-model fusion.
5. Disaster document summarization methods using ontology.
6. A disaster situation reporting system.
7. A multimedia search engine.

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

N/A

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), 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.

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.

N/A

Project Period (only complete if different than 4/1/12-6/30-13)

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Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

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

1. Yimin Yang, Hsin-Yu Ha, Fausto C. Fleites, and Shu-Ching Chen, "A Multimedia Semantic Retrieval Mobile System Based on Hidden Coherent Feature Groups." accepted for publication, IEEE Multimedia.

2. Hsin-Yu Ha, Yimin Yang, Fausto Fleites, and Shu-Ching Chen, "Correlation-Based Feature Analysis and Multi-Modality Fusion Framework for Multimedia Semantic Retrieval," accepted for publication, The 2013 IEEE International Conference on Multimedia and Expo (ICME 2013), "Multimedia for Humanity" Theme Track, San Jose, California, USA, July 15-19, 2013.

3. Li Zheng, Chao Shen, Liang Tang, Chunqiu Zeng, Tao Li, Steve Luis, and Shu-Ching Chen, "Data Mining Meets the Needs of Disaster Information Management," conditionally accepted for publication, IEEE Transactions on Human-Machine Systems (THMS).

4. Li Zheng, Chao Shen, Liang Tang, Chunqiu Zeng, Tao Li, Steve Luis, Shu-Ching Chen and Jainendra K. Navlakha." Disaster SitRep - A Vertical Search Engine and Information Analysis Tool in Disaster Management Domain".The 13th IEEE International Conference on Information Integration and Reuse (IRI 2012).

5. Lei Li, and Tao Li. "An Empirical Study of Ontology-based Multi-document Summarization in Disaster Management". IEEE Transactions SMC: Systems, in press, 2013.

6.Wenting Lu, Jingxuan Li, Tao Li, Honggang Zhang, and Jun Guo. "Web Multimedia Object Classification using Cross-Domain Correlation Knowledge", IEEE Transactions on Multimedia, 2013, in press.

7. Wenting Lu, Lei Li, Jingxuan Li, Tao Li, Honggang Zhang, and Jun Guo. "A Multimedia Information Fusion Framework for Web Image Categorization", Multimedia Tools and Applications, in press, 2012.

Please also see attachment.

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

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.

N/A

Patents/Copyrights (List names)

Applications: N/A

Awarded: N/A

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Summary of Outcomes and Impact of Project

The developed Disaster Multimedia Search Engine has been developed based on the image retrieval methods proposed by our group. These methods are developed based on correlation-based feature analysis and multi-model fusion. The Disaster Multimedia Search Engine is an iPad application and can be used for retrieving and visualizing the categorized disaster multimedia data. The search results include information (subject, location, description, and URL) of images falling into a relevant concept specified by query keywords. To improve the image classification performance, several image retrieval and classification methods are developed and disaster ontology is generated for disaster related document summarization.

Impact or success story associated with project

The Disaster Multimedia Search Engine 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.

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

Georgia Institute of Technology

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Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

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.

XXX	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
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
XXX	N/A

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Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

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

Hannah Pileggi, Georgia Tech, School of Interactive Computing

Undergraduate supported students (need number only)	0
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	0

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

Zhicheng Liu, Network-based visual analysis of tabular data, Ph.D. Dissertation, Georgia Institute of Technology, School of Interactive Computing, April 2012.

Youn-ah Kang, Informing design of visual analytics systems for intelligence analysis: understanding users, user tasks, and tool usage, Ph.D. Dissertation, Georgia Institute of Technology, School of Interactive Computing, July 2012.

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If any item does not apply to your project, please indicate "NA" under the heading.

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 portrays 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.

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Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
	Data Mining
	Expert Consultation
	Field Monitors
	Survey
X	Other:

Analytic Methods

X	Case Studies
	Modeling
	Sampling
X	Statistical Analysis
X	Other:

Nature of Research

X	Applied
X	Basic
	Consultation
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	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 (8/09-7/13)

"FODAVA-Lead: Dimension Reduction and Data Reduction: Foundations for Visualization", National Science Foundation & Dept. of Homeland Security, PI: Haesun Park, $3,000,000 (9/08-8/14)

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 4/1/12-6/30-13)

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Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

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:

Youn-ah Kang and John Stasko, "Examining the Use of a Visual Analytics System for Sensemaking Tasks: Case Studies with Domain Experts", *IEEE Transactions on Visualization and Computer Graphics*, (Paper presented at VAST '12), Vol. 18, No. 12, December 2012, pp. 2869-2878.

Carsten Görg, Youn-ah Kang, Zhicheng Liu, and John Stasko, "Visual Analytics Support for Intelligence Analysis", *IEEE Computer*, Vol. 46, No. 7, July 2013, pp. 30-38.

Carsten Görg, Zhicheng Liu, Jaeyeon Kihm, Jaegul Choo, Haesun Park, John T. Stasko, "Combining Computational Analyses and Interactive Visualization for Document Exploration and Sensemaking in Jigsaw", *IEEE Transactions on Visualization and Computer Graphics*, 2013, to appear.

Carsten Görg, Zhicheng Liu, and John Stasko, "Reflections on the Evolution of the Jigsaw Visual Analytics System", *Information Visualization*, 2013, to appear.

Zhicheng Liu, Sham Navathe, and John Stasko, "Ploceus: Modeling, Visualizing and Analyzing Tabular Data as Networks", *Information Visualization*, 2013, to appear.

Youn-ah Kang and John Stasko, "Characterizing the intelligence analysis process through a longitudinal field study: Implications for visual analytics", *Information Visualization*, 2013, to appear.

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.

Examining the Use of a Visual Analytics System for Sensemaking Tasks: Case Studies with Domain Experts, Youn-ah Kang, Oct. 2012, IEEE VAST Conference, Seattle, WA.

The Value of Visualization for Exploring and Understanding Data, John Stasko, Feb. 2013, Distinguished Seminar Series , Purdue University Industrial Engineering Dept. , West Lafayette, IN.

The Value of Visualization for Exploring and Understanding Data, John Stasko, May 2013, Keynote Lecture, Graphics Interface Conference, Regina, Saskatchewan, Canada

Patents/Copyrights (List names)

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Applications:

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.) In the fall of 2012, we put Jigsaw onto the web where anyone can download it for free. We support the system with big fixes and new releases. The website includes a manual, tutorial videos to help with learning and using it, and example document collections. Hundreds of people and organizations have downloaded the system over the last year. We have been working with police departments in West Lafayette and Lafayette, IN and Rock Hill, SC to use the system in investigations. Over the last year we have had a number of papers accepted about our work on Jigsaw. One (*TVCG* '13) explores how to combine computational text analyses with interactive visualization to help investigators exploring document collections. Another (VAST & *TVCG* '12) examined six analysts who had been using the system for periods ranging from 2 to 14 months. We studied how they used it and learned ways to improve the system. In another article (*Computer* '13) we describe how visual analytics systems like Jigsaw can assist intelligence analysis.

In October 2012, project PI Dr. John Stasko received the 2012 IEEE Visualization and Graphics Technical Committee (VGTC) Visualization Technical Achievement Award. The award was given to Dr. Stasko "in recognition of his seminal achievements in new visualization techniques and for the Jigsaw system which allows understanding large document collections."

This grant also has supported research on another project for visual analytics called Ploceus. The Ploceus project focused on multivariate tabular data in which an analyst seeks to model and understand the data as a network. We developed techniques and a system that allow a user to model their data as a graph and then explore different network visualizations of the data to understand and explore it more efficiently. We have an upcoming paper in the *Information Visualization* journal about this project.

Impact or success story associated with project

A variety of organizations have reported to us how they have benefited from using Jigsaw. One fraud investigator in Malaysia reported that it assisted in a 1.5 million dollar fraud case.

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.

Morgan State University

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Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Morgan State University

PI and/or Co-PI: Dr. Kofi Nyarko / Dr. Timothy Akers

Project Name: iLaw Enforcement Apps Assistance Program for Students (iLEAPS)

Academic Disciplines: Electrical & Computer Engineering & Computer Science

Keywords associated with project: Campus Security, Safety, Mobile Apps, Android, iOS

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

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Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

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

None

Undergraduate supported students (need number only)	8
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	0

Student Thesis in 2013 (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).**

On most college and university campuses, students, faculty and staff are not aware of the telephone number for the campus police and often resort to dialing 911 when an incident occurs on campus. When the police dispatch receives these calls, they often redirect them to campus police, since the city's police forces are unfamiliar with the physical layout of college campuses. Valuable time can be lost due to lack of geographic familiarity and communication delays. To address this problem, MSU has created a campus security system, comprising of mobile apps and a web service that provides students, staff, and faculty with a means to easily contact campus police and dispatch when help is needed. Dispatch and police are then able to efficiently coordinate a response. The use of this system will expedite responses to potential threat areas on a college campus with the added benefit of mitigating additional harm due to late responses by police. Moreover, the commercialization potential for other college campuses to utilize this system is significant, as it has the potential to be easily replicated to other academic venues by simply incorporating their campus maps and dispatch telephone call-in-numbers and operational procedures.

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Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
	Data Mining
	Expert Consultation
	Field Monitors
X	Survey
X	Other: Data is acquired from mobile apps; processed/stored/retrieved in/from a database

Analytic Methods

	Case Studies
	Modeling
	Sampling
	Statistical Analysis
X	Other: Use of full SDLC, design/functionality changes driven by surveys from alpha/beta testers

Nature of Research

X	Applied
	Basic
	Consultation
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

- Undergraduate students trained in various methods of mobile app development, requirements analysis, data collection and analysis, and documentation/technical writing
- Mobile campus security app for the end user (students/admin/faculty)
- Mobile campus security app for police officers
- Campus security web service for dispatch to coordinate activity between both mobile apps
- Surveys from beta testers consisting of project steak holders (students, faculty, campus security)

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

MSU considers the iLEAPS project a good candidate for the Maryland Innovation Initiative (MII) program. The MII was created as a partnership between the State of Maryland and five Maryland academic research institutions (Johns Hopkins University, Morgan State University, University of Maryland College Park, University of Maryland Baltimore and University of Maryland Baltimore County.) The program is designed to promote commercialization of research conducted in the partnership universities and leverages each institution's strengths. The Program was created to foster the transition of promising technologies having significant commercial potential from Qualifying Universities, where they were discovered, to the commercial sector, where they can be developed into products and services that meet identified market needs. MSU will present the iLEAPS program in September of 2013 as a candidate project for this program.

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.

Morgan State Campus Police
Deputy Chief of Police Lance Hatcher
lance.hatcher@morgan.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.

Received training for Purdue's VALET software as part of a plan to implement the software on the campus of Morgan State University to help the police department better understand crime statistics on campus. In addition, data obtained from the iLEAPS project would feed into the VALET software for visual analysis of crime trends.

Project Period (only complete if different than 4/1/12-6/30-13)

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If any item does not apply to your project, please indicate "NA" under the heading.

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.

Title: iLEAPS
Presenters: Benjamin Hall, Nathan Scott, Kendric Squire, Alfred Shoetan, Vladimir Celestin
Date: February 28, 2013
Meeting: Morgan Innovation Day 2013
Location: Annapolis, Maryland

Title: iLEAPS Radio Interview
Interviewees: Dr. Kofi Nyarko, Benjamin Hall
Date: March 19, 2013
Station: WEAA 88.9 FM
Location: Baltimore, MD

Patents/Copyrights (List names)

Applications: Copyright application for iLEAPS submitted to MSU's technology transfer office

Awarded: None

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Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

Students have undergone hands on training for various web and mobile application technologies while continuously developing the various components of the iLEAPS system through the use of the Software Development Lifecycle. All three interfaces of the project (user, officers, and dispatch) have been developed and demonstrated. Three beta testing sessions were planned, of which two have been fully executed. The first session involved 10 students from the School of Engineering. The second sessions involved 10 pre-freshmen students and 10 undergraduate students across several disciplines. The last session, which is planned for the end of July, will involve the campus security (including the Deputy Chief of Police) as well as faculty members from several schools.

Impact or success story associated with project

After the radio interview conducted in March, several MSU students, faculty and individuals from the community expressed an interest in following the development of this project and even volunteered to participate in the project. The university Site Miner for the Maryland Innovation Commercialization Program has indicated that the project would be a good candidate for commercial transition.

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.

- Survey Instruments for beta tests
- Radio interview

Navajo Technical College

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Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Navajo Technical College

PI and/or Co-PI: Alice Carron, Mark Trebian

Project Name: Navajo Nation Graffiti Project

Academic Disciplines: Social Sciences: Area Studies, Cultural & Ethnic Studies, Geography

Formal Science: Computer Science, Logic, Math, Systems

Keywords associated with project: Navajo Nation, graffiti, reservation, American Indian, crime

Theme for Research Projects (Check all that apply)

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

	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
x	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
	Professional Education and In-Service Programs
	N/A

VACCINE Annual Report – Year 4

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)
Winston Cambridge, Navajo Technical College, Computer Science
Aaron Huber, Navajo Technical College, Computer Science
Dustin Perry, Navajo Technical College, Computer Science
Myron Peters, Navajo Technical College, Computer Science
Antawane Temple, Navajo Technical College, Computer Science

Undergraduate supported students (need number only)	5
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	0

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

VACCINE Annual Report – Year 4

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

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 Navajo Nation encompasses an extremely widespread, rural and isolated area being the largest land area assigned primarily to a Native American jurisdiction covering 27,425 square miles across Arizona, Utah, and New Mexico. As of July, 2011 there were 300,048, enrolled members. Our overarching goal is to develop mechanisms that will provide Navajo law enforcement appropriate systems that will enable them to respond in a timely fashion to instances of gang-related activities. The tracking of graffiti can assist local law enforcement in identifying movement and migration trends of gang members. However caution needs to be exercised in evaluating trends due to the low volume of population data that is spread over a region larger than the state of West Virginia. Our accompanying goals are to establish and maintain a sustainable relationship between the Navajo Nation Law Enforcement Gang Unit (and other Navajo Units as appropriate) and local community stakeholders so that the services and techniques developed under this grant can be sustained beyond the grant period. We also hope to increase the number of Native Americans who pursue and excel in advanced courses and careers in STEM (science, technology, engineering, and mathematics) subjects.

VACCINE Annual Report – Year 4

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
	Data Mining
	Expert Consultation
X	Field Monitors
X	Survey
	Other:

Analytic Methods

	Case Studies
	Modeling
X	Sampling
	Statistical Analysis
	Other:

Nature of Research

X	Applied
	Basic
	Consultation
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below) N/A

VACCINE Annual Report – Year 4

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

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

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

Pending related Grants include a RUS Grant and a TAACT Grant.

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

We have had several meetings with, and are developing relationships with RAVE Alert System (for communication and notification); Community Safe Environment Consortium; Internet to the Hogan (communication system to reach out to communities); Crownpoint Wellness Center, and the G4S Campus Security Reporting Portal . Additionally, we are developing the NTC Radio Station as a means to enhance communications.

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.

I am not yet at liberty to provide these, we did state in our proposal that there are Sovereignty and privacy issues associated with working on the reservation, however after our Aug. 20 meeting I will be better able to provide these.

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.

See Summary of Outcomes

Project Period (only complete if different than 4/1/12-6/30-13)

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VACCINE Annual Report – Year 4

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

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: N/A

Accepted:

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

Internal Reports from 5/2; 5/29, and 7/29.

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.

N/A

Patents/Copyrights (List names)

Applications:

Awarded:

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SUMMARY OF OUTCOMES and IMPACT OF PROJECT: On a National Scale, although it is not directly related to this Grant, on April 2 Secretary of Homeland Security Janet Napolitano announced that Navajo Tech. was selected to participate in DHS Campus resilience (CR) Pilot Program with 6 other colleges and universities. We are now actively engaged with HS, and through this opportunity we are developing a "CaRES" (Campus Resilience Enhancement System). On a local scale, we have identified many of the strengths and challenges that local law enforcement and their collaborating partners face with regard to utilizing the systems that are being developed to track crime with VACCINE support. Within our communities we have developed the Community Safe Environment Consortium that is developing protocols for addressing emergency situations within the close-knit reservation community while eliminating the social negativity associated with tracking local criminal activity. The Navajo Nation is a multi-cultural, bi-lingual environment and some of the graffiti that we observed seems to be traceable gang symbols being imported from the cities (such as Phoenix and California) and some seems to be self-expressions of local community members. Further investigation is warranted to determine which graffiti is associated with criminal activity and which is artistic expression. More time is needed to continue this investigation.

Impact or success story associated with project

Several of the Navajo students had a personal history with gang activity. They took on the project with the hope that it would have a positive impact on deterring the gang-related activity that directly influences their families. Their communities are struggling with outside influences coming from gangs from other parts of the country. They felt this project would give them one more tool in the war on gang activities encroaching on the reservation. Motivated by this project students worked diligently to collect as many images as they could. Now there is a pilot database of gang symbols that law enforcement can make use of in the future.

Issues Encountered, if applicable: intellectual property, data sensitivity, publication of high risk/sensitive/proprietary findings, institutional collaboration and relationships, etc. Areas identified to be mapped covered a larger land mass than originally anticipated. A major problem encountered was the apparent fragility of the phones. All the phones have cracked screens but are still functional. In the future, it is recommended to purchase protective covers along with the purchase of any phones. Another recommendation is to add the capability to choose a GPS coordinate/point from which the range of selections can be applied. Currently, the only way to view images that are outside the maximum range is to choose all images. This can be problematic if there are a large number of images because they all have to be downloaded to the phone in order to view an area of interest. Two of our principal concerns as stated in our proposal- confidentiality within a Sovereign Nation- and dead zones that extend across the reservation are continuing to be addressed.

Pennsylvania State University

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VACCINE Annual Report – Year 4

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Penn State

PI and/or Co-PI: Alan M. MacEachren (PI)

Project Name: Wrap up on MDRP 3: Situational Surveillance & In-Field Criminal Investigative Analytics: Geovisual Analytics Methods and CrimeViz Transition

Academic Disciplines: Geography, Information Science and Technology

Keywords associated with project: Geospatial Information, Crime Data Analytics, Work Domain Analysis

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
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
x	N/A

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VACCINE Annual Report – Year 4

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

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

Alexander Savelyev, Penn State, Geography
Sujatha Gollapalli, Penn State, Information Sciences & Technology
Ryan Mullins, Penn State, Geography

Undergraduate supported students (need number only)	
O**ther Graduate Students** (non-supported) involved in project (need number only)	1
Other Undergraduate Students (non-supported) involved in project (need number only)	1

Student Thesis in 2013 (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 research focused on developing an understanding of the multiple roles of maps and map-enabled software applications in support of law enforcement and on using that understanding to develop web-based interactive mapping tools to support law enforcement applications of crime incident maps. Over the course of the project, through a work domain analysis process (that included interviews, observational studies, and task-based experiments with law enforcement personnel), a comprehensive understanding of crime mapping and its application for law enforcement was developed. In addition, challenges faced by (often underfunded) law enforcement agencies at the local level were identified. This knowledge provided a base for developing CrimeViz, a free, web-based interactive mapping tool and demonstrating its potential with data provided (3 times per day) by the Harrisburg Bureau of Police. During the current period of performance, reports on the work domain analysis were developed to distribute findings widely and a portion of the CrimeViz web-mapping technology was translated from an Adobe Flex application to JavaScript software components that can be more broadly used.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
	Data Mining
x	Expert Consultation
x	Field Monitors
x	Survey
x	Other: Task analysis (law enforcement professionals completing tasks with prototype software)

Analytic Methods

	Case Studies
	Modeling
	Sampling
x	Statistical Analysis
x	Other: coding of interviews

Nature of Research

	Applied
	Basic
	Consultation
	Coordination/Integration
	Education
x	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

GeoViz.JS: A pair of open source JavaScript software components that provide a starting point for redeveloping the key capabilities of CrimeViz in JavaScript. The components consist of a basic map and basic histogram. For each, and API reference, code, and a working example are provided.

http://www.geovista.psu.edu/resources/GeoVizCoordinator/GeoVizJS.201305.dist.zip

In addition, one component of the CrimeViz software -- a time wheel query tool -- was generalized for broad use and demonstrated in our SensePlace 2 text analytics software. The component supports time queries for times of the day, days of the week, months of the year, etc. Example queries it enables are: what is the frequency of event type X for every Friday night during the academic year; what is the frequency of event type X during the night shift for the past 8 weeks (with X being any entity coded in the database).

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

In collaboration with the Harrisburg Bureau of Police, we successfully implemented CrimeViz to provide access to crime incident data from their database, updated three times per day. We carried out a training activity with Harrisburg and they were very positive about the product and its potential.

A small amount of VACCINE transition funding allowed the system to remain operational for an uncertain period (subject to changes in underlying operating system or other software, which no resources are available to address). No resources were available to adopt the Harrisburg Bureau of Police suggestions on extending the tool, thus the application has not become part of day to day activities.

The plan to re-develop CrimeViz using JavaScript has the potential to make the methods and tools developed more widely useful. At present, available funds supported only a proof of concept set of partial tools in the form of GeoVis.js (described above).

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.)

Harrisburg Bureau of Police – 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).

In addition to making the original CrimeViz software available to VACCINE researchers at Purdue prior to last year's report, the GeoViz.JS software API for building a map and a histogram in JavaScript have been made available with an open source license and can be downloaded from the URL listed above.

Project Period (only complete if different than 4/1/12-6/30-13)

This report covers work done using a small amount of funds carried over from the previous year plus transition funds budgeted for the 11/15/2012-6/30/2012 time period (the latter was the time frame represented by Year 4 funds).

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If any item does not apply to your project, please indicate "NA" under the heading.

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:

- Murdock, M.J., Maziekas, N.V. and Roth, R.E. 2012: The Basic Ordnance Observational Management System: Geovisual exploration and analysis of improvised explosive device incidents. *Journal of Maps* 8, 120-124.
- Roth, R.E., Ross, K.S., Finch, B.G., Luo, W. and MacEachren, A.M. 2013: Spatiotemporal Crime Analysis in U.S. Law Enforcement Agencies: Current Practices and Unmet Needs. *Government Information Quarterly* 30, 226-240.

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.

- Roth, R.E. and MacEachren, A.M. (2013) Design and Use Guidelines for Interactive Maps: A Case Study, The 109th Annual Meeting of the Association of American Geographers. Los Angeles: April 9-13, 2013
- Roth, R.E. (2013) The New Cartography: Current states of science & technology in interactive cartography & geovisualization, Workshop on Advances in Geospatial Technologies and National/Homeland Security Implications, Argonne National laboratory, May 21-22, 2013.

Patents/Copyrights (List names)

NA

Summary of Outcomes and Impact of Project

The research produced a detailed analysis of the current role of interactive maps in law enforcement and insights on impediments to making use of the latest advances in technology. It also generated evidence about the relative success of different representation and interface strategies. Implementation of the CrimeViz software in collaboration with the Harrisburg Bureau of Police provided a real-world proof of concept for the web-based interactive query and mapping methods developed. Parts of the results have been translated into general web-based software components that can take advantage of a strategy for multi-component coordination in JavaScript developed with separate funding (from the US Army Corps of Engineers).

Impact or success story associated with project

Working with the Harrisburg Bureau of Police resulted in a web-mapping tool that fit their needs plus general guidelines for design of map-based crime analytics tools that are relevant to multiple VACCINE and other efforts in this domain.

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.

In relation to the CrimeViz Transition proposal, the task of converting all of CrimeViz into JavaScript proved to be more difficult than originally planned, thus the end product is a partial set of component tools that are useable by others.

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

available here: http://www.geovista.psu.edu/resources/GeoVizCoordinator/GeoVizJS.201305.dist.zip

- GeoVizJS_MapComponent.pdf: the API Reference for the JavaScript Map Component
- GeoVizJS_HistogramComponent.pdf: the API Reference for the JavaScript Histogram Component
- GeoVizJS.201305.dist.zip: contains the above, plus working examples and all software code

VACCINE Annual Report – Year 4

Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Penn State University

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

Project Name: E2E: GeoTxt API

Academic Disciplines: Geography, Information Science and Technology, Computer Science

Keywords associated with project: Geoparsing, Information Extraction, Web Services, Geospatial Information, Social Media and Emergency Management,

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
X	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
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
x	N/A

VACCINE Annual Report – Year 4

Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and dept) – *includes that on matching funds*
Sujatha Das Gollapalli, Penn State, Computer Science and Engineering
Wenyi Huang, Penn State, Information Sciences and Technology
Morteza Karimzadeh, Penn State, Geography
Siddhartha Banerjee, Penn State, Information Sciences and Technology

Undergraduate supported students (need number only)	
O**ther Graduate Students** (non-supported) involved in project (need number only)	
Other Undergraduate Students (non-supported) involved in project (need number only)	1

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

- Anuj Rattan Jaiswal, On statistical schema matching with embedded value mappings, The Pennsylvania State University, College of Information Sciences and Engineering, Ph.D. in IST, June 7, 2012.
- Sujatha Das Gollapalli, Semi-supervised approaches for Identifying and Annotating Researcher Homepages. The Pennsylvania State University, Department of Computer Science, and Enginnering, Ph.D., August 31, 2013.

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).**

GeoTxt detects mentions of location names in text, and assigns geographic coordinates to those location names. GeoTxt as a project concerns itself both with the research aspects of the problem (named entity recognition) and the practical aspects of delivering a working system. The research aspects have focused on how to perform more accurate and efficient identification of geographic locations in text produced by microblogging platforms such as Twitter. We are pursuing various means of using context (geographic and personal, for example) to improve our accuracy. We have created a gold standard dataset that we are currently using to evaluate the accuracy of different strategies. We have explored ensemble strategies that involve combining the results of multiple taggers to improve the tagging accuracy.

We have pursued a state-less service behind a REST-ful API to make our service scalable. A state-less service can easily be scaled by adding more instances of the service, and then routing requests to those additional instances. A REST-ful API is one which uses the basic HTTP verbs to communicate, rather than exposing any internals of the service. We developed programming abstractions to help us include context in our processing, while keeping a clean and extensible implementation. As a proof of concept, SensePlace 2 (our microblog analytics application) will adopt the GeoTxt API to replace its current custom geoparsing tools.

VACCINE Annual Report – Year 4

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

X	Compiling & Sorting DB
X	Data Mining
	Expert Consultation
	Field Monitors
X	Survey
	Other:

Analytic Methods

	Case Studies
	Modeling
	Sampling
X	Statistical Analysis
	Other:

Nature of Research

	Applied
	Basic
	Consultation
	Coordination/Integration
	Education
X	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

E2E: GeoTxt: The GeoTxt graphical interface is accessible at http://GeoTxt.org. The application programming interface (API) is accessible at http://geotxt.org/api/.

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

The GeoTxt web client interface is openly available for use at the URL above. The web services API is available for testing by any VACCINE partner organization. During the next phase of research and development, web services access will be extended to additional DHS-affiliated organizations and options for transition will be explored.

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)

We have begun discussions with Ed Hovy at Carnegie Mellon (who is affiliated with CCICADA) on research to enhance the potential for locating microblog posts geography in situations for which explicit geolocation is not provided and explicit place references are not used in the text.

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.

N/A

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.

We collaborated with Junghood Chae of the Purdue VACCINE. He evaluated the service and Purdue is preparing to use it.

Project Period (only complete if different than 4/1/12-6/30-13)

The project has had two increments that span the period of: 11/15/2012-6/30/2013

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If any item does not apply to your project, please indicate "NA" under the heading.

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.

none yet

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.

- Frank Hardisty, Visualizing Spatial, Temporal, and Social Graph Phenomena with the GeoViz Toolkit, May 23rd 2013, FOSS4G-NA, Minneapolis, MN.
- Morteza Karimzadeh, GeoTxt: Current Status, Progress Report, Future Directions, June 6, 2013, PSU Site Visit by US Army Corps of Engineers, GeoVISTA Center, Penn State.

Patents/Copyrights (List names)
NA

Summary of Outcomes and Impact of Project

The E2E GeoTxt component of the research has generated a generic web service that geo-codes locations in text. The interface is such that any application can access the service over the web and obtain geo-codes by inputting the text. Even in the case of social media text that is terse, we show that the service works with reasonably high accuracies. One of our other applications, SensePlace 2 will leverage the GeoTxt API as a proof of concept use of GeoTxt for geographic entity recognition and geolocation from text in microblogs.

Impact or success story associated with project

E2E GeoTxt: Generic web-client for geocoding made available online and web API provided to partners.

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.

The research has proceeded as planned.

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

NA

VACCINE Annual Report – Year 4

Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Penn State

PI and/or Co-PI: Alan M. MacEachren (PI), Anthony Robinson (CoPI)

Project Name: Symbology Standardization Support

Academic Disciplines: Geography, Information Science and Technology

Keywords associated with project: Geospatial Information, Cartography, Work Domain Analysis, Emergency Management, Map Symbology

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.)
x	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
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
x	N/A

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Please complete **ALL** fields.
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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)
Jennifer Smith, Penn State, Geography
Joshua Stevens, Penn State, Geography
Raechel Bianchetti, Penn State, Geography
Eun-Kyeong Kim, Penn State, Geography
Ryan, Mullins, Penn State, Geography
Peter Koby, Penn State, Geography

Undergraduate supported students (need number only)	
O**ther Graduate Students** (non-supported) involved in project (need number only)	1
Other Undergraduate Students (non-supported) involved in project (need number only)	1

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)
Elaine Guidero, Representing ordinal change in dynamic point symbols for emergency management applications (MS Paper), Penn State U, Geography, MS, Summer, 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).**

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, Symbol Store allows users to contribute the symbols they use and to tag them with metadata and categories to support natural language searches through the Symbol Store interface to retrieve symbols that are relevant to specific crisis situations. In this project period, the Symbol Store was improved by adding new upload/download options as well as tools for reviewing and refining user-contributed symbol sets.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

x	Compiling & Sorting DB
	Data Mining
x	Expert Consultation
	Field Monitors
x	Survey
x	Other: e-Delphi

Analytic Methods

x	Case Studies
	Modeling
	Sampling
	Statistical Analysis
x	Other: coding and summarization of e-Delphi input

Nature of Research

	Applied
	Basic
	Consultation
x	Coordination/Integration
	Education
x	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

- SymbolStore.org, a public-facing version of our Symbol Store tool, was made available to the public during the reporting period. It can be accessed at www.symbolstore.org.
- Changes to the Symbol Store to improve its interface, provide new upload/download options, and deliver a symbol set refinement capability were added to the tool set.
- Changes to the Symbol Store web service and database to allow users to access symbols directly through the Symbol Store API.
- Symbol Reviewer, a complement to SymbolStore that supports contribution of new map symbols by authorized personnel, structured assessment of symbol sets, and submission of validated map symbols to Symbol Store for wide distribution.

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

The Symbol Store and Symbol Reviewer are currently in transition to the U.S. Federal Government GeoPlatform system. This transition effort will be conducted in cooperation with GeoPlatform personnel and personnel at DHS. (*www.**geoplatform**.gov*). GeoPlatform is managed by the Federal Geographic Data Committee (FGDC), which has representation from all federal agencies that produce or leverage geospatial data, including DHS. As stated on the web site, "The Geospatial Platform provides shared and trusted geospatial data, services, and applications for use by government agencies, their partners and the public." The Symbol Store application serves as a repository and distribution site for map symbology and the Symbol Reviewer provides support for contributing map symbols to the repository, for evaluating those symbols using methods developed and refined in our earlier work with multiple DHS agencies, and then for validating and committing approved symbols to the Symbol Store.

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

In-kind contributions of time from the GeoPlatform.gov team

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

DHS Science and Technology (Honore Nyuyse and Jon Dale)

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

In earlier work, we worked with personnel at IICD, CBP, and FEMA to assess map symbols in use at these agencies. Their validated map symbols will be distributed through the Symbol Store. End users who participated include:

Customs and Border Protection: Scott Crozier, SCOTT.CROZIER@cbp.dhs.gov *Department of Homeland Security* Desta O'Connor, Desta.O'Connor@hq.dhs.gov Ponish, Howard Howard.Ponish@associates.hq.dhs.gov White, Gregory Gregory.White@hq.dhs.gov Borkowski, Joshua Joshua.Borkowski@hq.dhs.gov Carolyn Jeter, Carolyn.Jeter@oig.dhs.gov Witcoski, Jonathan Jonathan.Witcoski@associates.hq.dhs.gov Smith, Christopher Christopher.Smith2@hq.dhs.gov Marc Caplan, marc.caplan@dhs.gov Reisner, Paul paul.reisner@associates.hq.dhs.gov BetteJo Walker, BetteJo.Walker@oig.dhs.gov Nasiatka, Nicole Nicole.Nasiatka@oig.dhs.gov Maldonado, Gabriela Gabriela.Maldonado@associates.hq.dhs.gov	*Booz-Allen Hamilton:* Ross, Amanda ross_amanda@bah.com Barrett, Jeffrey barrett_jeffrey@bah.com Springsteen, Thomas springsteen_thomas@bah.com *National Geospatial Intelligence Agency*, Yvonne Tuttle, Yvonne.O.Tuttle@nga.mil *Food and Drug Administration*, Stephen Perrine Stephen.Perrine@fda.hhs.gov *National Oceanic and Atmospheric Administration*, Joshua Murphy joshua.murphy@noaa.gov

As noted above, GeoPlatform.gov represents end users across the federal government.

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 4/1/12-6/30-13)

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Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

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

Accepted:

- Bianchetti, R.A., Wallgrün, J.O., Yang, J., Blanford, J., Robinson, A.C. and Klippel, A. 2012: Free Classification of Canadian and American Emergency Management Map Symbol Standards. *Cartographic Journal, The* 49, 350-360.
- McClendon, S. and Robinson, A.C. 2012: Leveraging Geospatially-Oriented Social Media Communications in Disaster Response. *Information Systems for Crisis Response and Management (ISCRAM) conference,* Vancouver, BC.
- McClendon, S. and Robinson, A.C. 2013: Leveraging Geospatially-Oriented Social Media Communications in Disaster Response. *International Journal of Information Systems for Crisis Response and Management (IJISCRAM)* 5, 22-40.
- MacEachren, A.M., Roth, R.E., O'Brien, J., Li, B., Swingley, D. and Gahegan, M. 2012: Visual Semiotics & Uncertainty Visualization: An Empirical Study. *IEEE Trans. on Visualization & Computer Graphics* 18, 2496-2505.
- Robinson, A.C., Pezanowski, S., Troedson, S., Bianchetti, R., Blanford, J., Stevens, J., Guidero, E., Roth, R.E. and MacEachren, A.M. 2013: SymbolStore.org: A Web-based Platform for Sharing Map Symbols. *Cartography & Geographic Information Science* http://dx.doi.org/10.1080/15230406.2013.803833.
- Robinson, A.C., Roth, R.E., Blanford, J., Pezanowski, S. and MacEachren, A.M. 2012: Developing map symbol standards using a distributed, asynchronous process. *Environ. & Planning B: Planning and Design* 39, 1034-1048.
- Stevens JE, Robinson AC, MacEachren AM. (In Press) Designing Map Symbols for Mobile Devices: Challenges, Best Practices, and the Utilization of Skeuomorphism. In: Proceedings of the International Cartographic Conference. Proceedings of the International Cartographic Conference. Dresden, Germany.

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

- Task 2.3 Design and implement prototype map application for use in symbology assessment
- Project report to DHS S&T: Final Report: Symbology Standardization Support, Covering Performance Period: 4/2012 – 6/2013

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.

- Bianchetti, R.A., Roth, R.E., Blanford, J., Robinson, A., MacEachren, A. Defining the Typical Department of Homeland Security Map. North American Cartographic Information Society Annual Meeting, Portland, OR: October 15-17, 2012.
- Mullins R, Pezanowski S, Robinson AC, MacEachren AM (2013). The SymbolStore: A Social Forum for the Creation, Sharing, and Evaluation of Symbols. The 109th Annual Meeting of the Association of American Geographers. Los Angeles: April 9-13, 2013.
- Robinson, A., Pezanowski, S., Bianchetti, R.A., Guidero, E., Stevens, J., Blanford, J., MacEachren, A. Sharing Map Symbology for Emergency Management. GeoCart'2012, New Zealand, August 2012.
- Robinson AC, Pezanowski S, Bianchetti R, Stevens JE, Guidero E, Blanford J and MacEachren AM. SymbolStore.org–An Open Resource for Map Symbols North American Cartographic Information Society Annual Meeting, Portland, OR: October 15-17, 2012
- Stevens JE, Pezanowski S, Guidero E, Robinson AC and MacEachren AM. (2012) Map Symbol Design and Event Reporting for Mobile Devices: A Preview of a Mobile Application and Developer API Based on an Online Symbol Repository. North American Cartographic Information Society Annual Meeting, Portland, OR: Oct. 15-17, 2012.

Patents/Copyrights (List names): NA

Summary of Outcomes and Impact of Project

- Development of a revised Symbol Store, featuring a new interface design, improved symbol uploading workflow, new downloadable formats (SVG and PNG), and integration with Drupal to support iterative refinement of user-contributed symbol sets.
- Provision of these improvements in a public-facing Symbol Store, accessible at www.SymbolStore.org
- Presented the Symbol Store to DHS and other Federal Stakeholders in an in-person workshop and an online webcast to encourage adoption and solicit feedback.
- Developed a set of Map Symbols designed for mobile devices and a Mobile Mapping Experiment to assess those symbols.
- Publication of four journal articles, one conference paper, and six presentations.

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 map symbol use 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 took lessons learned from this in-depth work with DHS stakeholders to develop an interactive web-based tool called Symbol Store that allows users to contribute, search for, preview, and retrieve map symbols through an easy to use interface. The Symbol Store is the first end-to-end system designed based on the evaluated needs of DHS mapmakers and map users to make it easy to quickly find and re-use existing map symbols, as well as to contribute new symbols to share with a wider community. Until now, symbol discovery and sharing has been done primarily through ad hoc means. In 2012-2013, the project team developed a new and improved interface for the Symbol Store, and implemented new upload/download features to improve interoperability. Major progress was also made on integration of tools for symbol set refinement for user-contributed symbols. The Symbol Store is now in transition to the GovCloud to serve broader audiences of mapmakers.

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.

The original proposal had limited funds for transition beyond simple hand-off of software.

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

A detailed report on this research will be provided to Honore Nyuyse, S&T Project Officer for this effort; a copy will be provided to VACCINE once the report is approved.

VACCINE Annual Report – Year 4

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Penn State University

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

Project Name: MDRP 13: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness

Academic Disciplines: Geography, Information Science and Technology, Computer Science

Keywords associated with project: Geoparsing, Information Extraction, Web Services, Geospatial Information, Situational Awareness, Social Media and Emergency Management, spatio-temporal analytics

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
X	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
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
x	N/A

VACCINE Annual Report – Year 4

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and dept) – *includes that on matching funds*

Sujatha Das Gollapalli, Penn State, Computer Science and Engineering
Alexander Savelyev, Penn State, Geography
Ying Chen, Penn State, Computer Science and Engineering
Ishan Behoora, Penn State, Information Sciences and Technology
Eun-Kyeong Kim, Penn State, Geography

Undergraduate supported students (need number only)	
O**ther Graduate Students** (non-supported) involved in project (need number only)	2
Other Undergraduate Students (non-supported) involved in project (need number only)	

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

- Anuj Rattan Jaiswal, On statistical schema matching with embedded value mappings, The Pennsylvania State University, College of Information Sciences and Engineering, Ph.D. in IST, June 7, 2012.
- Sujatha Das Gollapalli, Semi-supervised approaches for Identifying and Annotating Researcher Homepages. The Pennsylvania State University, Department of Computer Science, and Enginnering, Ph.D., August 31, 2013.

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 has developed a web-based tool that can help emergency managers and analysts monitor open-source microblog data in real-time, with the emphasis on supporting situational awareness. The initial application focus of the prototype visual analytic system, SensePlace2, is in the domain of emergency management and disaster relief. SensePlace 2 processes a stream of tweets obtained from Twitter in response to about 200 keywords. The tweets are entity-extracted, geocoded, and stored in a back-end text index and spatial database to support fast place, time, and attribute queries. SensePlace 2 enables end-users to query the data using keywords, a timeline, a geospatial place hierarchy tool, and geospatial range queries directly on a map. Results appear in a map and in multiple linked views depicting attribute and time components of the information. During the last year, the research focused on multiple enhancements to SensePlace 2. These include: improving the accuracy with which place names are geolocated, building more efficient indexes to support fast query of the database that is now approximately one-half billion tweets, and (with complementary funding from the U.S. Army Corps of Engineers) re-engineered the web-client interface using a novel component-based structure and added several new linked views including a co-occurrence matrix. In addition, we have begun to leverage the database of tweets collected by SensePlace 2 plus a second database of 100 million geolocated tweets to investigate the potential of studying human spatio-temporal behavior through the representation of that behavior in microblog posts.

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Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

X	Compiling & Sorting DB
X	Data Mining
	Expert Consultation
	Field Monitors
X	Survey
	Other:

Analytic Methods

	Case Studies
	Modeling
	Sampling
X	Statistical Analysis
	Other:

Nature of Research

X	Applied
X	Basic
	Consultation
	Coordination/Integration
	Education
X	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

SensePlace 2, a web-based application to support information foraging and situational awareness based on space-time-attribute analysis of microblog data continues to evolve and we anticipate posting a public version that processes the most recent week of data (continually updated) in Aug. 2013.

Two videos have also been produced in the past year:

- SensePlace 2 video posted Oct. 2012:

  http://www.youtube.com/watch?v=fC7-yGwxhX4&list=PLC8DC0DA5F32D8331&index=2

- SensePlace 2 video published April, 2013 (created by NSF IGERT trainee who participated in the research):

  http://www.youtube.com/watch?v=YW7shbEUrXU

VACCINE Annual Report – Year 4

Please complete **ALL** fields.

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If any item does not apply to your project, please indicate "NA" under the heading.

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

none so far

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

For SensePlace 2 (the most recent development of the MDRP 13 effort), additional funding (in 3 phases thus far) has been provided by the US Army Corps of Engineers:

Phase 1: $120,642, PI MacEachren, 3/1/2011-5/31/2012
Phase 2: $90,529, PI MacEachren, 4/1/2012-6/30/2013
Phase 3: $58,565, PI MacEachren, 7/1/2013-10/31/2013

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

As noted elsewhere, the US Army Corps of Engineers is providing funding to develop advanced visualization tools for SensePlace 2 targeted at particular analytical tasks related to analysis focused on place, person, and social networks.

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.

N/A

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.

We have begun VACCINE-wide discussions on a coordinated approach to social media analytics. In addition to providing our GeoTxt API for team use in geoparsing text, we have begun to modularize client-aide components of SensePlace 2 so that these components can be shared with other Javascript-based web applications beyond our own.

Project Period (only complete if different than 4/1/12-6/30-13)

No new DHS funds were provided to the MDRP-13 effort in this project period. The "wrap up" reported here used approximately $37,000 in funds from the previous year carried forward into this time period along with a portion of the matching funds from Penn State.

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If any item does not apply to your project, please indicate "NA" under the heading.

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:

- Luo, W. and MacEachren, A.M. (in review) Geo-Social Visual Analytics. Journal of Spatial Information Science.

Accepted:

- Robinson, A.C., Savelyev, A., Pezanowski, S. and MacEachren, A.M. 2013: Understanding the Utility of Geospatial Information in Social Media. In 2013, M., Comes, T., Fiedrich, F., Fortier, S., Geldermann, J. and Yang, L., editors, *Proceedings of the 10th International ISCRAM Conference,* Baden-Baden, Germany: ISCRAM.
- Tomaszewski, B. and MacEachren, A.M. 2012: 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}* 11, 339-359.
- Designing a Web Service to Geo-Locate Subjects of Volunteered, Textual Geographic Information. (in press) Ryan Mullins, Frank Hardisty, Scott Pezanowski, Sujatha Das, Alexander Savelyev, Alan MacEachren, Prasenjit Mitra, Anuj Jaiswal, August 29th 2013, ICC, Dresden, Germany.

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.

- 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.
- Luo, W. (2012) Geo-Social Visual Analytics with Applications to Catastrophic Risk Management. Invited Speaker at the Global Catastrophic Risk Institute. October 25, 2012.
- MacEachren, Alan M. (2012) Geovisualization to Geovisual Analytics: Visual Reasoning with Big & Messy Data GI Forum, **Invited Keynote** at Salzburg, Austria, July 5, 2012.
- MacEachren, AM (2013) Visualizing Uncertainty and Decision-Making. **Invited** Speaker, Workshop on Uncertainty in Decision Making in a Changing Climate, University of Zurich, March 21, 2013.
- Frank Hardisty, Visualizing Spatial, Temporal, and Social Graph Phenomena with the GeoViz Toolkit, May 23rd 2013, FOSS4G-NA, Minneapolis, MN.

Patents/Copyrights (List names)
NA

Summary of Outcomes and Impact of Project

The conclusion of the MDRP-13 effort resulted in the SensePlace 2 web application that is continuing (currently with funding from the US Army Corps of Engineers). SensePlace 2 will leverage the GeoTxt API as a proof of concept use of GeoTxt for geographic entity recognition and geolocation from text in microblogs and new JavaScript coordination methods implemented in SensePlace 2 (supported by the USACE funding) have enabled demonstration of the utility of web software components derived from our CrimeViz application.

Impact or success story associated with project

SensePlace 2: Funding to focus on the visual interface and on specific user cases provided by the US Army Corps of Engineers.

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.

The research has proceeded as planned.

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

See video URLs above

Purdue

University

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VACCINE Annual Report – Year 4

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: Edward Delp

Project Name: Gang Graffiti Recognition and Analysis (GARI)

Academic Disciplines: Electrical and Computer Engineering

Keywords associated with project:

Theme for Research Projects (Check all that apply)

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

XX	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
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
	N/A

VACCINE Annual Report – Year 4

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If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

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

Albert Parra
Bin Zhao
Joonoo Kim

Undergraduate supported students (need number only)

1

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

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

Student Thesis in 2013 (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).**

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 the development of a mobile-based system capable of gang graffiti and gang tattoo image analysis. This system will provide an accurate and useful output to a user based on a database of gang graffiti tattoo images.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
XX	Data Mining
	Expert Consultation
	Field Monitors
	Survey
XX	Other: geotagged image collection

Analytic Methods

	Case Studies
XX	Modeling
	Sampling
XX	Statistical Analysis
	Other:

Nature of Research

XX	Applied
XX	Basic
	Consultation
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

There are versions of the GARI system that have been deployed by the Indiana Fusion Center and Cook County Sheriff Office. We have had inqurues from more than 20 law enforcement agencies in the US. Both an Android and iPhone version of the applications are available.

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If any item does not apply to your project, please indicate "NA" under the heading.

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

We have talk with several companies that are interested in transitioning the GARI system.

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.

This contact information for the law enforcement people can be obtained from Kaethe.

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 4/1/12-6/30-13)

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If any item does not apply to your project, please indicate "NA" under the heading.

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:

A. Parra, M. Boutin, and E. J. Delp, "Location-Aware Gang Graffiti Acquisition and Browsing on a Mobile Device", Proceedings of the IS&T/SPIE Electronic Imaging on Multimedia on Mobile Devices, San Francisco, CA, January 2012

A. W. Haddad, S. Huang, M. Boutin, E. J. Delp, "Detection of Symmetric Shapes on a Mobile Device with Applications to Automatic Sign Interpretation", Proceedings of the IS&T/SPIE Electronic Imaging on Multimedia on Mobile Devices, San Francisco, CA, USA, January 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.

Gang Graffiti Automatic Recognition and Interpretation (GARI)

Automatic Recognition and Interpretation of Gang Graffiti (GARI)

Patents/Copyrights (List names)

Applications:

Awarded:

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VACCINE Annual Report – Year 4

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If any item does not apply to your project, please indicate "NA" under the heading.

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.

VACCINE Annual Report – Year 4

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This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: Edward Delp

Project Name: Mobile Emergency Response GuidE (MERGE)

Academic Disciplines: Electrical and Computer Engineering

Keywords associated with project:

Theme for Research Projects (Check all that apply)

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

XX	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
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
	N/A

VACCINE Annual Report – Year 4

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

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

Albert Parra
Bin Zhao
Joonoo Kim

Undergraduate supported students (need number only)

1

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 2013 (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).**

Hazardous materials can cause serious accidents, emergency situations and therefore can make them dangerous to society and the environment. A federal law in the US requires vehicles transporting hazardous materials to be marked with a standard sign (hazmat sign) identifying the type of hazardous material the vehicle is carrying. Hazmat signs help identify the material and determine what special equipment, procedures and precautions should be taken in the event of an emergency. This information is contained in the Emergency Response Guidebook (ERG) published by the US Department of Transportation (DOT).

The MERGE system is an integrated mobile-based system that makes use of location-based services and image analysis methods to automatically interpret the hazmat sign and quickly provide guide information to users. The MERGE mobile application is capable of detecting hazmat signs from an image and querying an internal database to provide accurate information to first responders in real time. MERGE has an easy to understand user interface to instruct emergency responders or civilian in the proper way to handle a hazardous material emergency.

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VACCINE Annual Report – Year 4

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
XX	Data Mining
	Expert Consultation
	Field Monitors
	Survey
XX	Other: geotagged image collection

Analytic Methods

	Case Studies
XX	Modeling
	Sampling
XX	Statistical Analysis
	Other:

Nature of Research

XX	Applied
XX	Basic
	Consultation
	Coordination/Integration
	Education
	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

There are versions of the MERGE system that have been deployed by the TSA and local fire departments. Both an Android and iPhone version of the application are available.

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

We have talk with several companies that are interested in transitioning the MERGE system.

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

VACCINE Annual Report – Year 4

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

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.

This contact information for the TSA people can be obtained from Kaethe.

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 4/1/12-6/30-13)

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VACCINE Annual Report – Year 4

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

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:

A. Parra, B. Zhao, E. J. Delp, "Hazardous Material Sign Detection and Recognition," Proceedings of the IEEE International Conference on Image Processing (ICIP 2013), Melbourne, Australia, September 2013

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.

Gang Graffiti Automatic Recognition and Interpretation (GARI)

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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

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VACCINE Annual Report – Year 4

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: Niklas Elmqvist

Project Name: VASA – Visual Analytics for Security Applications

Academic Disciplines: Advanced Data Analysis and Visualization

Keywords associated with project: visual analytics, critical infrastructure, simulation, weather, food distribution, food protection

Theme for Research Projects (Check all that apply)

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

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

VACCINE Annual Report – Year 4

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

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

None.

Undergraduate supported students (need number only)	0
O**ther Graduate Students** (non-supported) involved in project (need number only)	0
Other Undergraduate Students (non-supported) involved in project (need number only)	0

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)

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).**

The VASA project is concerned with applying visual analytics to critical infrastructure management including aspects such as security, weather, emergencies and their impact on food distribution and safety, critical infrastructure, and public safety. The idea is to couple interactive visual representations with online discrete simulation of event sequences, both natural and manmade, and study their impact on other simulations for food distribution, transportation, power management, and similar. While VASA is a large project with many investigators and partners, Co-PI Elmqvist's role in the project is the development of a common spatiotemporal visual analytics tool that binds together multiple data sources and simulation models to provide a decisionmaking platform for stakeholders in critical infrastructure management.

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Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
X	Data Mining
X	Expert Consultation
	Field Monitors
	Survey
	Other:

Analytic Methods

X	Case Studies
X	Modeling
	Sampling
X	Statistical Analysis
	Other:

Nature of Research

X	Applied
	Basic
	Consultation
	Coordination/Integration
	Education
X	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

The current objective for deliverables in the VASA project is a prototype of the visual analytics tool, to be delivered in Fall 2013, as well as presentation materials and example runs for the tool.

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

No current technology transitions.

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)

David Ebert (Purdue University), Shaun Kennedy (University of Minnesota), Bill Ribarsky (UNC Charlotte), Tom Ertl (University of Stuttgart, Germany), Daniel Keim (University of Konstanz, Germany)

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.

Name and contact information of end-users not known.

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.

NCFPD (Shaun Kennedy) for food distribution simulation models used in the visual analytics tool.

Project Period (only complete if different than 4/1/12-6/30-13)

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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)

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.

None.

Patents/Copyrights (List names)

Applications: N/A

Awarded: N/A

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Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

Summary of Outcomes and Impact of Project

Project PI (David Ebert) has a more complete overview of the outcomes and impact of the entire VASA project. From my perspective, the outcome of the project is to integrate a large number of heterogeneous simulation and data sources into a coherent and comprehensive decision-making tools that leverages visual representations and analytics methods to allow stakeholders to explore different scenarios and ask hypothetical questions about critical infrastructure management. The impact of such a tool would be potentially far-reaching: it could point to a common methodology for integrating multiple simulation models into a comprehensive platform that many other agencies might find useful.

Impact or success story associated with project

The German side of this project has already deployed and demonstrated their work to stakeholders in the German authorities. Their demonstration was very effective and well-received.

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.

None.

VACCINE Annual Report – Year 4

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Purdue University

PI and/or Co-PI: Niklas Elmqvist

Project Name: 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.

	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
X	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
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
X	N/A

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If any item does not apply to your project, please indicate "NA" under the heading.

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
O**ther 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 2013 (include name, thesis title, university, department, degree, date)

- Sohaib Ghani (Ph.D. 2013), *Advanced Visualization, Navigation, and Interaction in Graphs: Theory, Design, and Evaluation*, School of Electrical and Computer Engineering, Purdue University, June 2013.

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.

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

X	Compiling & Sorting DB
X	Data Mining
	Expert Consultation
X	Field Monitors
	Survey
	Other:

Analytic Methods

X	Case Studies
	Modeling
	Sampling
X	Statistical Analysis
	Other:

Nature of Research

	Applied
	Basic
	Consultation
	Coordination/Integration
	Education
X	Hybrid Basic—Applied
	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 (no public website)

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

The above deliverables have already been made available online 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.

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 was an active collaboration between VACCINE (Purdue University, Georgia Tech, and SFU) and VACCINE (USC). The areas of responsibility were 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. During the course of the project, this division of labor was very successful, largely thanks to a well-defined interface between the two centers.

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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 *Information Visualization* (Summer 2013).

Accepted:

S. Ghani, B. Kwon, S. Lee, J. S. Yi, N. Elmqvist. Visual Analytics for Multimodal Social Network Analysis: A Design Study with Social Scientists. *IEEE Transactions on Visualization and Computer Graphics* (IEEE SciVis/InfoVis/VAST 2013 proceedings), to appear, 2013. [32/125, 26% acc. rate]

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.

S. Ghani. Perception of Animated Node-Link Diagrams for Dynamic Graphs. IEEE EuroVis 2012, June 7, Vienna, Austria.

S. Ghani. MultiNode-Explorer: A Visual Analytics Framework for Generating Web-based Multimodal Graph Visualizations. IEEE EuroVA 2012, June 5, Vienna, Austria.

Patents/Copyrights (List names)

Applications: N/A

Awarded: N/A

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Summary of Outcomes and Impact of Project

The COE Explorer project was not only 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 capabilties, 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.

No changes. The project is currently mostly inactive (all deliverables ready, student has graduated).

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

None.

Simon Fraser University, CA

SIMON FRASER UNIVERSITY

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Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: Simon Fraser University

PI and/or Co-PI: Brian Fisher

Project Name: MDRP06

Academic Disciplines: Cognitive Science, Computer Science, Social Science

Keywords associated with project: Cognitive Science, Interaction Design

Theme for Research Projects (Check all that apply)

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

	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)
x	Enterprise Resiliency Environments
	Event Evacuations
	Visual Analytics for Security Applications
x	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
	Undergraduate and Graduate Education Program
	Professional Education and In-Service Programs
	N/A

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Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

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

Undergraduate supported students (need number only)	
O**ther Graduate Students** (non-supported) involved in project (need number only)	6
Other Undergraduate Students (non-supported) involved in project (need number only)	

Student Thesis in 2013 (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).**

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. Funding for this work comes from Canadian sources (NSERC, PSTP).

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If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

	Compiling & Sorting DB
	Data Mining
x	Expert Consultation
x	Field Monitors
	Survey
x	Other: pair analytic" planning sessions in our "shadow EoC" lab using real data and systems

Analytic Methods

x	Case Studies
	Modeling
x	Sampling
x	Statistical Analysis
	Other:

Nature of Research

x	Applied
	Basic
x	Consultation
x	Coordination/Integration
	Education
	Hybrid Basic—Applied
x	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. 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)

We have confirmation of a sole-source contract from the Canadian Centre for Security Science for transition of our technology to application.

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 3 of 3. work with Canadian EOCs, tech companies, and PSTP officals 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 2 of 3 to evelop analytic tools for exploring, visualizing, and examining sensor network data (e.g. for tracking the evacuations of personnel) Pourang Irani PI (Fisher Co-i)

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.

Co-investigator with Edward Delp and David KIrsh on seed project.

Project Period (only complete if different than 4/1/12-6/30-13)

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Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

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:

Arias-Hernández, R. , Green, T.M., Fisher,B. (2012) 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). (paper attached)

Al-Hajj, S. I. Pike and B. Fisher "Visual Analytics to Support Medical Decision Making Process". Short communication, XXIV Conference of the European Federation for Medical Information: Quality of life through Quality of Information. Pisa, ITALY (2012). (paper attached)

Kaastra, L.T., Arias-Hernandez, R., Fisher, B. (2012) Evaluating Analytic Performance. BELIV 2012: Beyond Time and Errors - Novel Evaluation Methods for Visualization. Visweek 2012, Seattle WA

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.

Fisher, B (2012) Visual Analytics as a Cognitive Science. Dagstuhl Seminar No. 12081 on Information Visualization, Visual Data Mining and Machine Learning.

Fisher, B (2012) Opportunities in Data Visualization and Visual Analytics for Behavioral and Social Science Research. National Institutes of Health (NIH) Office of Behavioral and Social Science Research (OBSSR), National Cancer Institute, and National Institute of Drug Abuse. Bethesda, MD. (video online at http://videocast.nih.gov/summary.asp?Live=10949)

Patents/Copyrights (List names)

Applications:

Awarded:

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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 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 approval for new financial support from PSTP for our collaboration with the City of Richmond and City of Vancouver and have added the city of Delta as a third municipality. This will fund both our group and end-users 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.

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University of California – San Diego

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Institution: UCSD

PI and/or Co-PI: Prof David Kirsh, Prof Edward Delp

Project Name: Combining Crowdsourcing technology with machine learning to do visual analytics on big qualitative data (video datasets).

Academic Disciplines: Cognitive Science, Computer Science Engineering

Keywords associated with project: video analytics, crowd sourcing, video annotation,

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

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Students Supported on Project

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

Daniel Frysinger, UCSD, Cognitive Science
Khalid Tahboub , Purdue, Computer Science
Neeraj Gadgil, Purdue, Computer Science

Undergraduate supported students (need number only)

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

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

4

Student Thesis in 2013 (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).**

Our goal is to test and develop a system that will allow us to evaluate how well crowdsourcing and machine learning can be used to increase the accuracy and lower the cost of detecting suspicious and illegal acts in police surveillance camera feeds. Our system must scale up to thousands of cameras and also help track suspects across multiple cameras. We are building a web based crowd sourcing system that efficiently sends video to hundreds of users, making it easy for them to identify possible incidents, such as vandalism, sexual offences, drug related actions, theft, assault, abnormal social behavior in crowds, and many others. Our scientific objectives are 1) to determine the viability of using crowds instead of experts to identify incidents quickly and accurately, 2) to determine how effectively machine learning can be used to reduce the amount of crowd power needed for successful incident discovery, and 3) to analyze mixed systems of crowdsourcing and machine learning to determine optimal divisions of labor, assigning to humans the jobs that they do comparatively better than machines, and vice versa for machines. If we are successful we should be able to identify illegal and suspicious acts in real time, and at a small cost per video camera hour. If turkers are trained further they could look for suspects or for suspicious actions specially defined (such as leaving a paper bag or other container in a crowded place, exchanging defined items etc). Visualizations that help track complicated events from camera to camera will also be developed.

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Technical Approach (Check all that apply)

Data Collection Methods

X	Compiling & Sorting DB
X	Data Mining
X	Expert Consultation
	Field Monitors
	Survey
	Other:

Analytic Methods

X	Case Studies
	Modeling
X	Sampling
X	Statistical Analysis
	Other:

Nature of Research

	Applied
X	Basic
	Consultation
	Coordination/Integration
	Education
X	Hybrid Basic—Applied
	Hybrid Applied—Consultation

Deliverables (other than publications and reports listed below)

- Wireframes:
  - of crowd sourcing video management and delivery system
    - of turker workflow
    - of admin workflow
  - of Tagging and Training system
- Pilot System that shows a first prototype of the live system

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

N/A

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

NSF Grant IIS-1002736 PI David Kirsh, 8/1/10 – 7/31/13 $346,783

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

Prof Ed Delp, Purdue

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.

Purdue Police Department:

John Cox
Chief
Purdue University Police Department
jkcox@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.

We have been working with members of Prof Ed Delp's team, also supported by VACCINE, relying on their expertise in video streaming, real time transcoding and knowledge of system design to build our system. Two of Prof Delp's students are working as developers on this project.

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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: not yet

Accepted: not yet

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

Not yet

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:

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Summary of Outcomes and Impact of Project

We have no outcomes to report as we are in the system building stage of our pilot. But we

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.

We have altered our timeline by significantly advancing it, owing to the speed and intensity of the development team. We are currently engaged in real time 'play' trials and working on canned police video. To simulate the real time environment we need in order to address the problem of real time identification of illegal and suspicious action, we are creating a model capture system with 10 video cameras on poles that capture, then send video to a labeled database, and then on to the cloud. Using this system we will soon be able to test real time response of Turkers to simulations of suspicious behavior. This system might also be made into a portable system for setting up on *disaster response sites* to enable better surveillance at the Command Center to address the known problem of situation awareness. We are also adding tracking of suspects across multiple cameras and we are proposing using livescribe pens for police on the beat to identify their location without GPS by touching a map of their route and then noting what they want others to look at on the video feeds. The right camera feed is automatically found and then displayed in headquarters. This allows extending the view of the policeman on the beat to cameras beyond his own sight.

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University of North Carolina at Charlotte

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VACCINE Annual Report – Year 4

Please complete **ALL** fields.

This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Institution: University of North Carolina at Charlotte

PI and/or Co-PI: William Ribarsky, PI; Xiaoyu Wang, co-PI; William Tolone, 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, critical infrastructure, 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.

X	Public Safety Coalition Projects (state or local law enforcement, fire, emergency management, etc.)
X	Federal Operating Component Projects (TSA,FEMA, Secret Service, ICE, CBP, USCIS, Coast Guard)
X	Enterprise Resiliency Environments
X	Event Evacuations
X	Visual Analytics for Security Applications
X	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
	Undergraduate and Graduate Education Program
X	Professional Education and In-Service Programs
	N/A

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VACCINE Annual Report – Year 4

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

Students Supported on Project

Graduate Research Assistants (include name(s), university and department)
Todd Eaglin UNCC Computer Science
Thomas Kraft UNCC Computer Science

Undergraduate supported students (need number only)	2
O**ther Graduate Students** (non-supported) involved in project (need number only)	
Other Undergraduate Students (non-supported) involved in project (need number only)	

Student Thesis in 2013 (include name, thesis title, university, department, degree, date)
Todd Eaglin Mobile Situational Awareness for Emergency Response M.S. June, 2013

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:

- 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. In addition, methods have been developed to determine risk and possible fraud by looking for trends and events in multiple different types of data, including unstructured data,
- A system of systems model has been set up for investigating an urban electric smart grid infrastructure under duress from natural or man-made disasters. 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.

VACCINE Annual Report – Year 4

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This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**

If any item does not apply to your project, please indicate "NA" under the heading.

Technical Approach (Check all that apply)

Data Collection Methods

X	Compiling & Sorting DB
X	Data Mining
X	Expert Consultation
	Field Monitors
X	Survey
	Other:

Analytic Methods

X	Case Studies
X	Modeling
	Sampling
X	Statistical Analysis
X	Other: Time-dependent probabilistic event and topic modeling

Nature of Research

	Applied
	Basic
	Consultation
X	Coordination/Integration
	Education
X	Hybrid Basic—Applied
	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 for DHS exercises (e.g., CAUSE-ERE exercise team)
- Modeling system for time-dependent, cascading critical infrastructure outages at the front of large scale weather events (e.g., ensembles of hurricanes)
- Complete set of data for critical infrastructure in North Carolina and northern South Carolina (now supplied to VASA colleagues at Purdue and in Germany)
- A set of social media visual analytics tools to investigate the narrative arc of social movements by following relevant topics, events, and social networks.

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

A desktop version of the command interface for our mobile emergency response and evacuation system has been deployed to the UNC Charlotte Police Chief. With the system, the Chief can immediately see the distribution of people at any time in any building in campus and determine routes to get to any point in those buildings. This system gives the Chief constant situation awareness should an emergency occur. In addition, a similar system has been deployed to Provost's office to help determined optimal movement of students, faculty, and staff between buildings on campus.

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

Xiaoyu Wang and William Ribarsky, $150,000 Army Research Office, starting May 15, 2013

William Ribarsky, $46,000, NIH, September 1, 2012 to August 31, 2013

William Ribarsky and KR Subramanian, $60,000, UNC Charlotte emergency planning, July 1, 2012 to June 30, 2013

William Tolone, William Ribarsky, and Xiaoyu Wang, USSOCOM, $155,000, starting July 1, 2013

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

David Ebert, Purdue University, ebertd@ecn.purdue.edu

Daniel Keim, University of Konstanz, keim@uni-konstanz.de

Thomas Ertl, University of Stuttgart, Thomas.Ertl@vis.uni-stuttgart.de

Niklas Elmqvist, Purdue University, elm@purdue.edu

Shaun Kennedy, University of Minnesota, Shaun.Kennedy@ncfpd.umn.edu

Ted Thomas, Duke Energy, Ted.Thomas@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.

Chief Jeffrey Baker, UNC Charlotte Police, 704-687-8300, jbaker88@uncc.edu

Henry James, Associate Vice Chancellor for Risk Management, Safety & Security, UNC Charlotte, 704-687-8454, 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

Heidi Preuss, Environmental Policy Administrator, Mecklenburg County, 704-336-5597, Heidi.Pruess@mecklenburgcountync.gov

Seth Norris, Director Environmental Health, Safety, and Emergency Management, Appalachian State University, 828-262-8081, norrissa@appstate.edu

Guenther Hartfeil, BB&T, Head of Information Management, ghartfeil@BBandT.com

David Joffe, Quantitative Research Executive, Bank of America, david.n.joffe@bankofamerica.com

Michael Bess, Critical Infrastructure Protection, Charlotte-Mecklenburg Police Dept., 704-614-2610, mbess@cmpd.org

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 Joint work on graffiti image retrieval

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

VACCINE Annual Report – Year 4

Please complete **ALL** fields.
This form must be emailed to Mary Padget at padget@purdue.edu **by July 15, 2013.**
If any item does not apply to your project, please indicate "NA" under the heading.

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. William Ribarsky, Xiaoyu Wang, Wenwen Dou, and William Tolone. Towards a Visual Analytics Framework for Handling Complex Business Processes. Submitted to HICSS 2014.

Accepted:

1. Xiaoyu Wang, Wenwen Dou, Zhiqiang Ma, Li Yu, and William Ribarsky. Hierarchical Topics: Visually Exploring Large Text Collections Using Topic Hierarchies. To be published, IEEE Transactions on Visualization and Computer Graphics (VAST 2013).
2. Xiaoyu Wang, Dong Jeong, Remco Chang, Arun Pinto, and William Ribarsky. RiskVA: A Visual Analytics System for Consumer Credit Risk Analysis. Tsinghua Science and Technology: Special Issue on Visualization and Computer Graphics, Vol. 17(4), pp. 440-451 (2012).
3. Jack Guest, KR Subramanian, and William Ribarsky. Visual Analysis of Situationally Aware Building Evacuations. SPIE Visualization and Data Analysis (VDA 2013).
4. Jack Guest, KR Subramanian, and William Ribarsky. Large Scale Situationally Aware Building Evacuation. To be published. Information Visualization Journal.
5. Xiaoyu Wang, Zhiqiang Ma, Wenwen Dou, and William Ribarsky. Discover Diamonds-in-the-Rough using Interactive Visual Analytics System: Tweets as a Collective Diary of the Occupy Movement. Accepted for publication. IEEE SocMedVis 2013.
6. Wenwen Dou, Xiaoyu Wang, Drew Skau, and William Ribarsky. LeadLine: Interactive Visual Analysis of Text Data through Event Identification and Exploration. Proceeding of IEEE VAST 2012, pp. 93-102.

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, *Keynote Speaker*, "Analytics and the Textual World," Workshop on Interactive Visual Text Analytics, IEEE VisWeek 2012 (October, 2012).
2. William Ribarsky, Invited Speaker, "Texts and Big Data Analytics," Clemson University (November, 2012)
3. William Ribarsky, Invited Speaker, "Social Media Analysis as Social History," University of Indiana (April, 2013).
4. William Ribarsky, Keynote Address, "Visual Analytics for Competitive Advantage," EG EuroVA 2013 (June, 2013).

Patents/Copyrights (List names)

Applications:

Awarded:

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Summary of Outcomes and Impact of Project

- We developed very general text and event (location, time) 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. To demonstrate the ability of the combined tools, we
- We have developed a full narrative of the Occupy Wall Street Movement (via Twitter analysis) including all events of any import over its whole history. This provides not only events and topics, but organized discussion around each event and topic. See the "Diamond in the Rough" paper for details.
- We have collected and integrated a large amount of infrastructure data for North and South Carolina (electrical, water, roads, key buildings, etc.). We are running ensembles of simulations for different hurricane paths with a distribution of widths, strengths, and detailed paths. This permits a probabilistic analysis of outcomes and identification of parts of the infrastructure plus key served components (e.g., schools, hospitals, etc.) that are most at risk. We have developed a set of visual interfaces that run on a range of devices, including iPads. The goal is to provide emergency responders or planners at any level a picture of what will happen, when it will happen, and at what locations. We have started integrating data from the food distribution network models of Shaun Kennedy, permitting modeling of disruptions to that network.

Impact or success story associated with project

- We carried out a large joint exercise in late Summer, 2012 that combined the capabilities of both our mobile emergency response system and the real- time evacuation simulation and decision support system. A high-rise building, the 12 story Atkins library, is the site for this exercise. This exercise was carried out with the UNC Charlotte Police SWAT team and got extensive press coverage.
- We are making the complete set of critical infrastructure data for North and South Carolina available to both German and American VASA partners.
- Using the modeling environment we have set up for VASA, we have continued 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.
- With our college and the College of Business, we have developed a MS Certificate in Data Science and Business Analytics. Examples from this project will be used in the certificate courses.

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,